NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

October 1, 1987 - December 31, 1987

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APPENDIX A. List of Reprints Received, October - December 1987

A. TELESCOPE USAGE

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

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1866.25	1929.50	1769.00	1439.8
Scheduled maintenance and equipment changes	132.00	102.25	77.75	365.0
Scheduled tests and calibrations	99.75	92.25	292.45	347.3
Time lost	50.00	123.25	237.75	-
Actual Observing	1816.25	1806.25	1531.25	1334.7

B. 140-FT OBSERVING PROGRAMS

The following continuum program was conducted during this quarter.

No.	Observer(s)	Program
L-277	Liszt, H. Braun, R. Lockman, F. J.	Mapping at 1400 MHz the HII region IC 410.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A-086	Albert, C. (USNA) Blades, J. (STScI) Morton, D. (Herzberg) Lockman, F. J.	Observations of HI combined with an optical study of the Galactic Halo.
B-464	Batrla, W. (Illinois) Henkel, C. (MPIR, Bonn)	Observations at 5 cm of extraglactic OH Masers.
B-471	Baan, W. (Arecibo) Haschick, A. (Haystack) Henkel, C. (MPIR, Bonn)	Observations at 18 cm for OH in selected IRAS galaxies.
B-479	Batrla, W. (Illinois) Menten, K. (MPIR, Bonn)	Search at 12.2 GHz for methanol maser emission from OH megamaser galaxies.

No.	Observer(s)	Program
B-482	Baan, W. (Arecibo) Gusten, R. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Wilson, T. (MPIR, Bonn)	Observations at 2 cm of H_2CO in external galaxies.
B-483	Baan, W. (Arecibo) Haschick, A. (Haystack) Henkel, C. (MPIR, Bonn)	Observations at 2.5 cm of methanol in megamaser galaxies.
D-157	Danly, L. (Wisconsin) Savage, B. (Wisconsin) Lockman, F. J.	Observations of HI toward galactic halo stars.
D-158	Danly, L. (Wisconsin) Shull, J. M. (Colorado) Van Steenberg, M. (Colorado)	Observations of the anticenter HI shell.
E-054	Elvis, M. (CFA) Wilkes, B. (CFA) Lockman, F. J.	Observations at 21 cm of X-ray spectra of QSOs.
G-303	Goss, W. M. Yusef-Zadeh, F. (Goddard) Anantharamaiah, K.	Observations of 2 cm recombination lines toward 3C 391.
I-005	Irvine, W. (Massachusetts) Friberg, P. (Chalmers) Hjalmarson, A. (Chalmers) Madden, S. (Massachusetts) Ziurys, L. (Massachusetts) Turner, B.	Observations at 1.5 cm of molecular clouds, particularly the cold clouds TMC-1 and L134N.
I-007	Impey, C. (Arizona) Bothun, G. (Michigan)	Observations of hydrogen toward Malin 1; a huge low surface brightness galaxy.
I-009	Irvine, W. (Massachusetts) Friberg, P. (Chalmers) Matthews, H. (Herzberg) Minh, Y. (Massachusetts)	Observations over the wavelength range 1.19 to 1.34 cm of sulfur-containing organic molecules in cold dark clouds.
L-218	Lockman, F. J.	Observations at high-latitude galactic positions of spectra exhibiting several peculiar HI features.

No.	Observer(s)	Program
M-273	Matthews, H. (Herzberg) Avery, L. (Herzberg) Bell, M. (Herzberg) Feldman, P. (Herzberg)	Survey of the properties of interstellar C_2S and C_3S at 1.3 and 2.7 cm.
O-037	Odenwald, S. (NRL) Lockman, F. J.	Observations of HI in cometary infrared clouds.
P-142	Payne, H. Anantharamaiah, K.	Observations of Cas A at 327 MHz for H and C recombination lines.
T-235	Turner, B. Lanping, X. (Beijing) Rickard, L. J (Applied Research)	Observations at 18.3 GHz for C_3H_2 in IRAS/Cirrus clouds.
V-063	Verschuur, G. (unaffiliated)	Observations of the 21 cm Zeeman effect.
Y-003	Yusef-Zadeh, F. (Goddard) Anantharamaiah, K.	Observations at 2 cm of recombination lines from the galactic center region.
Y-004	Yusef-Zadeh, F. (Goddard) Anantharamaiah, K.	Observations at 2 cm of H76α recombinations lines in the outer regions of M42.

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 at 1400 MHz 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:

B - Effelsburg, MPIR 1000 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 25 m
Km - Haystack 120 ft
Lm - Medicina 32m
N - NRL Maryland PT 85 ft
O - Owens Valley 130 ft
Sa - Shanghai 25 m
So - Onsala 25 m
Wn - Westerbork n=1-14x26 m
Yn - Socorro n=1-27x35 m

No.	Observer(s)	Program
A-017V	Alef, W. (MPIR, Bonn) Preuss, E. (MPIR, Bonn)	Studies at 6 cm of the structural variability in 3C 390.3 and 3C 111, with telescopes B, G, Lm, So, and Yn.
F-015V	Fix, J. (Iowa) Mutel, R. (Iowa)	High spectral resolution observations at 18 cm of OH/IR stars, with telescopes G, Km, O, and Yn.
G-051V	Gurvits, L. (IFSR, USSR) Kardashev, N. (IFSR, USSR) Pauliny-Toth, I. (MPIR, Bonn) Popov, M. (IFSR, USSR) Schilizzi, R. (NFRA) Kellermann, K.	Observations at 6 cm of the radio structure of quasars which are ten times younger than the universe, with telescopes B, G, Km, Lm, O, So, Wn, and Yn.
G-054V	Gwinn, C. (CFA) Bartel, N. (CFA) Cordes, J. (Cornell) Mutel, R. (Iowa) Wolszczan, A. (Arecibo)	Observations at 92 cm for pulsar interstellar scattering, with telescopes A, F, G, I, Jb, Km, N, O, and Wn.
G-056V	Ghosh, T. (TATA) Ananthakrishnan, S. (TIFR) Pramesh Rao, A. (TIFR) Simon, R. (NRL)	Observations at 18 and 92 cm of low frequency variables, with telescopes B, F, G, H, I, Jb, Km, Lm, N, O, and Yn.
H-032V	Hewitt, J. (Haystack) Burke, B. (MIT) Lawrence, C. (Caltech) Schneider, D. (Inst. for Adv. Studies) Turner, E. (Princeton)	Observations at 18 cm of gravitational lens candidate 1042+178, with telescopes F, G, Km, O, and Yn.
H-036V	Hooimeyer, J. (Leiden) Barthel, P. (Caltech) Schilizzi, R. (NFRA)	Observations at 6 cm for superluminal motion in two large quasars with telescopes B, G, Km, Lm, O, So, Wn, and Yn.
M-080V	Marscher, A. (Boston) Bartel, N. (CFA) Padrielli, L. (Bologna) Rickett, B. (San Diego) Romney, J.	Observations at 18 cm of the low frequency variable NRAO 140, with telescopes B, F, G, H, I, Km, Lm, O, and Yn.

No.	Observer(s)	Program
M-091V	Moran, J. (CFA) Baan, W. (Arecibo) Greenhill, L. (CFA) Haschick, A. (Haystack) Hirabayashi, H. (NRO) Gong, Li (Shanghai) Gwinn, C. (CFA) Reid, M. (CFA) Tongshan, W. (Shanghai) Xing-Wu, Z. (Shanghai) Zhihan, Q. (Shanghai)	Measurements at 18 cm of the angular size of five OH masers, with telescopes G, Km, Sa, and O.
P-078V	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.	Monitor of the structural changes at 18 cm of sources showing low frequency variability, with telescopes B, F, G, Jb, Lm, N, O, and So.
R-238V	Rand, R. (Caltech) Backer, D. (Berkeley) Cohen, M. (Caltech) Cordes, J. (Cornell) Gwinn, C. (CFA) Kulkarni, S. (Caltech) Lyne, A. (Manchester) Readhead, A. (Caltech)	Observations at 327 MHz of interstellar scattered radio sources, with telescopes F, G, H, Jb, and O.
S-054V	Schalinski, C. (MPIR, Bonn) Eckart, A. (MPIR, Bonn) Johnston, K. (NRL) Krichbaum, T. (MPIR, Bonn) Simon, R. (NRL)	Observations at 92 cm for subarcsecond jet structures in four S5 sources, with telescopes G, H, Jb, Km, N, O, and Wn.
W-047V	Wilkinson, P. (Manchester)	Global network observation at 18 cm of M82, with telescopes B, G, Jb, Km, Lm, O, Wn, and Yn.
X-045V	Briggs, F. (Pittsburgh)	Observations at 92 cm of 0458-02, with telescopes G, H, I, Jb, Km, N, O, So, Wn, and Yn.
X-053V	Geldzahler, B. (NRL)	Observations at 18 cm of a selected source to determine whether fringes are detectable on a GB to Yn baseline.

