NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

October 1 - December 31, 1989

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A. TELESCOPE USAGE

The NRAO telescopes have been scheduled for research and maintenance in the following manner during the fourth quarter of 1989.

	140-ft	12-m	VLA
Scheduled observing (hrs)	1901.75	1583.50	1565.2
Scheduled maintenance and equipment changes	132.00	107.75	259.8
Scheduled tests and calibrations	20.75	425.75	327.1
Time lost	139.25	208.25	107.0
Actual observing	1762.50	1375.25	1458.2

B. 140-FOOT OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A-95	Avery, L (Herzberg) Bell, M. (Herzberg) Feldman, P. (Herzberg) MacLeod, J. (Herzberg) Matthews, H. (Herzberg)	Observations at 18.2, 18.6, and 23.7 GHz of cyanopolyynes in carbon stars part II.
B-493	Bania, T. (Boston) Rood, R. (Virginia) Wilson, T. (MPIR, Bonn)	Measurements at 8.666 GHz of $^3He^+$ emission in HII regions and planetary nebulae.
C-258	Clark, F. (AF Geophysics Lab) Mann, P. (Kentucky) LaHaise, W. (Kentucky)	Studies at 23.7 GHz of ammonia in infrared objects.
C-261	Cersosimo, J. (NAIC)	Search at 8.880 GHz for the α and β lines of carbon.
C-263	Cersosimo, J. (NAIC) Onello, J. (SUNY, Cortland)	Studies of 18 cm recombination lines from the diffuse interstellar gas.
D-163	De Geus, E. (Maryland) Leisawitz, D. (GSFC)	Studies of HI around young open clusters.
D-164	da Costa, L. (CNPq, Brazil) Giovanelli, R. (NAIC) Haynes, M. (Cornell)	Hydrogen observations of southern low-surface brightness galaxies.

No.	Observer(s)	Program
E-56	Elvis, M. (CFA) Lockman, F. J. Morris, M. (UCLA) Likkel, L. (UCLA)	Hydrogen survey of the north ecliptic pole.
M-283	Maddalena, R.	Monitor at 1.3 cm unusual H_2O emission from two IRAS sources.
M-284	Madden, S. (Massachusetts) Brown, R. (Monash University) Godfrey, P. (Monash University) Henkel, C. (MPIR, Bonn) Irvine, W. (Massachusetts) Wilson, T. (MPIR, Bonn) Maddalena, R.	Time variability study at 1.5 cm of ammonia masers.
M-296	McCammon, D. (Wisconsin) Jahoda, K. (GSFC) Snowden, S. (MPIR, Bonn) Lockman, F. J.	Search for HI "edges."
M-301	Bally, J. (Bell Labs) Maddalena, R. Blitz, L. (Maryland) Pachowsky, R. (Maryland)	Observations of HI toward selected areas of Monoceros.
S-330	Schloerb, F. (Massachussetts) Tacconi-Garman, L. (Massachusetts)	OH observations of Comet P/Brorsen-Metcalf and C/Okazaki-Levy-Rudenko.
T-268	DeFrees, D. (Molecular Research Inst.) McLean, A. (Molecular Research Inst.)	Search at 19 GHz for interstellar C_5O.
W-280	Wootten, H. A.	H_2O monitoring in star forming cores in rho Oph.

The following pulsar programs were conducted during this quarter.

No.	Observer(s)	Program
B-484	Backer, D. (Berkeley) Foster, R. (Berkeley) Taylor, J. (Princeton)	Timing observations at 750-800, and 1355 MHz of PSR 1821-24 and other millisecond pulsars.

No.	Observer(s)	Program
T-265	Taylor, J. (Princeton) Stinebring, D. (Princeton) Dewey, R. (JPL) Nice, D. (Princeton) Thorsett, S. (Princeton)	Pulsar timing observations over the range 450-500, 750-800, and 1355 MHz.

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

A - Arecibo 1000 ft	N - NRL Maryland Pt. 85 ft
B - Effelsburg, MPIR 100 m	No - Noto, Sicily
E - Hartebeesthoek, South Africa 26 m	O - Owens Valley 130 ft
F - Fort Davis 85 ft	Pt - Pietown 25m
G - Green Bank 140 ft	R - Crimea, USSR 30 m
H - Hat Creek 26 m	Sa - Shanghai 25 m
I - Iowa 60 ft	So - Onsala 25 m
Jb - Jodrell Bank 250 ft	Sn - Onsala 20 m
Km - Haystack 120 ft	T - Torun 15 m
Kp - Kitt Peak 25 m	Wn - Westerbork n=1-14x26 m
Lb - Bologna 25 meter	X - Itapetinga 20 m
Me - Merlin	Yn - Socorro n=1-27x25 m

No.	Observer(s)	Program
AH-46V	Wilkinson, P. (Manchester) Akujor, C. (Nigeria)	Observations at 18 cm of 3C 380, with telescopes B, Jb, So, Lm, Wn, Km, G, F, O, Pt, and Kp.
AH-7V	Hewitt, J. (Haystack)	Observations at 3.6 cm of reference sources for dMe stars, with telescopes G, H, and Pt.
B-93V	Booth, R. (Chalmers) Kus, A. (Chalmers) Wilkinson, P. (Manchester)	Observations at 3.6 cm of the core of the steep spectrum compact QSO 3C 380, with telescopes B, Lm, Sn, Km, G, F, O, Y27, and Pt.
B-94V	Barthel, P. (Groningen) de Bruyn, A. (NFRA) Schilizzi, R. (NFRA) O'Dea, C. (NRFA) Wieringa, M. (Leiden)	Studies at 6 cm of the cores in giant core dominated quasars, with telescopes B, Wn, Jb, So, Km, G, H, I, O, F, and Y27.
B-98V	Bartel, N. (CFA) Lestrade, J.-F. (JPL) McClintock, J. (CFA) Phillips, R. (Haystack) Shapiro, I. (CFA) Preston, R. (JPL)	Observations of Cyg X-1 at 3.8 cm--neutron star or black hole--with telescopes B, Lm, Sn, Km, G, F, O, Y27, and Pt.

No.	Observer(s)	Program
B-99V	Bartel, N. (CFA) Biretta, J. (CFA)	"World Array" bandwidth-synthesis observations of 3C 84 at 18 cm, with telescopes B, Lm, So, Wn, Jb, R, T, No, Km, G, F, O, I, N, Y_{27}, Pt, Kp, and Me.
F-23V	Field, D. (Bristol, England) Gray, M. (Bristol, England) Cohen, M. (Caltech) Zhou, Z. (Shanghai Observatory) Liang, S. (Shanghai Observatory) Winnberg, A. (Chalmers) Booth, R. (Chalmers)	Observations at 18 cm of OH masers, with telescopes B, So, Jb, G, O, Pt, and Sa.
G-60V	Giovannini, G. (Bologna) Wehrle, A. (Caltech) Comoretto, G. (Arcetri) Feretti, L. (Bologna) Venturi, T. (Bologna)	Observations at 6 cm of a sample of Fanaroff-Riley Type I radio galaxies, with telescopes at B, Jb, So, Wn, Km, G, F, O, Y_{27}, and Pt.
G-61V	Garrett, M. (Manchester) Wilkinson, P. (Manchester) Walsh, D. (Manchester) Porcas, R. (MPIR, Bonn) Quirrenbach, A. (MPIR, Bonn)	Observations at 18 cm of the gravitationally lensed quasar 0957+561 A,B, with telescopes B, So, Lm, Wn, Jb, G, Y_1, O, and Pt.
G-62V	Gwinn, C. (CFA) Moran, J. (CFA) Reid, M. (CFA) Zheng, X. (Nanjing) Peng, Y. (Nanjing)	Study at 18 cm the OH magamaser in IIIZw 035, with telescopes B, G, Y_{27}, Pt, and A.
H-51V	Heflin, M. (MIT) Lawrence, C. (Caltech) Burke, B. (MIT) Shapiro, I. (MIT)	Observations at 18 cm of the gravitational lens system 2016+112, with telescopes B, Wn, Jb, Km, G, F, O, Y_{27}, and A.
K-24V	Kus, A. (Chalmers) Booth, R. (Chalmers) Mareki, A. (Torun)	Observations at 3.6 cm of the core of the steep spectrum compact QSO 3C 386, with telescopes B, Lm, Sn, Km, G, F, O, Y_{27}, and Pt.
L-57V	Mutel, R. (Iowa) Spangler, S. (Iowa)	Measure at 18 cm the inner scale of interstellar turbulence, with telescopes B, Lm, Wn, Km, G, F, O, and Y_{27}.

No.	Observer(s)	Program
M-103V	Mutel, R. (Iowa) Spangler, S. (Iowa)	Measure at 18 cm the inner scale of interstellar turbulence, with telescopes B, Lm, Wn, Km, G, F, O, and Y_{27}.
N-18V	Neff, S. (Goddard) Antonucci, R. (Calif., Santa Barbara) Pedlar, A. (MRAO)	High resolution observations at 18 cm of the NGC 1068 core, with telescopes B, Lm, G, O, and Y_{27}.
O-5V	O'Dea, C. (NRFA) Baum, S. (NFRA) Murphy, D. (JPL)	Observations at 6 cm of gigahertz peaked spectrum sources, with telescopes B, Wn, Jb, So, Km, G, O, F, Y_{27}, and Pt.
P-91V	Phillips, R. (Haystack) Titus, M. (Haystack) Lestrade, J-F. (JPL)	Studies of hot O-giant stars at 18 cm, with telescopes G, O, Y_{27}, and Pt.
P-95V	Pauliny-Toth, I. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) Zensus, A. Kellermann, K.	Observations at 18 cm of 3C 454.3, with telescopes B, Jb, So, Lm, Wn, R, T, Km, G, O, Pt, E, and Me.
P-98V	Pearson, T. (Caltech) Readhead, A. (Caltech)	Second epoch maps and spectra of four sources at 18 cm, with telescopes B, So, Lm, Wn, Jb, No, Km, G, O, Y_1, Pt, Kp, and La.
S-84V	Sakurai, T. (Iowa) Spangler, S. (Iowa) Cairns, I. (Iowa) Mutel, R. (Iowa) Armstrong, J. (JPL)	Studies at 18 cm of the density turbulence in the outer corona and solar wind, with telescopes N, I, O, F, and Y_{27}.
W-54V	Walker, R. C. Benson, J. Unwin, S. (Caltech) Pilbratt, G. (ESA)	Third epoch observations at 18 cm of 3C 120, with telescopes B, Jb, Wn, So, Lm, T, R, No, K, G, N, I, F, O, Y_1, Pt, Kp, and A.

C. 12-METER TELESCOPE

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A-94	Adler, D. (Illinois) Allen, R. (Illinois) Lo, K. (Illinois) Sukumar, S. (Illinois)	Study of the structure of the interstellar medium in the spiral galaxy M83.