C. 300-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
C-238	Condon, J. Broderick, J. (VPI & SU) Seielstad, G.	Observations at 4.8 GHz sky survey covering $-2° < \delta < +77°$.
D-155	Dennison, B. (VPI & SU) Fiedler, R. (NRL) Johnston, K. (NRL) Simon, R. (NRL)	A patrol survey at 2.7 GHz for occultation events.

D. 12-M OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observers	Programs
A-85	Adler, D. (Virginia) Liszt, H. Roberts, W. (Virginia)	Study of the distribution of molecular clouds in spiral galaxies.
B-487	Batrla, W. (Illinois) Jewell, P. Snyder, L. (Illinois)	Search for 3 mm lines of methylamine in galacatic sources.
B-489	Butner, H. (Texas) Loren, R. (Texas)	High resolution mapping of cold dense cores.
B-490	Bregman, J. Hogg, D.	Study of star formation in cooling flow elliptical galaxies.
B-491	Band, D. (Berkeley) Gordon, M.	Study of SS433 and nearby sources.
D-159	Dent, W. (Massachusetts) Balonek, T. (Colgate) Christensen, J. (Colgate)	Study of the evolution of extragalactic radio sources at millimeter wavelengths.
F-100	Fabian, A. (Cambridge) Lasenby, A. (Cambridge) Lasenby, J. (Cambridge) Green, D. (Cambridge)	Observations to detect the 3.06 m FeXXIV line in the hot gas of the Perseus Cluster.
F-101	Fuller, G. (Berkeley) Myers, P. (CFA)	CS observations of starless cores.

No.	Observer(s)	Program
G-294	Gordon, M.	Survey of 3 mm recombination lines from selected HII regions.
G-297	Grabelsky, D. (Northwestern) Ulmer, M. (Northwestern)	Search for CO (J=2-1) emission from cD galaxies at the centers of cooling flows.
G-301	Gordon, M.	Measurements of 1.3 mm dust continuum in Cepheus OB3.
H-232	Hollis, J. M. (Goddard) Lovas, F. (NBS, Maryland) Stevens, W. (NBS, Maryland)	Search for the first transition of interstellar SiC.
H-238	Hunter, D. (Arizona State) Thronson, H. (Wyoming)	CO observations of small galactic HII regions.
H-241	Henkel, C. (MPIR, Bonn) Jacq, T. (Bordeaux, France) Walmsley, C. M. (MPIR, Bonn) Baudry, A. (Bordeaux, France) Jewell, P.	Study of $H_2{}^{18}O$ in compact cores.
K-306	Kutner, M. (Rensselaer) Evans, N. (Texas) Mead, K. (NRL) Natta, A. (Arcetri)	A study of high density structures in bipolar flows.
K-309	Koo, B-C. (Berkeley) Heiles, C. (Berkeley)	CO (J=1-0) study of neutral stellar winds in HH7-11 and L1551.
L-208	Lubowich, D. (Hofstra, NY) Turner, B.	Observations of lithium nucleosynthesis: LiOH in the galactic center.
L-209	Lubowich, D. (Hofstra, NY) Turner, B.	Observational tests of deuterium nucleosynthesis: DCO^+ and DCN in the shocked molecular cloud associated with the IC 443 SNR.
M-271	McCutcheon, W. (CSIRO) Purton, C. (DRAO, Canada) Dewdney, P. (DRAO, Canada) Hutter, J. (British Columbia)	CO observations of selected infrared sources.
M-275	Mozurkewich, D. (NRL) Schwartz, P. (NRL)	Study of low luminosity, broad wing sources.

No.	Observer(s)	Program
M-276	Martin, R. (Arizona) Walker, C. (Arizona) Miller, R. (Bell Labs)	Engineering tests of a 345 GHz SIS receiver.
P-139	Pompea, S. (Arizona) Reike, G. (Arizona)	Study of inhibition of starburst in Sa galaxies.
P-140	Phillips, J. (Queen Mary College) Mampaso, A. (Laguna, Spain)	J=2-1 CO observations of bipolar outflow sources.
S-313	Kerr, F. (Maryland) Salter, C. (unaffiliated) Sinha, R. (ST Systems) Emerson, D. Stobie, E. Hobbs, R. (Comp. Tech. Assoc.)	90 and 230 GHz observation of the galactic center.
S-316	Scoville, N. (Caltech) Sanders, D. (Caltech) Soifer, B. (Caltech)	CO observations (maps) of intermediate luminosity IRAS galaxies.
S-317	Sanders, D. (Caltech) Scoville, N. (Caltech) Soifer, B. (Caltech) Tinney, C. (Caltech)	CO observations of infrared quasars.
T-231	Turner, B.	Search for phosphorus compounds PH3 and HCP.
V-54	Kutner, M. (Rensselaer) Verter, F. (Goddard)	Completion of study of arm-interarm contrast in M51.
V-61	Vallee, J. (Herzberg) MacLeod, J. (Herzberg)	Descent into neutral interfaces within molecular cloud edges (near blistering HII regions).
V-64	Vallee, J. (Herzberg) Avery, L. (Herzberg)	Study of star formation in the nearest molecular clouds.
W-234	Wootten, H. A. Loren, R. (Texas)	SO_2 cores in the Rho Oph cloud: Harbingers of star formation?
W-235	Walker, C. (Arizona) Lada, C. (Arizona) Young, E. (Arizona)	Study of 1.3 mm thermal dust emission in cold molecular cloud cores.

No.	Observer(s)	Program
W-246	Wootten, H. A. Combes, F. (Meudon) Encrenaz, T. (Meudon) Gerin, M. (Meudon)	Preliminary search for acetic acid in the interstellar medium.

E. VLA OBSERVING PROGRAMS

Third quarter, 1987 was spent in the following configurations:

A configuration from September 1 to October 12
A/B configuration from October 12 to November 12
B configuration from November 12 to December 31.

The following 147 research programs were conducted with the VLA during this quarter.

No.	Observer	Program
AA-68	Anantharamaiah, K. Radhakrishnan, V. (Raman) Shukre, C. (Raman)	Positronium recombination lines. 6 and 20 cm.
AA-76	Anantharamaiah, K. Narayan, R. (Steward Obs.)	Scattering in the inner galaxy. 20 and 90 cm.
AB-401	Baum, S. (NFRA) O'Dea, C. (NFRA)	Search for OH absorption in 3C 84. 18 cm line.
AB-408	Bookbinder, J. (Colorado) Caillault, J. (Colorado) Gary, D. (Caltech) Giampapa, M. (Nat. Solar Obs.) Golub, L. (SAO) Linsky, J. (Colorado) Gibson, D. (MIT-Lincoln Lab)	A first-epoch, volume-limited, multifrequency survey of M dwarf stars. 1.3, 2, 6, and 20 cm.
AB-414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring radio flux of HD 193793 and P Cygni. 2 and 6 cm.
AB-434	Braun, R. Perley, R. Gull, S. (Cambridge) Rudnick, L. (Minnesota)	Physical processes in Cassiopeia A. 2, 6, and 20 cm.
AB-440	Brown, R.	Extended structure of 0235+164. 18 and 20 cm.