No.	Observer(s)	Program
B-526	Buhl, D. (GSFC) Chin, G. (GSFC) Goldstein, J. (NASM)	Study of CO in the atmospheres of Venus and Jupiter.
B-527	Blitz, L. (Maryland) Gir, B. (Maryland) Hobbs, L. (Chicago) Welty, V. (Chicago	Study of stars toward high latitude clouds and the nature of infrared excess clouds.
C-262	Clancy, R. (Colorado) Muhleman, D. (Caltech)	CO/temperature studies of Venus and Mars.
D-165	Dent, W. (Massachusetts) Balonek, T. (Colgate)	Study of the evolution of extragalactic radio sources at millimeter wavelengths.
G-308	Gordon, M.	Study of gas densities and fragmentation in warm dust clouds.
G-311	Gordon, M. Martin-Pintado, J. (Yebes, Spain)	Monitoring program for the RRL maser in MWC 349.
H-265	Hogg, D. Roberts, M. Bregman, J. (Michigan)	A search for CO emission from early-type galaxies.
H-266	Hurt, R. (UCLA) Turner, J. (UCLA)	CO (1-0) and CO (2-1) mapping of starburst galaxy Maffei 2.
K-319	Kutner, M. (RPI) Verter, F. (GSFC)	Study of the response of GMCs in M31 to the spiral shock.
K-325	Koo, B. (Berkeley) Heiles, C. (Berkeley) Bieging, J. (Berkeley)	CO observations of HI shells in M101.
L-236	Smith, B. (Texas) Lord, S. (NASA-Ames)	An investigation of the molecular disks of a complete, flux-limited sample of interacting galaxies.
L-241	Loren, R. (Unaffiliated) Wootten, H. A.	Study of molecular abundances in oxygen-rich cores in the rho Oph cloud.
M-295	McCutcheon, W. (British Columbia) Sato, T. (British Columbia) Dewdney, P. (DRAO) Purton, C. (DRAO)	Study of molecular outflow source 0555+16.
M-299	Meyer, D. (Northwestern) Hawkins, I. (Berkeley)	Study of the excitation of interstellar CN toward HD 21483.

No.	Observer(s)	Program
M-300	Maizels, C. (UCLA) Turner, J. (UCLA)	Study of CO in the nucleus of M31.
M-307	Maizels, C. (UCLA)	Search for CO in carbon stars.
N-9	Noreau, L. (Toronto)	Search for the 57FE XXIV hyperfine line.
P-150	Puchalsky, R. (Maryland) Blitz, L. (Maryland)	A search for high-density cores in molecular clouds.
P-151	Puchalsky, R. (Maryland) Blitz, L. (Maryland)	Further observations of clump substructure in molecular clouds.
R-241	Roberts, M. Hogg, D. Bregman, J. (Michigan)	Study of CO in HI-deficient galaxies.
S-327	Sage, L. (NMIMT) Isbell, D. (NMIMT)	Study of ^{13}CO emission from a sample of nearby galaxies.
S-328	Smith, B. (Texas) Lord, S. (NASA-Ames)	A CO (J=1-0) map of the ripple galaxy Arp 215.
S-334	Sage, L. (NMIMT) Shore, S. (NMIMT) Solomon, P. (SUNY)	Study of dense molecular gas in nearby spiral galaxies: further CS observations.
S-335	Smith, B. (Texas) Lord, S. (NASA-Ames)	Study of star formation processes in interacting galaxies.
T-264	Turner, B. Rickard, L. J (NRL) Lanping, X. (Beijing)	Study of CO in cirrus molecular cloud cores.
T-269	Turner, B.	Search for interstellar NaO.
T-271	Turner, B. Amano, T. (Herzberg) Feldman, P. (Herzberg)	A search for $SiOH^+$: a test of new Si-chemistry models.
T-273	Turner, B. Amano, T. (Herzberg) Feldman, P. (Herzberg)	Confirmation of a tentative detection of HC_3HN^+.
W-234	Wootten, H. A. Loren, R. (unaffiliated)	Study of SO_2 cores in rho Oph cloud: Harbingers of star formation?

No.	Observer(s)	Program
Z-81	Ziurys, L. (Arizona State) Lis, D. (Massachusetts) Goldsmith, P. (Massachusetts) Steimle, T. (Arizona State)	A proposed 270-300 GHz spectral line survey of Sgr B2N and Orion-KL.
Z-82	Ziurys, L. (Arizona State)	Searches for interstellar NaO and AlO.
Z-83	Ziurys, L. (Arizona State)	Confirmation of interstellar FeO.

D. VERY LARGE ARRAY

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

No.	Observer(s)	Program
AA-98	Anglada, G. (Barcelona) Estalella, R. (Barcelona) Rodriguez, L. (UNAM) Torrelles, J. (IAA, Spain) Canto, J. (UNAM)	Ammonia circumstellar structure associated with the HH34 jet. 1.3 cm line.
AA-104	Andre, P. Montmerle, T. (Saclay) Feigelson, E. (Penn State)	Emission from embedded sources in Rho Ophiuchi cloud core. 2, 3.8 and 6 cm.
AB-414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring radio stars HD193793 and P Cygni. 2 and 6 cm.
AB-525	Braun, R. (NFRA) van Gorkom, J. (Columbia) Walterbos, R. (Berkeley) Kennicutt, R. (Steward Obs.) Norman, C. (STScI)	The interstellar media of nearby galaxies. 20 cm line.
AB-534	Baum, S. (NFRA) Leahy, P. Perley, R. Riley, J. (MRAO) Scheuer, P. (MRAO)	A survey of nearby hotspots. 3.8 cm.