No.	Observer(s)	Program
AB-441	Bastian, T. Dulk, G. (Colorado) Walter, F. (Colorado) Bookbinder, J. (Colorado)	Radio emission from post-common envelope binaries. 2, 6, and 20 cm.
AB-444	Barsony, M. (Caltech)	Imaging of S87 over 3 orders of magnitude in spatial scale. 2, 6, and 18 cm.
AB-447	Barthel, P. (Caltech)	Radio spectra of very high redshift quasars. 1.3, 2, 6, 18, 20, and 90 cm.
AB-454	Bridle, A. Browne, I. (NRAL) Burns, J. (New Mexico) Dreher, J. (MIT) Hough, D. (JPL) Laing, R. (RGO) Lonsdale, C. (Haystack) Scheuer, P. (Cavendish Lab) Wardle, J. (Brandeis)	Sidedness in jets in high luminosity sources. 6 cm.
AB-456	Burke, B. (MIT) Hewitt, J. (Haystack) Roberts, D. (Brandeis)	Time variation of 0957+561 A,B. 6 cm.
AB-457	Brown, A. (Colorado) Bookbinder, J. (Colorado)	Parallax of T Tauri. 6 cm.
AB-460	Benz, A. (ETH) Gudel, M. (ETH)	Radio observations of dwarf novae. 6 and 18 cm.
AB-461	Benz, A. (ETH) Gudel, M. (ETH)	Broadband radio observations of the quiescent emission of a flare star. 1.3, 2, 6, 18, 20, and 90 cm.
AB-462	Bandiera, R. (Arcetri) Brinks, E. (RGO)	Optical knots in Kepler's SNR. 6 cm.
AB-463	Brinks, E. (RGO) Pagel, B. (RGO) Terlevich, R. (RGO)	High resolution HI observations of NGC 5253 and NGC 5408. 20 cm line.
AB-464	Bally, J. (Bell Labs) Yusef-Zadeh, F. (Goddard)	Cometary source G359.2-0.8. 2, 6, and 20 cm.
AB-465	Bally, J. (Bell Labs) Forrest, W. (Rochester) Fulbright, H. (Rochester)	HI in high velocity bipolar flows. 20 cm line.

No.	Observer(s)	Program
AB-466	Bietenholz, M. (Toronto) Kronberg, P. (Toronto)	High resolution studies of the Crab Nebula. 6 and 20 cm.
AC-173	Cameron, R. (Mt. Stromlo) Parma, P. (Bologna) de Ruiter, H. (Bologna)	PKS 2149-158, a binary radio jet system. 6, 18 and 21 cm.
AC-176	Crane, P. Dahari, O. (STScI) Ford, H. (STScI) Jacoby, G. (NOAO) Ciardullo, R. (STScI)	Anomalous spiral arms of NGC 4258. 20 cm.
AC-187	Campbell, B. (New Mexico) Simon, M. (Stony Brook)	Outflow young stellar objects. 2 and 6 cm.
AC-188	Campbell, B. (New Mexico) Stocke, J. (Colorado)	Inner disk and jet structure in L1551 IRS 5. 1.3, 2 and 6 cm.
AC-200	Cohen, N. (Boston) Falco, E. (CFA)	Overluminous radio galaxies as gravitational lens candidates: 3C 13. 6 cm.
AC-205	Condon, J. Helou, G. (IPAC) Sanders, D. (Caltech) Soifer, B. (Caltech)	IRAS bright galaxy sample. 20 cm.
AC-206	Chanmugam, G. (Louisiana State) Dulk, G. (Colorado) Bastian, T.	Radio observations of magnetic cataclysmic variable stars: AE Agr. 2, 3, and 6 cm.
AC-207	Cornwell, T. Yusef-Zadeh, F. (Goddard)	Follow-up AF-137 observations of a unique HH object. 6 and 20 cm.
AC-208	Caganoff, S. (Mt. Stromlo) Bicknell, G. (Mt. Stromlo) Ekers, R.	A grab bag of southern sources. 20 cm.
AC-219	Cordova, F. (Los Alamos) Mason, K. (Mullard) Hjellming, R.	Soft X-ray source 0656+14. 20 cm.
AD-160	de Pater, I. (Berkeley)	Jupiter patrol. 6 and 20 cm.
AD-184	Drake, S. (SASC Tech) Reimers, D. (Hamburg) Brown, A. (Colorado)	Zeta Aurigae and similar binaries containing B dwarf secondaries. 2 and 6 cm.

No.	Observer(s)	Program
AD-188	Drake, S. (SASC Tech) Florkowski, D. (USNO) Simon, T. (Hawaii) Stencel, R. (Colorado) Bookbinder, J. (Colorado) Linsky, J. (Colorado)	Variability of emission in supergiants: Alpha Ori, Alpha Her, Alpha Sco. 2 and 6 cm.
AD-203	Drake, S. (SASC Tech) Linsky, J. (Colorado)	Are warm supergiants radio continuum sources? Survey of B2-F8 I stars. 6 cm.
AD-204	Duric, N. (New Mexico) Dittmar, M. (New Mexico) Crane, P.	Multifrequency scaled array study of four normal spiral galaxies. 20 cm.
AD-206	de Pater, I. (Berkeley) Dickel, J. (Illinois)	Saturn. 2 cm.
AD-208	Duric, N. (New Mexico) Morisette, K. (New Mexico)	SNRs in M33. 20 cm.
AD-209	Dickel, H. (Illinois) Goss, W. M. van Breugel, W. (Berkeley)	H_2CO absorption and H76α study of NGC 6334. 6 cm line.
AE-50	Ekers, R. Morris, M. (UCLA) Yusef-Zadeh, F. (Goddard)	Sgr A west. 1.3 and 2 cm.
AE-51	Elitzur, M. (Kentucky) Hollis, J. M. (Goddard) Michalitsianos, A. (Goddard) Kafatos, M. (George Mason)	Search for continuum emission at the SiO Maser position in R Aquarii. 2 cm.
AF-137	Feigelson, E. (Penn State) Montmerle, T. (CEN Saclay) Andre, P. (CEN Saclay)	Monitoring radio flaring stars in the Rho Oph cloud. 2, 6, and 20 cm.
AF-146	Fabbiano, G. (CFA) Gioia, I. (CFA)	High resolution observations of early-type galaxies observed in X-rays with the Einstein Observatory. 6 cm.
AF-147	Fanti, C. (Bologna) Fanti, R. (Bologna) Parma, P. (Bologna) Schilizzi, R. (NFRA) Spencer, R. (NRAL) van Breugel, W. (Berkeley)	Search for extended structure associated with CSS radio sources. 20 cm.

No.	Observer(s)	Program
AF-148	Feldman, P. (Herzberg) Van Horn, H. (Rochester)	Observations of nearby cool, strongly convective white dwarfs. 6 cm.
AF-150	Frail, D. (Toronto) Cordes, J. (Cornell) Seaquist, E. (Toronto) Weisberg, J. (Carleton)	Astrometry of pulsars in the inner galaxy. 20 cm.
AF-151	Frail, D. (Toronto) Cordes, J. (Cornell) Hankins, T. (Dartmouth) Weisberg, J. (Carleton) Seaquist, E. (Toronto)	Neutral hydrogen absorption measurements of distant pulsars in the inner galaxy. 20 cm line.
AF-152	Feigelson, E. (Penn State)	Mapping of the radio galaxy PKS 0745-191. 2, 6 and 20 cm.
AG-145	Geldzahler, B. (NRL) Schwartz, P. (NRL) Gear, W. (Royal Obs.) Ade, P. (Queen Mary College) Robson, E. (Lancashire Polytechnic) Nolt, I. (Oregon) Smith, M. (Royal Obs.)	Simultaneous multifrequency observations of blazars. 1.3, 2, 6, 20, and 90 cm.
AG-247	Garrington, S. (NRAL) Laing, R. (RGO) Leahy, J. (NRAL) Conway, R. (NRAL)	Origin of depolarization asymmetry. 6, 18 and 20 cm.
AG-248	Giovannini, G. (Bologna) Feretti, L. (Bologna) Venturi, T. (Bologna)	Low frequency observations of NGC 4869. 90 cm.
AG-252	Goss, W. M. Viallefond, F. Boulanger, F. (Caltech) Peimbert, M. (UNAM)	Survey of the spiral M101. 90 cm.
AG-254	Gaume, R. (NRL) Claussen, M. (Massachusetts)	The rotating molecular envelope of Sgr B2 F. 2 cm line.
AH-254	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Calgary) Seaquist, E. (Toronto)	Three pre-1987 and bright 1987 novae. 1.3, 2, 6, and 20 cm.

No.	Observer(s)	Program
AH-271	Hill, G. (Hawaii) Lilly, S. (Hawaii) Stockton, A. (Hawaii)	Radio source population at z = 0.5. 20 cm.
AH-277	Helfand, D. (Columbia) Backer, D. (Berkeley) Becker, R. (Calif., Davis)	Search for millisecond pulsars in globular clusters. 20 and 90 cm.
AH-278	Hewitt, J. (Haystack) Turner, E. (Princeton) Burke, B. (MIT)	The unusual ring-shaped source 1129+052: What is it? 1.3 and 2 cm.
AH-287	Hewitt, J. (Haystack) Burke, B. (MIT) Turner, E. (Princeton)	The gravitational lens candidate 1042+178. 2 and 6 cm.
AH-288	Hjellming, R. Johnston, K. (NRL)	Search for radio spectra typical of conical jets in X-ray binaries: LSI degrees 303. 1.3, 2, 6, 18 and 20 61 cm.
AH-289	Hjellming, R. Bastian, T. Dulk, G. (Colorado)	Search for emission from He star CCV's, the AM CVn binaries. 2, 6, and 20 cm.
AH-291	Hutchings, J. (DAO) Neff, S. (Goddard) Gower, A. (Victoria)	Radio galaxies at z < 1.0; comparison with radio quasars. 6 and 20 cm.
AH-293	Hanisch, R. (STScI) Miley, G. (STScI)	The rich X-ray cluster Abell 2256. 20 and 90 cm.
AI-32	Inoue, M. (Nobeyama) Kato, T. (Utsunomiya) Tabara, H. (Utsunomiya) Aizu, K. (Rikkyo)	Large rotation measure source Hyd A. 2 and 6 cm.
AJ-131	Johnston, K. (NRL) Florkowski, D. (USNO) de Vegt, C. (Hamburg) Wade, C.	Parallax of the nearby stars UX Ari and HR 5110. 6 cm.
AJ-160	Joshi, M. (TIFR) Bagchi, J. (TIFR) Kapahi, V.	Spectral index mapping of very steep spectrum sources in clusters. 90 cm.
AK-151	Kundu, M. (Maryland) Jackson, P. (Maryland) White, S. (Maryland)	Narrowband flares on red dwarf stars. 6 and 20 cm.

No.	Observer(s)	Program
AK-177	Kronberg, P. (Toronto) Sramek, R.	Monitoring M82. 1.3 and 2 cm.
AK-180	Kronberg, P. (Toronto) Zukowski, E. (Toronto)	Rotation measure maps of three radio-extended quasars. 2 cm.
AK-182	Kundu, M. (Maryland) Schmahl, E. (Maryland) White, S. (Maryland) Nitta, N. (Maryland)	Coronal magnetic structures. 6 and 20 cm.
AK-184	Kazes, I. (Meudon) Mirabel, F. (IAP, Argentina) Dickey, J. (Minnesota)	OH and continuum observations of two megamaser galaxies. 2, 6, and 20 cm line.
AK-185	Kapahi, V. Subrahmanya, C. (TIFR)	Quasars from the Molongo reference catalog. 6 and 20 cm.
AK-187	Kronberg, P. (Toronto) Wolfe, A. (Pittsburgh/Mt. Wilson) Briggs, F. (Pittsburgh)	Faraday rotation mapping of the unusual strong absorption-line quasar, P0458-02. 1.3, 2, and 6 cm.
AK-188	Kulkarni, S. (Caltech) Rand, R. (Caltech) Goss, W. M.	Deep imaging of globular clusters. 20 cm.
AK-189	Kundu, M. (Maryland) Shevgaonkar, R. (Maryland)	Simultaneous observations of dMe flare stars. 20 and 90 cm.
AK-191	Knapp, G. (Princeton) Jura, M. (UCLA) van Gorkom, J. Kim, D. (UCLA) Guhathakurta, P. (Princeton)	Mapping and measuring the spectrum of the continuum emission from the elliptical galaxies NGC 5018 and NGC 2974. 1.3, 4, 3.6, 20, and 90 cm.
AL-140	Lestrade, J-P. (JPL) Preston, R. (JPL) Mutel, R. (Iowa) Boloh, L. (CNES) Charlot, P. (IGN)	Search for compact extragalactic sources near RS CVn stars. 6 and 90 cm.
AL-146	Leahy, J. (NRAL) Perley, R.	Bridges in nearby 3C sources. 20 and 90 cm.
AL-150	Lestrade, J. (JPL) Preston, R. (JPL)	Statistical properties of RS CVn stars. 6 cm.
AL-156	Lind, K. van Breugel, W. (Berkeley)	An edge-brightened jet in PKS 0623-206. 6 cm.

No.	Observer(s)	Program
AL-161	Lang, K. (Tufts) Willson, R. (Tufts)	Compact transient sources on the sun. 2, 6 and 20 cm.
AL-163	Lang, K. (Tufts) Willson, R. (Tufts) Strong, K. (Lockheed-SMM/XRP) Holmon, G. (Goddard)	Simultaneous SMM and VLA observations of coronal loops. 6 and 20 cm.
AL-164	Lonsdale, C. (Haystack) Muxlow, T. (NRAL) Barthel, P. (Caltech)	Double hotspots. 6 cm.
AM-193	Migenes, V. (Pennsylvania) Johnston, K. (NRL) Pauls, T. (NRL) Norris, R. (CSIRO) Wilson, T. (MPIR, Bonn)	Masers in OMC-1. 1.3 and 18 cm line.
AM-217	Morris, D. (Iowa) Mutel, R. (Iowa)	Radio emission in RS CVn binaries and comparable single stars. 6 cm.
AM-219	Menon, T. (British Columbia) Hickson, P. (British Columbia)	Structure of compact group galaxies. 20 cm.
AM-221	Morganti, R. (Bologna) Fanti, C. (Bologna) Fanti, R. (Bologna) Parma, P. (Bologna) de Ruiter, H. (Bologna)	Jets in low luminosity radio galaxies. 6 cm.
AM-222	Morganti, R. (Bologna) de Ruiter, H. (Bologna) Fanti, R. (Bologna) Parma, P. (Bologna) Ferrari, A. (Torino) Massaglia, S. (Torino) Trussoni, E. (Torino)	Knots in low luminosity radio galaxy jets. 6 cm.
AM-224	McCarthy, P. (Berkeley) van Breugel, W. (Berkeley) Spinrad, H. (Berkeley)	Radio properties of Lyman Alpha Proto-Galaxies. 2, 6, and 20 cm.
AN-46	Narayan, R. (Steward Obs.) Cornwell, T. Anantharamaiah, K.	High time-resolution imaging of a scatter-broadened radio source. 6, 20 and 90 cm.
AO-74	O'Dea, C. (NFRA) Baum, S. (NFRA) Killeen, N. (Illinois)	Giant galaxies in accretion flows. 2 cm.

No.	Observer(s)	Program
AO-76	O'Dea, C. (NFRA) Gregorini, L. (Bologna) Feretti, L. (Bologna) Giovannini, G. (Bologna)	Complex radio emission in Abell 568. 6 cm.
AP-131	Pauls, T. (NRL) Schwartz, P. (NRL) Johnston, K. (NRL)	Positronium recombination lines toward Sgr A. 6 cm line.
AP-135	Perley, R.	Rotation measure of 3C 295. 2 and 6 cm.
AP-142	Pedlar, A. (NRAL) Saikia, D. (NRAL) Unger, S. (RGO) Whittle, M. (Virginia)	Polarization observations of Seyfert nuclei. 2 cm.
AP-145	Phillips, J. (Queen Mary College) Mampaso, A. (IAC) Zijlstra, A.	Core mapping of Type I planetary nebulae. 2 and 6 cm.
AP-151	Pedlar, A. (NRAL) Anantharamaiah, K. van Gorkom, J. Ekers, R.	Continuum image of the galactic center. 90 cm.
AP-152	Preston, R. (JPL) Purcell, G. (JPL) Ulvestad, J. (JPL) Jones, D. (JPL) Linfield, R. (JPL)	Phobos lander VLBI reference sources. 6 cm single antenna VLB.
AR-160	Roeser, H. (MPIA, Heidelberg) Perley, R.	Pictor A. 2, 6, and 20 cm.
AR-162	Rodriguez, L. (UNAM) Mendoza, E. (UNAM)	Radio continuum from T Tauri stars with large u-filter excesses. 6 cm.
AR-166	Roeser, H. (MPIA, Heidelberg) Perley, R. Meisenheimer, K. (MPIA, Heidelberg)	Hotspots, jet and lobes of Pictor A. 2 cm.
AR-167	Roeser, H. (MPIA, Heidelberg) Perley, R. Hiltner, P. (MPIA, Heidelberg) Meisenheimer, K. (MPIA, Heidelberg)	Mapping of optically identified hotspots in classical double radio sources. 2, 6, and 20 cm.