No.	Observer(s)	Program
AB-541	Bally, J. (Bell Labs) Wilson, R. (Bell Labs) Yusef-Zadeh, F. (Northwestern)	The Orion Superbubble. 20 and 90 cm.
AB-546	Bastian, T. Anantharamaiah, K. (TIFR) van Gorkom, J. (Columbia)	Recombination lines from the symbiotic binary H1-36. 3.6 cm line.
AB-551	Berkhuijsen, E. (MPIR, Bonn) Beck, R. (MPIR, Bonn) Hummel, E. (NRAL)	Structure of the magnetic field in the central region of M31. 6 and 20 cm.
AB-556	Burns, J. (New Mexico State) Gisler, G. (LANL) Perley, R.	Perseus cluster of galaxies. 90 cm.
AC-256	Capetti, S. (Inst. di Fisica) Ferrari, A. (Inst. di Fisica) Trussoni, E. (Inst. di Fisica) Morganti, R. (Bologna) Fanti, R. (Bologna) Parma, P. (Bologna) de Ruiter, H. (Bologna)	Knots in low luminosity radio galaxy jets. 6 and 20 cm.
AC-259	Carilli, C. (CFA) Perley, R. Dreher, J. (NASA-Ames)	Cygnus A. 1.3 cm.
AC-262	Campbell, B. (New Mexico)	Radio emission from new young stellar objects. 6 cm.
AC-263	Cordes, J. (Cornell) Hankins, T. (NMIMT) McKinnon, M. (NMIMT)	Radio pulsars in the directions of selected galactic sources. 20 and 90 cm.
AC-264	Condon, J. Broderick, J. (VPI&SU)	UGC galaxies. 6 cm.
AD-188	Drake, S. (GSFC) Simon, T. (Hawaii) Florkowski, D. (USNO) Stencel, R. (Colorado) Bookbinder, J. (CFA) Linsky, J. (Colorado)	Variability of M supergiant: Alpha Orionis. 2 and 6 cm.
AD-238	Drake, S. (GSFC) Linsky, J. (Colorado) Judge, P. (Colorado)	Survey of cool giants and supergiants. 2 and 3.5 cm.

No.	Observer(s)	Program
AD-240	de Pater, I. (Berkeley) Palmer, P. (Chicago) Snyder, L. (Illinois)	Comet Okazaki.
AE-61	Eilek, J. (NMIMT) Owen, F. Leahy, P.	Abell clusters without cooling cores. 3.5 and 6 cm.
AF-175	Fischer, M. (Silver High School) Gibson, D. (Lincoln Lab) Gonzalez, P. (La Plata Jr. High)	Observations over 176-day cycle of 4U1820-30. 6 and 20 cm.
AF-178	Franx, M. (CFA) de Zeeuw, P. (Caltech) van Gorkom, J. (Columbia)	The dark halo and shape of IC 2006. 20 cm line.
AF-179	Fomalont, E. Hogan, C. (Steward Obs.) Partridge, B. (Haverford) Windhorst, R. (Arizona State)	CBR fluctuations. 3.8 cm.
AF-184	Freudling, W. (Cornell) Haynes, M. (Cornell) van Gorkom, J. (Columbia) Huchtmeier, W. (MPIR, Bonn)	Structure of the Magellantic stream. 20 cm line.
AF-185	Fruchter, A. (Carnegie)	The integrated flux of millisecond pulsars in globular clusters. 6 and 20 cm.
AG-267	Gottesman, S. (Florida) Hawarden, T. (UKIRT)	HI observations of NGC 1512 and NGC 5291. 20 cm line.
AG-278	Garcia-Barreto, J. (UNAM)	Barred galaxies NGC 1022 and NGC 1326. 2, 6 and 20 cm.
AG-287	Gaume, R. (NRL) Claussen, M. (NRL) Goss, W. M.	H and He recombination lines in Sgr B2. 1.3 cm line.
AG-292	Guhathakurta, P. (Princeton) van Gorkom, J. (Columbia) Knapp, G. (Princeton)	"Cirrus." 20 cm line.
AG-293	Gregorini, L. (Bologna) Vettolani, G. (Bologna) Parma, P. (Bologna) de Ruiter, H. (Bologna)	Optically selected dumbbells. 6 cm.

No.	Observer(s)	Program
AG-295	Gregg, M. (Mt. Stromlo Obs.)	HI observations of the Bootes Void galaxies. 20 cm line.
AG-297	Gaume, R. (NRL) Pauls, T. (NRL) Johnston, K. (NRL) Wilson, T. (MPIR, Bonn)	Protostars in NGC 2024. 1.3 cm line.
AG-298	Goldstein, S. (Virginia)	Low surface brightness spiral arms in M33 and M74. 90 cm.
AG-299	Goldstein, S. (Virginia)	Diffuse radiation from globular clusters. 90 cm.
AG-301	Giovanelli, R. (NAIC) Haynes, M. (Cornell)	Intergalactic HI cloud. 20 cm line.
AG-302	Glendenning, B. (Toronto) Kronberg, P. (Toronto)	Search for variability in NGC 2146. 6 cm.
AH-301	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Calgary) Seaquist, E. (Toronto)	Monitoring radio novae. 1.3, 2, 3.6, 6, and 20 cm.
AH-337	Hankins, T. (NMIMT) Horton, E. (Dartmouth)	Measurements of the Crab pulsar average profile. 3.8 pulsar.
AH-343	Holmes, G. (NRAL) Garrington, S. (NRAL) Saikia, D. (NRAL) Conway, R. (NRAL)	Depolarization asymmetry and jet sidedness of FR 1 sources. 6 cm.
AH-349	Hollis, J. M. (GSFC) Wagner, M. (GSFC) Oliversen, R. (GSFC)	Large-scale structure of cataclysmic binary 0623+71. 6 cm.
AH-351	Haschick, A. (Haystack) Baan, W. (NAIC)	HI emission in a quasar/galaxy pair. 20 cm.
AH-355	Hewitt, J. (Princeton) Cappallo, R. (Haystack) Corey, B. (Haystack) Lonsdale, C. (Haystack) Niell, A. (Haystack) Phillips, R. (Haystack) Lestrade, J. (JPL/Bur.de Longitudes)	VLBI reference sources near dMe stars. 3.5 and 20 cm.