No.	Observer(s)	Program
AR-169	Rudy, D. (UCLA) Muhleman, D. (Caltech) Berge, G. (Caltech) Paige, D. (UCLA)	Polarization studies of Ganymede 22 and Callisto. 2 and 6 cm.
AR-170	Rodriguez, L. (UNAM) Roth, M. (UNAM) Tapia, M. (UNAM) Persi, P. (IAS) Ferrari-Toniolo, M. (IAS)	Spectral index of Cyg OB2 No. 5. 1.3, 2, 6, and 20 cm.
AR-171	Rao, A. (TIFR) Subrahmanyan, R. (TIFR) Narasimha, D. (TIFR) Swarup, G. (TIFR)	High resolution observations of a compact double radio source. 1.3, 2, and 6 cm.
AS-80	Sramek, R. van der Hulst, J. (NFRA) Weiler, K. (NRL)	Supernovae SN1980 in NGC 6946 and SN1979c in M100. 2 cm.
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-271	Seaquist, E. (Toronto) Bell, M. (NRC)	Absorption by H_2CO against the strong nuclear continuum radio sources in Centaurus A. 6 cm line.
AS-286	Stine, P. (Penn State) Weedman, D. (Penn State)	Relationship between radio and IR emission in starburst galaxies. 6 and 20 cm.
AS-293	Sramek, R. Skillman, E. (NFRA)	The SNR in NGC 5471. 2 cm.
AS-294	Strom, R. (NFRA)	A probable neutron star in CTB 80. 6, 20, and 90 cm.
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. 90 cm.
AS-303	Saikia, D. (NRAL) Wiita, P. (Georgia State) Cornwell, T. Junor, W. (NRAL)	Observations of the nearby radio galaxy 1759+211. 6 cm.

No.	Observer(s)	Program
AS-304	Shara, M. (STScI) White, R. (STScI) Becker, R. (Calif., Davis)	Multifrequency mapping of the shell of the old nova Ck Vul. 6 and 20 cm.
AS-309	Sumi, D. (Illinois) Norman, M. (Illinois) Smarr, L. (Illinois)	Structure of cooling inflow galaxies. 2, 6, and 20 cm.
AS-310	Surdej, J. (Liege) Courvoisier, T. (ESO, FRG) Kellermann, K. Kuhr, H. (MPIA, Heidelberg) Magain, P. (ESO, Chile) Refsdal, S. (Hamburg Obs.) Swings, J. (Liege)	The most luminous quasars as gravitationally lensed objects. 2 and 6 cm.
AS-313	Stocke, J. (Colorado) Morris, S. (Mt. Wilson) Maccacaro, T. (CFA) Gioia, I. (CFA)	Search for "radio quiet" BL Lacertae objects and for BL Lacs in clusters. 6 cm.
AS-315	Simon, R. (NRL) Johnston, K. (NRL)	Large scale structure of superluminal sources. 6 cm.
AS-316	Simonetti, J. (VPI & SU) Cordes, J. (Cornell)	Faraday rotation through the molecular cloud L1551. 6 and 20 cm.
AS-320	Schmelz, J. (Goddard) Gonzalez, R. Holman, G. (Goddard) Strong, K. (Lockheed-SMM/XRP)	Coronal magnetic structures observing campaign. 6 and 20 cm.
AT-87	Torbett, M. (Kentucky) Campbell, B. (New Mexico)	Radio emission and morphology of variable stars. 2 and 20 cm.
AT-90	Taylor, A. (Calgary) Waters, L. (Utrecht) Bjorkman, K. (Colorado) Persi, P. (IAS, CNR)	Radio survey of IRAS selected Be stars. 2 cm.
AT-91	Taylor, A. (Calgary) Seaquist, E. (Toronto) Bode, M. (Lancashire Polytechnic)	Hen 1383 - another stellar radio jet. 2, 6, and 20 cm.
AU-27	Umana, G. (Catania) Catalano, S. (Catania) Gibson, D. (MIT, Lincoln Labs)	Survey of nearby Be stars. 2 cm.

No.	Observer(s)	Program
AV-96	van der Hulst, J. (NFRA) Sramek, R. Weiler, K. (NRL)	Radio supernova in NGC 4258. 6 and 20 cm.
AV-146	Viallefond, F. Heydari-Malayeri, M. (ESO, Chile)	HI observations in the low metallicity blue compact galaxy Mk 600. 20 cm line.
AV-150	van Breugel, W. (Berkeley) McCarthy, P. (Berkeley) Heckman, T. (Maryland) Miley, G. (STScI) Baum, S. (NFRA)	Extended line emission in powerful radio galaxies. 2 cm.
AV-151	van Gorkom, J. Knapp, G. (Princeton) Ekers, R.	Search for atomic and molecular gas in elliptical radio galaxies. 6 and 20 cm line.
AV-152	van Buren, D. (STScI) Miley, G. (STScI)	Search for high redshift molecules in absorption. 2, 6, and 20 cm line.
AV-153	van Breugel, W. (Berkeley) McCarthy, P. (Berkeley) Spinrad, H. (Berkeley)	High redshift radio galaxies with extended optical line emission. 2, 6, and 20 cm.
AW-169	Winglee, R. (Colorado) Dulk, G. (Colorado) McKean, M. (Colorado)	Substellar and planet-like companions of nearby stars. 20 and 90 cm.
AW-193	White, S. (Maryland) Kundu, M. (Maryland) Jackson, P. (Maryland)	Further observations of narrow-band flaring on red dwarf stars. 6 and 20 cm.
AW-206	Wolszczan, A. (Arecibo) Kulkarni, S. (Caltech) Cordes, J. (Cornell) Dewey, R. (Cornell) Blaskiewicz, M. (Cornell)	A new millisecond pulsar candidate. 20 cm.
AY-21	Yin, Q. (Peking)	Optical selected clumpy galaxies. 6 and 20 cm.
AY-22	Yun, M. (Harvard) Ho, P. (Harvard) Lo, K. (Illinois)	HI synthesis mapping of M82. 21 cm line.
AZ-31	Zhao, J. (New Mexico) Burns, J. (New Mexico) Owen, F.	Turbulent radio jets in cluster galaxies. 6 and 20 cm.

No.	Observer(s)	Program
AZ-35	Zheng, X. (Nanjing Obs.) Reid, M. (CFA) Birkinshaw, M. (Harvard) Ho, P. (Harvard)	The low frequency characteristics of NGC 6251. 90 cm.
VL-99	Lonsdale, C. (Haystack) Geldzahler, B. (NRL)	0123+633. 18 cm single antenna MK III VLB.
V8631	Briggs, F. (Pittsburg)	Low frequency variable 0605-08. 90 cm single antenna VLB.

F. SCIENTIFIC HIGHLIGHTS

Millimeter Pulsar in M4

The VLA has played an important role in the detection of the second millisecond pulsar to be found in a globular cluster. After researchers at Jodrell Bank identified pulses coming from the general direction of the M4 cluster, the VLA was used at 20 cm to pinpoint the pulsar within the cluster core radius at a radial distance of just 44 arcseconds. The VLA polarization measurements also showed a linear polarization of 31 percent, characteristic of the majority of pulsars. The VLA map of the cluster also fails to show any faint point sources, other than the pulsar, down to levels that are only one-tenth of the pulsar brightness. The null detection implies that the millisecond pulsar luminosity function is not the same as that for slow pulsars.

Investigators: W. M. Goss (NRAO), S. R. Kulkarni (Caltech), and A. Lyne (Jodrell Bank).