No.	Observer(s)	Program
AH-367	Hummel, E. (NRAL) Pedlar, A. (NRAL) Davies, R. (NRAL)	The B-field structure in NGC 3310. 3.8 and 6 cm.
AH-369	Hummel, E. (NRAL)	Polarization measurements of NGC 4631. 3.8 and 6 cm.
AH-370	Hummel, E. (NRAL) van der Hulst, J. (Kapteyn)	The B-field in interacting systems: NGC 2207/IC 2163 and NGC 4038/39. 3.8 and 6 cm.
AH-371	Hogg, D. Roberts, M. Bregman, J. (Michigan)	Radio emission from hydrogen-rich SO galaxies. 20 cm.
AH-372	Hibbard, J. (Columbia) van Gorkom, J. (Columbia) Schweizer, F. (Carnegie)	Interacting and merging galaxies. 20 cm line.
AH-373	Habbal, S. (CFA) Gonzalez, R. Harvey, K. (Solar Phys Res. Co.)	Time-varying phenomena at the solar limb. 6 cm.
AH-374	Hunter, D. (Lowell Obs.) Gallagher, J. (AURA) van Woerden, H. (Kapteyn)	HI in amorphous irregular galaxies. 20 cm line.
AH-375	Hunter, D. (Lowell Obs.) Gallagher, J. (AURA) van Woerden, H. (Kapteyn)	Relationship between star formation and HI in irregular galaxies. 20 cm line.
AH-376	Henning, P. (Maryland) Kerr, F. (Maryland)	HI selected sample of galaxies. 20 cm line.
AH-377	Hawkins, G. (UCLA) Zuckerman, B. (UCLA)	HI around red giant W Hydrae. 20 cm line.
AH-378	Henkel, C. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Baan, W. (NAIC)	Formaldehyde (H_2CO) emission in NGC 253. 6 cm line.
AH-379	Herter, T. (Cornell) Shupe, D. (Cornell) Chernoff, D. (Cornell)	Structure of infrared cirrus clouds. 20 cm line.

No.	Observer(s)	Program
AH-382	Ho, P. (Harvard) Martin, R. (Steward Obs.) Turner, J. (UCLA) Jackson, J. (MPIE, Munich)	Extragalactic ammonia. 1.3 cm line.
AH-383	Hjellming, R.	Recurrent nova V745 Sco. 3.6, 6, and 20 cm.
AH-385	Han, X. (NMIMT) Hjellming, R.	Imaging the radio remnant of V404 Cyg X-ray nova. 3.6 cm.
AI-37	Impey, C. (Steward Obs.) Foltz, C. (MMTO) Weymann, R. (Mt. Wilson) Hewett, P. (Cambridge)	The nature of optically selected quasars. 6 cm.
AJ-178	Jackson, J. (MPI, Garching) Ho, P. (Harvard) Rodriguez, L. (UNAM) Moran, J. (CFA)	NH_3 toward the bipolar HII region NGC 6334A. 1.3 cm line.
AJ-181	Johnston, K. (NRL) Gaume, R. (NRL) Stolovy, S. (NRL) Wilson, T. (MPIR, Bonn) Wamsley, C. M. (MPIR, Bonn) Menten, K. (CFA)	CH_3OH masers associated w/OMC-1. 1.3 cm line.
AK-232	Kormendy, J. (Hawaii) Westpfahl, D. (NMIMT) Fisher, J. R. van Gorkom, J. (Columbia)	Dark matter in late-type dwarf galaxies. 20 cm line.
AK-234	Kundu, M. (Maryland) White, S. (Maryland) Schmahl, E. (Maryland) Gopalswamy, N. (Maryland)	Microwave and millimeter imaging of solar flares. 1.3 and 2 cm.
AK-237	Knapp, G. (Princeton) Bowers, P. (NRL)	Search for HI in the circumstellar envelopes of evolved stars. 20 cm line.
AL-150	Lestrade, J. (JPL) Preston, R. (JPL)	Statistical properties of RSCVn stars. 6 cm.

No.	Observer(s)	Program
AL-200	Leahy, P. Muxlow, T. (NRAL)	Spectral mapping of classical radio sources. 2 and 3.8 cm.
AL-201	Lasenby, J. (MRAO) Lasenby, A. (MRAO) Yusef-Zadeh, F. (Northwestern)	A search for Zeeman splitting of the HI line in Sgr A. 20 cm line.
AL-204	Lustig, A. (Sydney) Hunstead, R. (Sydney)	Extended cluster sources. 6 and 20 cm.
AL-206	Loushin, R. (Illinois) Crutcher, R. (Illinois) Troland, T. (Kentucky)	HI Zeeman effect toward dense interstellar clouds. 20 cm line.
AL-212	Linsky, J. (Colorado) Veale, A. (Colorado) Byrne, B. (Armagh Obs.) Butler, C. (Armagh Obs.) Rodono, M. (Catania) Neff, J. (GSFC)	Flares and active regions on the BY Draconis star CC Eridani. 3.8 cm.
AM-278	Menten, K. (CFA) Reid, M. (CFA)	HC_3N towards Sgr B2. 3.5 cm line.
AN-49	Norris, R. (Australia Telescope) Roy, A. (Sydney) Allen, D. (Anglo-Australian Tel.) Sramek, R.	Extremely luminous but cool far-infrared galaxies. 3 and 18 cm.
AN-53	Niell, A. (Haystack) Lestrade, J. (Obs. de Paris) Lonsdale, C. (Haystack)	VLBI phase reference sources near AE Aquarii. 3.6 and 20 cm.
AO-93	Owen, F. O'Dea, C. (NFRA)	Nearby Abell clusters. 90 cm.
AP-167	Pauls, T. (NRL) Schwartz, P. (NRL)	G159.6-18.5: A possible high galactic latitude SNR.
AP-170	Perley, R. Taylor, G. Inoue, M. (Nobeyama) Kato, T. (Utsunomiya) Tabara, H. (Utsunomiya) Aizu, K. (Rikkyo)	Very large Faraday rotation in Hydra A. 3.5 cm.