High-Redshift Radio Galaxies

The VLA has been systematically used to perform a multi-configuration, multi-frequency survey of a sample of luminous, high-redshift radio sources. The objects were originally selected from the 3C and 4C catalogues on the basis of their ultra-steep radio spectra, which correlates strongly with both redshift and radio luminosity. Radio source morphologies of the sample are not unlike those typical of well-known high luminosity radio sources (Cyg A). However, when compared to optical images of the identifiable radio galaxies (KPNO 2.1 m telescope, R band, CCD frames), the radio sources show an unusually strong tendency to align with their optical counterparts. The relationship is completely opposite to that found in studies of brighter, lower-redshift radio galaxies seen on the Palomar Sky Survey. The observations indicate very conclusively that for distant powerful radio galaxies the optical and radio emission are intimately related. High-redshift radio galaxies may therefore be fundamentally different from their low-redshift counterparts as a result of what might have been a substantially different environment in an epoch of galaxy formation.

Investigators: K. Chambers (Johns Hopkins), G. Miley (STScI), W. van Breugel (Berkeley)

Filaments in Galactic HI

The NRAO Image Storage Unit (ISU) has been used to create a movie of HI absorption in the direction of Cas A. Observations with the B, C, and D arrays made use of the strong background continuum from the supernova remnant in order to illuminate the intervening absorbing gas which lies primarily in the Perseus Arm at a distance of 3 kpc from the sun. At that distance the 3.7 arcsecond resolution corresponds to 0.05 pc. The velocity resolution is 0.6 km/sec. The morphology of the absorbing gas is clearly visible as predominantly filamentary in nature as progressive velocity elements are imaged in the movie sequence. The filaments are typically 0.15 pc x 1.5 pc, with average volume densities of a few 100 cm^{-3}.

Investigators: J. Bieging (Berkeley), W. M. Goss (NRAO), F. Wilcots (Princeton)

The 6 cm Sky

The 300-ft telescope has now produced 6 cm maps of the sky between δ = -2° and +77° on two epochs separated by a year. The seven-feed receiver covers the entire sky twice in 28 observing sessions (24^h each) to an approximate background noise level of 4 mJy rms. The maps are comparable in source density and resolution with the IRAS infrared maps and will be made available as a service to the astronomical community on FITS tapes. Only limited areas have so far been imaged, and no searches for variable sources have been made, although they are planned. The maps will provide a standard reference of the radio sky for many purposes, including: multi-waveband radio identifications of discrete sources, multi-epoch radio variability surveys, detailed studies of very extended radio sources, studies of the isotropy and large-scale homogeneity of the Universe at large redshift, and as a source for "zero spacing" flux densities needed for synthesis maps of extended sources.

Investigators: J. Condon (NRAO), J. Broderick (VPI&SU), and G. Seielstad (NRAO)

G. PUBLICATIONS

Attached as Appendix A is a tabulation of all reprints 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

The Central Development Laboratory delivered three more front-ends this quarter (#24 through #27). Two more (#28 and #29) are ready for shipment; #9 is back for repair, and #30 is being used for testing L-band HEMT amplifiers. These two remaining ones will be shipped during the next quarter.

L-Band Cooled HEMT Amplifier Development

There is a demand for L-band HEMT amplifiers for the VLBA project, use as IF amplifiers for millimeter-wave receivers, and to retrofit the L-band receiver in Green Bank. A test setup to do this is being assembled. During this quarter we will retrofit some existing L-band amplifiers with HEMT's and will also build some new amplifiers for the VLBA project. We hope to produce sufficient amplifiers such that the current and near future demands are met.

23 GHz Cooled HEMT Amplifier Development

This program continues. Thirty-four amplifiers have been constructed to date. One setback has been the discovery that some of the Fujitsu HEMT's from later batches are unusable at cryogenic temperatures. Fortunately, we have sufficient devices from the good batch to meet our needs for the next six months or so. In the meantime, we are getting samples from Fujitsu of new batches for evaluation.

43 GHz Cooled HEMT Amplifier Development

The goal of this work is a cryogenically-cooled, 4- to 6-stage amplifier giving ~ 30 dB gain and 60 K noise temperature in the 42 to 44 GHz range. The key requirement is for a HEMT device which can meet these requirements. Small-width, very high frequency devices received from GE earlier this year had unusually poor cryogenic performance as exhibited by DC characteristics. A new batch is expected by mid-1988.

During this quarter work has been performed in the following areas:

a) Completion of an amplifier test set.
b) Further tests and analysis of a prototype chip test fixture operating at 23 GHz.
c) Completion of the fabrication of a prototype 43 GHz amplifier.
d) Tests of a scale model of the microstrip-to-waveguide transition required by the amplifier.

During the next quarter a room temperature, one-stage amplifier should be tested and some existing HEMT devices will be evaluated.

Hybrid Spectrometer

Work on the digital section of the 1536 channel and 2.4 GHz bandwidth hybrid correlator is complete. It has been shipped to Tucson, and interfacing with the analog section and system testing starts in January 1988.

Superconducting (SIS) Millimeter-Wave Mixer Development

The Nb/Al-Al_2O_3/Nb trilayer process for fabricating superconducting circuits appears to be the best available for millimeter-wave SIS mixers. This process, originally developed at Bell Labs and now in use at Hypres Inc., is being implemented at UVA as part of a collaborative effort with NRAO to develop better SIS mixers. The UVA process is producing excellent trilayer material, as

is evident from the I-V characteristics of test junctions. However, relatively minor but time consuming difficulties in the five lithography steps have delayed the production of useful mixer junctions.

We have designed new mixers for 115 GHz and 230 GHz which will be fabricated by Hypres Inc. using their Nb/Al-Al_2O_3/Nb trilayer process. The seven masks for this process were laid out using the UVA CALMA mask design work station, and sent to Hypres for addition of test patterns, etc. We expect to have the first devices early in 1988.

Another set of new SIS mixers, also for 115 and 230 GHz, has been designed for fabrication by IBM using their Nb/Nb_2O_5/Pb-In-Au edge-junction process. It is IBM junctions of this kind that are now operating on the 12-m telescope at Kitt Peak with noise temperatures of 74 K to 138 K SSB in the better channel and about 20 K higher in the other channel.

A number of SIS mixers failed in the past year from the SIS chip becoming mechanically detached from the main RF substrate. We believe this was due to failure of the gold-to-indium pressure bond. We eventually developed a new mounting method: the SIS chip is soldered in place using low-temperature solder after masking the Pb-In-Au pattern with photoresist to prevent soldering flux dissolving it. With Nb trilayer junctions masking is not necessary and chips can be soldered directly in place.

Schottky Diode Millimeter-Wave Mixer Development

The new 270-310 GHz mixers are now under test, and two have been installed on the 12-m telescope. So far, we have only used UVA 2I1 diodes in these, and have measured mixer noise temperatures of 1000-1500 K SSB for the better ones. We now plan to test other diodes in these mounts. On the telescope, a receiver noise temperature of 1200-1500 K SSB is obtained over most of the 270-310 GHz range.

The 345 GHz mixers on the 12-m telescope have no back-ups. We are making new blocks to provide spare mixers to Tucson and to attempt to improve the performance. The present receiver has a receiver noise temperature of 1300-2200 K SSB over 335-355 GHz.

I. GREEN BANK ELECTRONICS

300-ft Spectral Processor

The Spectral Processor project continues in the design and construction phase. Most of the digital boards have been prototyped and tested. The first FFT board constructed on the custom wire-wrap panel was tested this quarter and found to work satisfactorily. An additional ten copies were wire-wrapped by an outside shop and are being assembled for testing. The Accumulator block, consisting of three wire-wrap cards, is being constructed, and cards needed to test the Accumulator are being designed.

Assembly of the digital racks, with the power distribution system, was started this quarter. The wirelist for the rack backplane is now being generated. The small computer that will serve as a rack controller and the interface cards needed were purchased.

Work started on the system software. The required program functions and data structures were defined, and some prototype routines were evaluated. Definition of the Masscomp/rack controller/digital hardware interface functions was started, and some of the required code was written.