No.	Observer(s)	Program
AP-173	Phillips, R. (Haystack) Lestrade, J. (Obs. de Paris)	Search for compact reference sources near radio-bright B-stars. 6 and 20 cm.
AP-175	Pedlar, A. (NRAL) Anantharamaiah, K. (TIFR) van Gorkom, J. (Columbia) Goss, W. M.	Recombination line from Sgr A. 20 cm line.
AP-176	Puche, D. Carignan, C. (Montreal) Goss, W. M.	HI studies of the M101 group galaxies. 20 cm line.
AP-180	Price, R. (New Mexico) Duric, N. (New Mexico) Campbell, B. (New Mexico)	Nearby spirals. 3.8 cm.
AR-205	Reynolds, S. (North Carolina State)	Young supernova remnants. 6 and 20 cm.
AR-209	Reipurth, B. (ESO, Chile) Rodriguez, L. (UNAM)	HH 80-81 spectral indices. 2 cm.
AR-210	Rodriguez, L. (UNAM) Torrelles, J. (IAA, Spain) Ho, P. (Harvard) Canto, J. (UNAM)	The ammonia disk associated with HH1-2. 1.3 cm line.
AR-211	Richter, O. (STScI) McMahon, P. (Columbia) van Gorkom, J. (Columbia) Ferguson, H. (Johns Hopkins)	HI survey of the Hydra I cluster of galaxies. 20 cm line.
AR-212	Rucinski, S. (York) Seaquist, E. (Toronto)	RS CVn systems: short time scales. 6 and 20 cm.
AR-213	Rucinski, S. (York) Udalski, A. (York)	The rapidly rotating active giant, FK Comae. 2, 3.5, 6 and 20 cm.
AR-215	Rupen, M. (CFA) Ho, P. (Harvard)	The interacting pair NGC 4631/4656. 20 cm line.
AR-216	Reid, M. (CFA) Menten, K. (CFA)	Measurement of the size and temperature of Mira variables. 1.3, 2, and 3.8 cm.

No.	Observer(s)	Program
AR-217	Rudolph, A. (Maryland) Mundy, L. (Maryland) de Geus, E. (Maryland) Palmer, P. (Chicago)	Ammonia observations of low-luminosity outflows. 1.3 cm line.
AS-333	Sramek, R. Weiler, K. (NRL) van der Hulst, J. (Westerbork) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2, 6, and 20 cm.
AS-349	Seaquist, E. (Toronto) Bell, M. (Herzberg)	Molecular absorption against Cen A. 1.3 and 2 cm line.
AS-374	Scalise, E. (INPE, Brazil) Rodriguez, L. (UNAM)	Bright, unassociated IRAS sources with water maser emission. 2 cm.
AS-378	Seaquist, E. (Toronto) Taylor, A. (Calgary)	Survey of symbiotic stars at 8.4 GHz. 3.5 cm.
AS-381	Sandqvist, A. (Stockholm Obs.) Karlsson, R. (Stockholm Obs.) Whiteoak, J. (CSIRO)	OH in the Sgr A molecular clouds. 18 cm line.
AS-383	Szczepanski, J. (MIT) Ho, P. (Harvard) Jackson, J. (MPI, Garching) Armstrong, J. (NRL)	Gas feeding of the galactic center region. 1.3 cm line.
AS-385	Simkin, S. (Michigan State) Sadler, E. (Anglo-Australian Tel.) van Gorkom, J. (Columbia)	HI content of powerful radio galaxies. 20 cm line.
AS-388	Seaquist, E. (Toronto) Smolinski, J. (Copernicus Astr.Ctr.)	Supergiant binary HR 8752. 1.3, 2, 3.5, 6, and 20 cm.
AS-389	Smith, B. (Texas) Lord, S. (NASA-Ames) Bushouse, H. (Northwestern)	HI structure in Arp 215 (NGC 2782) and Arp 284 (NGC 7714/5). 20 cm line.
AT-94	Taylor, A. (Calgary) Seaquist, E. (Toronto) Kenyon, S. (CFA)	Continued monitoring of the symbiotic stars Z and CH Cyg. 1.3, 2, 6, and 20 cm.