Work on the IF/Video converters continued. A breadboard filter and switching board was constructed, and the computer-aided-testing facility for the SSB network was completed. The breadboard SSB network initial evaluation showed rejection of 25 to 30 dB, without adjustment. It is hoped that adjustments to the network values will allow the 40 dB rejection goal to be met. The 180 to 660 MHz phase-locked synthesizer breadboard is now being evaluated.

Adaptive Array Receiver

The Adaptive Array Receiver project is designed to develop a receiver to increase the 300-ft antenna off-axis beam efficiency by synthesizing a clean beam using an array of feeds. The receiver will operate at 450 MHz and use a 2x8 array of crossed-dipole feeds. During this quarter, the sixteen low-noise FET amplifiers and voltage-controlled phase shifters were completed. A new staggered array pattern was evaluated and found to be satisfactory and allowed larger individual feed elements to be incorporated. The larger cavity-backed dipole feed was constructed and tested and found to give satisfactory performance. Design and construction of the feed array and front-end box can now proceed.

Local Area Network

During the past year, a plan has been developed to improve the computing environment at Green Bank and to allow gradual upgrades of the computing hardware. The backbone of this plan is a high-speed local area network that will interconnect all telescopes, the Jansky Lab, and other on-site buildings. The goal is to store acquired telescope data in a central buffer, which will allow quick access from any node on the LAN, and to allow more efficient and cost-effective use of our resources.

The LAN will be implemented as an Ethernet with interconnecting fiber-optic cables running in existing buried conduits. The basic elements of the LAN have been purchased and experiments have started to gain experience with Ethernet hardware and software, and the fiber-optics. A great deal of work has been required to clear and install pull-cables in the buried conduits. That task is about 60 percent complete.

Miscellaneous

The 2-5 GHz receiver has been in use on the Green Bank telescopes for several years. It has two bands of operation, one centered near 3.2 GHz and the other at 4.8 GHz. The receiver was designed to operate at either band, but not both simultaneously, and switchover required about an hour. This quarter, work

was completed for a special request that allows the two bands to be used simultaneously, with two feeds offset by a small amount. In this configuration, the receiver is only useful for continuum observations because the LO is shared. Two IF channels were added, and other minor modifications were made to the receiver. A four-channel IF polarimeter was constructed that allows the two polarizations from each band to be processed for Stokes measurements.

Five 4.8 GHz cooled amplifiers were completed this quarter. Assembly of two VLBA front-ends was completed and four units completed final tests.

J. 12-M ELECTRONICS

70-115 GHz Schottky Mixer Receiver

This dual-channel receiver remains unchanged since the last quarterly report. It is the only receiver to cover the 70-90 GHz spectral line band and is also used for continuum observations at 90 GHz.

200-350 GHz Schottky Mixer Receiver

This receiver has been updated during the last quarter to include the frequency ranges 270-310 GHz and 330-350 GHz. Dual-channel operation is now possible over the entire frequency range.

90-115 GHz SIS Receiver

This receiver is now in routine use and noise temperatures of around 100 K SSB are obtained across the frequency range. The receiver has proved very reliable during the last observing session. The hold time of the hybrid cryostat is three days. Maintenance on the receiver has become routine.

Multi-feed 230 GHz Receiver

During this quarter the receiver has been expanded from 4 feeds to 8 feeds. The receiver was tested on the telescope in December 1987 and performed well. The eight beams were identical, the correct shape, and correctly positioned. The receiver will be made available to observers when the hybrid spectrometer is completed.

Hybrid Spectrometer

The digital part of the hybrid spectrometer was delivered to Tucson in December 1987. Work will now be directed towards interfacing the analog and digital sections of the spectrometer and completing the software. The time scale for telescope tests is uncertain at this time.

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 percent 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. Currently, twenty-eight antennas have insulation installed. This part of the antenna pointing program was completed last quarter.

Another, lesser, pointing problem which will be addressed in the future is the occurrence of tilts of up to 20 arcseconds 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 showed that the temperature control of the tiltmeter meter unit was not adequate. This area has been redesigned and testing will start next 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 percent 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. NRAO has an agreement with NRL for further outfitting. The first level of funding (for four more systems) has been received and components are being procured.

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 arcminutes 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. This system is undergoing test and evaluation. The final feed configurations have been determined. To reduce local RFI, RFI enclosures for the vertex mounted "B" racks have been installed on four antennas (see RFI Improvements). No funding has been provided for continuation of this project. Material procured last year has been assembled. After the installation of the next two systems, completion of this project will be delayed pending further funding for this project.

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 have been incorporated into these systems during this quarter.

Twenty-seven 8.4 GHz front-ends have been received from the Central Development Laboratory in Charlottesville and fourteen have been installed on 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. Antennas being overhauled will be outfitted with X-band feed towers. Installation of the remaining twelve 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 were 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. No progress has been made this quarter.

Water-Vapor Radiometers

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

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 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 1987.

L. AIPS

During the quarter, two more major projects were released for general use in AIPS. In the first, we have implemented a generic and more rational structure for the "Z routines" (machine-dependent kernel of AIPS) and put it in place for UNIX systems. The VMS version will be done later and the COS version is under active development. In the second, we have developed spectral bandpass calibration routines and implemented them throughout the AIPS calibration package. The task BPASS determines the bandpass corrections, and several different tasks are capable of applying them. Other additions to the calibration package include optional spectral smoothing of the uv data in most tasks and the new task GETJY which determines point source fluxes from the calibration solutions. The new task IM2UV Fourier transforms images and converts the result into uv data format. This will allow the editing of images in the Fourier domain and the addition of single-dish data to interferometer data for imaging.

Single dish data within AIPS also received a great deal of attention this quarter. The internal format was changed from a kluge to a rational, uv-data like format with support for all projective geometries and for more than one IF. The data may be read from and written to tape in the AIPS format and may be read from tape in the special single dish FITS-table format by SD2UV. The AIPS calibration package was improved to do useful things with single dish data. New tasks SDCAL and CSCOR were added to help determine and apply single dish calibrations (gain, offset, position, and pointing corrections). At present, the package has only been tested with continuum data from the 300-ft telescope.

M. VLA COMPUTER DIVISION

The new on-line computer system was used to control the VLA during test observations in this quarter. This was extremely valuable in the discovery of software bugs and procedural problems. Based upon the success of the observations just before Christmas, it was decided to remove the old computers as planned. The VLA will be down until January 11, 1988 for this to take place.

The capability of the new on-line system is such that 512 spectral line channels may be produced using all antennas. This is an increase of a factor of more than 17.5 compared to the old system. It is also possible to produce continuum data with an integration time as short as 1.67 seconds. This is a factor of 4 faster than the old system. Since the image processing computers currently available at NRAO have very little spare capacity processing the data produced by the old system, an administrative limit has been placed upon the amount of data that may be produced by any observation. This may be relaxed in special cases by permission of the Director.

The new on-line system produces an archive tape that uses a new format at 6250 bpi. The old tapes were written at 1600 bpi. The program that fills

data from the archive tape into the DEC-10 has been enhanced to accept this new format. In order to read all old archive tapes, the old format can still be read by this program. The task of AIPS (FILLR) that reads the archive tapes will now be supported at the VLA. In the next quarter, this task will be enhanced to accept the new data format as well as the old.

The programs that produce images on the pipeline computers have now been completely recast to run on the Convex computer. It was possible to run timing benchmarks at the end of November, and the results were encouraging.

N. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

The Pie Town antenna participated in the 18-21 November, 327 MHz NUG run as a test and debug opportunity. Scientifically useful data were taken during most of the session, with fringe confirmations recently received from Charlottesville and Bonn. Correlator data also indicated that this antenna's sensitivity was consistent with VLBA specifications. Pie Town is tentaively being made available to the community through routine NUG proposal procedures starting with the June 1988 observing session.

The subreflector master mold and production mold surface tolerances have now been approved. The first subreflector is scheduled for shipment in mid-January to the University of Arizona for final surface measurements, and then to Pie Town in early February.

The first subreflector focus-rotation mount (FRM) required modifications to cure design problems described in the previous quarter's report. The resulting test FRM was subjected to cold chamber and endurance tests during this quarter. Good performance in these tests allowed authorization of five production FRMs incorporating these modifications. The test FRM is scheduled for installation, with subreflector, at Pie Town in February. The first production FRM (with subreflector) is scheduled for installation at Kitt Peak in May.