No.	Observer(s)	Program
AT-101	Torrelles, J. (IAA, Spain) Verdes-Montenegro, L. (IAA, Spain) Ho, P. (CFA) Rodriguez, L. (UNAM) Canto, J. (UNAM)	The thin rotating molecular disk in Cepheus A. 1.3 cm line.
AT-103	Tacconi, L. (Dwingeloo) van Woerden, H. (Kapteyn)	SO galaxies with molecular gas. 20 cm line.
AV-157	van Breugel, W. (LLNL) McCarthy, P. (Berkeley) Lilly, S. (Hawaii) Spinrad, H. (Berkeley)	B2 Jansky radio sources.
AV-165	Velusamy, T. (TIFR)	CTB 80. 90 cm.
AV-166	Velusamy, T. (TIFR) Venugopal, V. (TIFR)	Composite SNR G18.95-1.1. 6, 20, and 90 cm.
AV-170	Viallefond, F. (Meudon) Downes, D. (IRAM) Radford, S. (IRAM) Solomon, P. (Radio Millimetrique)	HI-CO emission in galaxies w/various star formation. 20 cm line.
AW-234	Williams, B. (Delaware) van Gorkom, J. (Columbia)	HI synthesis of four compact groups of galaxies. 20 cm line.
AW-235	Weinberg, D. (Princeton) van Gorkom, J. (Columbia) Szomoru, A. (Kapteyn) Gunn, J. (Princeton) Guhathakurta, P. (Columbia) Fruchter, A. (Carnegie)	A search for low luminosity, HI rich dwarf galaxies. 20 cm line.
AW-237	Wehrle, A. (Caltech) Jones, D. (JPL)	Optical jets in NGC 1097. 20 and 90 cm.
AW-238	Wolter, A. (CFA) Gioia, I. (CFA) Maccacaro, T. (CFA) Stocke, J. (Colorado) Morris, S. (Mt. Wilson)	Study of radio properties of X-ray selected BL Lac objects. 2, 6, 20, and 90 cm.
AW-239	White, S. (Maryland) Kundu, M. (Maryland)	Flare stars at high frequencies and impulsive phase of optical flares. 2 cm.

No.	Observer(s)	Program
AW-240	Wootten, H. A. Mundy, L. (Maryland) Wilking, B. (Missouri)	The star-forming center of a proto-stellar disk. 1.3 cm line.
AW-246	Wootten, H. A. Sahai, R. (Chalmers)	Circumstellar photochemistry: Si C2 and HC7N. 1.3 cm line.
AY-32	Yusef-Zadeh, F. (Northwestern) Anantharamaiah, K. (TIFR) Bastian, T.	Zeeman splitting in H92α emission from G0.1+0.08. 3.6 cm line.
BG-01	Gwinn, C. (Calif., Santa Barbara) Manchester, R. (CSIRO)	Speckles in a pulsar's scattering disk. 18 cm phased array VLB.

E. SCIENTIFIC HIGHLIGHTS

Green Bank

Pulsar Timing Array *(R. Foster and D. Backer, California, Berkeley)*

A mini-array for precision timing of pulsars has been established using the 140-foot telescope. The array consists of three millisecond pulsars which have been monitored regularly for about two years. Timing accuracies now are better than one microsecond. The array permits determination of various moments of a multipole expansion of the timing data. These moments help establish fundamental long-term time standards, solar system dynamics, and background radiation from primordial gravity waves.

Small Spiral Galaxy Found in Cosmic Void *(P. Henning and F. Kerr, Maryland)*

A hydrogen-line survey with the 300-foot telescope of a spatial region devoid of bright galaxies revealed a previously unknown spiral. The HI content of this galaxy is 2 percent, but its optical surface brightness is quite low, so low that it escaped detection in optical surveys of the void. The implication is that low surface brightness objects might be escaping detection in optical redshift surveys. Therefore, voids may have member galaxies whose presence is best detected by radio means.

Socorro

New Features of the Crab Nebula Pulsar Profile (T. *Hankins and M. McKinnon, NMIMT)*

The VLA was used in "phased array" mode in conjunction with the new High Time Resolution Processor (HTRP) to observe the Crab Nebula pulsar at 6 cm. In spite of the pulsar's very steep spectrum, the average profile was clearly seen at this short wavelength. With the VLA "resolving out" the strong Crab Nebula background, the signal to noise ratio was 100.

The observations have confirmed a preliminary result from Arecibo that has remained untested for the past decade. The main pulse/interpulse separation differs slightly from values obtained at lower frequencies. Furthermore, the VLA data show two new broad interpulses that have never been seen at lower frequencies. Apparently, the 6 cm observations penetrate sufficiently close to the stellar surface such that the effects of a quadrupole magnetic field are detectable. The new features may result from the additional magnetic polar caps beyond the two which are thought to form the main pulse and interpulse.

VLA HI Search for Dwarf Galaxies in Void *(D. H. Weinberg, Institute of Astronomy, Cambridge; A. Szomoru, Univ. Groningen; P. Guhathakurta, IAS, Princeton; J. H. van Gorkom, Columbia; J. E. Gunn, Princeton; and A. S. Fruchter, DTM)*

The VLA has been used to search for a population of low optical luminosity dwarf galaxies in the Pisces-Perseus supercluster and in the foreground void. The search was performed in the HI line in contrast to previous surveys, which almost all began with optically selected samples and which might therefore be biased against low surface brightness objects.

Approximately equal volumes (100 cubic megaparsec) were searched in void and supercluster. No dwarfs were found in the void, while ten were found in the supercluster, most of them lying close to known, optically bright galaxies. The results are consistent with the dwarfs being distributed like bright galaxies. It is perhaps surprising that we did not detect many more objects. These results may rule out some theoretical models that predict large numbers of low mass dwarfs.

The survey showed that the VLA is ideally suited to do such a search because of its wide field of view. In total, 42 fields were observed down to 5 sigma upper limits of 5×10^7 solar masses of HI at the center of the beam.

Tucson

CO in M83: Mapping with the Multibeam Receiver *(D. Adler, R. Allen, K. Lo, and S. Sukumar, all Illinois)*

The first results from the eight-beam, 230 GHz receiver have been obtained. One of the first projects was a natural choice for a rapid-mapping, multibeam receiver. This project was to observe the galaxy M83, which has a low declination and is only above the horizon at Kitt Peak for a few hours each day. M83 is a face-on spiral, and offers an excellent opportunity for study of the interstellar medium. The investigators had good success in following the CO emission along the spiral pattern of the galaxy, and intend to address problems relating to the interaction of CO with other phases of the ISM, the presence or lack of a spiral density wave characteristics, and the role of disruption of magnetic fields in the disk of the galaxy.