An apparent "wobble" in the azimuth track is detected in the first three antennas. The deflections are approximately twice manufacturer's expectations. The cause is not known with certainty, but attention is focusing on possible incorrect rail installation. The manufacturer has been formally notified of our concern about this part of the pointing error budget. They promise an analysis of the problem. In the meantime, they have modified their method of installing the azimuth rail to attempt to cure the problem.

Antenna erection at Kitt Peak is complete, except for punch list items. Electronic and cryogenic outfitting by NRAO is approximately 50 percent complete. Antenna erection at Los Alamos is complete, with installation of electrical servo control equipment and precision panel alignment remaining. At Fort Davis, TX, antenna erection was initiated on 7 December.

Site preparation, antenna foundation, and the control building are complete at Brewster, WA. At North Liberty, IA, the site preparation and antenna

foundation are complete, and the building 90 percent complete. Lease negotiations are underway for the sites at St. Croix, VI, Owens Valley, CA, and Mauna Kea, HI.

Electronics

The electronics racks for Kitt Peak are being operated with Monitor/Control equipment in the lab at the VLA, and will be moved to Kitt Peak in January. At Charlottesville, the Los Alamos racks were completed this quarter and are under test, with shipment to the VLA scheduled for January. Construction of racks for Fort Davis is well under way.

Front ends Serial #4 for both 1.5 and 4.8 GHz were completed in November and shipped to the VLA. The serial #5 units for these bands are being built for shipment in January. Work on the first 2.3 GHz front end continues at Green Bank. While cool-down tests were satisfactory, changes in the initial amplifier design are needed. Therefore, the unit will not be completed until February. The first 23 GHz front end has been satisfactorily tested at Charlottesville. Its final completion awaits only the modification of some components associated with the first frequency conversion, which, for this band, is performed in the front end package.

Hydrogen masers #1 and #2 were satisfactorily tested at the VLA and accepted. Maser #1 is now installed at Pie Town and was used as timing reference for that antenna's recent NUG run. Masers #3 and #4, received in November, are still under test. The latter two masers are scheduled for January shipment to JPL for longer term stability testing.

An initial version of the documentation index was compiled and made available in the field. Work on diagrams and manuals continues.

Data Recording

At Haystack Observatory an actual "fringe" test of the first VLBA Recorder (REC1) was successfully completed on 9 October 1987, using the Haystack and Westford antennas. The decoder/quality analyzer located in the Formatter was used to verify that the recorder met the error rate specifications.

A complete Data Acquisition System (DAS) consisting of a Data Acquisition Rack (DAR -- comprising Formatter #1, two I.F. distributors, four baseband converters, and other support modules), together with REC1, was shipped to the VLA where it is now being used by the Monitor and Control group in the development of required control software. A senior Haystack engineer assisted in this work during a December visit.

The second recorder, REC2, is now in final assembly and is scheduled for checkout and delivery in January. Formatter #2 is in construction, due for delivery 30 April 1988.

Change Order No. 10 was issued December 1, covering the pre-production phase (Phase III) of the Haystack contract. Procurement of long lead time items for DAR3 and DAR4, as well as the Honeywell tape transports for REC3 and the

first Playback Drive (PBD1), began earlier under advance funding authorized in August. Late in December, PBD2 was also authorized via change order #11, since it will be needed during the early phase of correlator subsystem checkout.

As indicated earlier, the production of future DAR's will be undertaken by NRAO, while it is anticipated that Haystack will continue to produce the REC and PBD units.

Monitoring and Control

During fourth quarter 1987 development of operator interface programs continued. These programs are now available for essentially all local station functions, although those for the recorders and formatters are still in rather preliminary form.

The astronomical observing routines are now logically complete, except for the setup of the tape recorder and formatter. Some of the programs are present in only skeleton form (especially the monitor data checker). Work is progressing on fleshing them out. The pointing programs have been debugged to the extent of deriving beam offset from observed detector data.

Work has begun on a set of programs that will eventually serve to communicate between the station computers and the MicroVax that will serve as the array controller. These programs now have a rudimentary capability to transfer observing schedules from the MicroVax to the station computer. Most of the program which will transfer monitor data from the station computer to the VAX is present, although the programs which will use this data in the VAX have not yet been designed.

The Motorola X-25 product that we have been planning to use at the sites for the software interface to the central VAX has been delayed beyond the originally expected delivery date. We are currently expecting to receive pre-release versions of this system in February.

Firmware for the focus/rotation controller is essentially complete. A preliminary version of the device itself is ready for installation at Pie Town. Modest changes are necessary for the final version of the mount.

A utility interface module has been designed to access various test and alarm points not available to other Monitor/Control bus devices. It is under construction, as well as a special interface to collect data from tilt and temperature sensors.

The Pie Town weather station is now essentially complete, but has not yet been installed at the site. Delivery of the fiberoptic connection (necessary for lightning protection) has been the pacing item, but now all parts are in hand.

The Kitt Peak computer system is now ready for shipment. Requisitions have been filed for the remaining parts for the Los Alamos and Fort Davis computers.

Correlator

The first Design Review for the VLBA FX Correlator was held on 1987 October 26 and 27. All aspects of the correlator design were reviewed, from the top level organization to details of the multi-purpose "FX chip" upon which both the FFT and multiplier/accumulator sections are based. Other topics considered at some length included:

- The playback interface section (incorporating the data playback functions recently transferred to the correlator).
- The VLBA data format.
- Model tracking algorithms and accountability.
- Overall organization and individual tasks in the control software.
- Expandability of the correlator and applications to orbiting interferometer elements.
- Subarraying capabilities, and the latest cost estimate and construction schedule.

With this review, the current FX development effort has now passed the stage at which work on the earlier lag correlator design was suspended late in 1985. Following very closely the plan envisioned at that time, work on the redesigned correlator is now ready to proceed to final design and construction when major expenditures resume for this area in 1988. As hoped, adoption of the FX architecture has made possible a reduction of close to $1 M in the estimated total hardware cost.

Additional progress on the FX chip included design and fabrication of a breadboard for verifying the logic design. This is currently being integrated into a complete test and simulation system which eventually will be used to generate test vectors for qualifying the prototype chips. Finally, the search for potential vendors continued in preparation for issuing a formal request for proposals early in 1988. At least two alternatives have emerged to the LSI Logic LSA 1502 product upon which the basic FX chip concept is based. One of these, in fact, would use a standard cell rather than a gate array approach.

The Motorola VME 1131 development system was delivered and has been installed. Initial use has so far been confined to tests aimed at the fringe-fitting application, which has been hampered by the need to resolve numerous deficiencies in the Fortran compiler.

Data Processing

Most of the software needed for normal processing of astronomical data from the VLBA is already in routine use. Pending the availability of the VLBA Correlator and computers toward the end of the Project, software development continues at a modest level in the areas of (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). In area (2), the emphasis is currently on spectral line and atmospheric calibration, while significant further progress in area (3) awaits the hiring of a suitable person.

Array Operations Center

Foundations for the AOC building are complete and the ground floor is covered. Currently steel structure is being erected for the main and upper floor. Construction is approximately on schedule for an occupancy date of 1 August 88.

O. PERSONNEL

New Hires

Kapahi, Vijay K.	Visiting Assoc. Scientist	10/01/87
Leahy, J. Patrick	Research Associate	10/06/87
Albing, William W.	Electronics Engineer II	11/02/87
Peck, George	Electronics Engineer II	12/07/87

Terminations

Palmer, Patrick E.	Visiting Scientist	10/07/87
Schenewerk, Mark S.	Systems Scientist	11/06/87
Bierer, Fred	Head, Plant Maintenance - GB	12/31/87
Hvatum, Hein	Scientist	12/31/87

Changes in Status

Bregman, Joel	to Scientist	07/01/87*
Wootten, H. Alwyn	to Scientist	07/01/87*
van Gorkom, Jacqueline	to Scientist (with tenure)	11/01/87
Dinius, Mark	to Business Manager - VLA	12/01/87

Other

van Gorkom, Jacqueline	return from leave of absence	10/06/87
Roberts, Morton S.	return from leave for professional advancement	11/03/87

** not reported in third quarter*

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