F. PUBLICATIONS

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

G. CENTRAL DEVELOPMENT LABORATORY

Amplifier Development

A new version of the 35-45 GHz amplifier has been built with experimental GE devices. The best amplifier revealed excellent room temperature performance (around 300 K across the band) and rather poor cryogenic performance (around 100 K) due to the properties of these particular devices at cryogenic temperatures. Work continues on another version of this amplifier using GE devices with proven cryogenic performance.

Two L-band, three-stage, 1.3-1.8 GHz amplifiers of a new design were built and tested: one with Fujitsu and the other with Mitsubishi devices. Both had similar performance: 2.8 K minimum, 3.2 K average at 13 K ambient temperature. The best L-band amplifier (S/N 322) of the old design built with GE HEMT's had similar performance if measured in the same system.

Assembly work on the last 12 (of a total of 91) of the Voyager-style 8.4 GHz amplifiers, two 8-18 GHz amplifiers and two 25-35 GHz amplifiers has been completed. Testing of these amplifiers is in progress.

A method and associated software for the Monte Carlo analysis of errors encountered in calibration of noise sources and noise temperature measurement has been developed. It is in preparation as an NRAO Electronics Division Internal Report.

Superconducting (SIS) Millimeter-Wave Mixer Development

Work continues on six SIS receiver modules for the new receivers to be installed on the 12-meter telescope early this year. These receivers will cover 68-90, 90-115, and 200-260 GHz with two polarizations in each band. Initial tests using Hypres junctions with integrated tuning structures gave overall receiver noise temperatures $19 \leq T_R \leq 30$ K DSB over most of the range 90-120 GHz. We are in the process of scaling this mixer for the 68-90 GHz band. In the 230 GHz band, using the new receiver, we have obtained $120 \leq T_R \leq 200$ K DSB over 200-230 GHz--about 60 K higher than in our old laboratory test receiver. We believe this to be a result of the slightly elevated mixer temperature and higher than expected loss in the teflon IR filter. The receiver noise temperature increases rapidly with frequency above 230 GHz, and we are still investigating the cause of this.

Collaboration on SIS mixer development continues with UVa, IBM Watson Research Center, and the University of Illinois/UC Berkeley. We have also been approached by IRAM to explore the possibility of collaborating as they develop a niobium-based process for fabricating SIS junctions.

During this quarter we have tested a total of 31 SIS mixers operating from 68-260 GHz.

Schottky Diode Millimeter-Wave Mixers and Multipliers

In support of the 12-meter telescope and millimeter-array site testing radiometers, we have built (or re-built) and tested a total of 21 Schottky mixers and multipliers in the 230, 300, and 345 GHz bands during this quarter.

Acousto-Optical Spectrometer Project

During this quarter, a part-time programmer was hired to assist with the development of test software. Firmware for the AOS microprocessor was written to allow rapid dumping of measured spectra to a PC. Software for the PC was written to allow simple analysis of the spectra, including display in numeric and graphic forms, computation of combinations of spectra, and computations of rms fluctuations within a spectrum. This should allow detailed testing of the system early in 1990.

H. GREEN BANK ELECTRONICS

A major project is underway to replace the collapsed 300-foot telescope with a state-of-the-art 100-meter class telescope. The Green Bank electronics division is supplying expertise to the design effort in a few areas. Several configurations of optics for an offset geometry telescope are being defined and evaluated. Lately, this effort has concentrated on an offset configuration with the feed arm at the top. Options for realizing an active surface are being evaluated; actuators and position transducers have recently been purchased for evaluation. Means of controlling the pointing accuracy to an arcsecond are being devised.

Interferometer Upgrade

The USNO is funding the upgrade of the Interferometer to improve their time-keeping capabilities. A major part of this upgrade includes the design and construction of new cryogenic receivers for the Green Bank three-element interferometer. The 85-3 telescope is to be operated as a VLBI terminal in conjunction with other USNO antennas. The 85-1 and 85-2 antennas are to be operated as a connected interferometer to continue a long-term flux monitoring program. Another aspect of the upgrade is the provision of a data acquisition terminal for the VLBI data. This terminal will consist of a VLBA data acquisition rack, longitudinal recorder, and control computer.

Effort this quarter concentrated on trying to reduce the delay noise in the data from the 85-3 VLBI antenna. This investigation determined that the phase of the 5 MHz reference through the single-mode fiber-optic cable was a significant contributor to this error. A temporary patch has been provided and a permanent fix is being constructed to significantly decrease the effect of the fiber on the baseline length.

Construction of modules for the data acquisition terminal continues.

140-Foot Cassegrain Receivers

The current 140-foot cassegrain receiver systems use parametric upconverters and 18-25 GHz masers to cover the 5-25 GHz frequency range. A project is underway to

replace the upconverters with HEMT amplifiers and to also extend the frequency range to greater than 30 GHz. The masers will be retained because of their significantly superior noise performance over current HEMT technology.

During this quarter testing of components for, and the design and development of, the LO system continued. It is estimated that the upgrade to 32 GHz is 80 percent complete, with completion of this part of the project slated for the second quarter of 1990. The level of effort on this project has been scaled down significantly due to manpower limitations.

Spectral Processor

The Spectral Processor is a high time resolution spectrometer capable of producing two 40 MHz spectra each 25.6 μs. A fair amount of flexibility, in terms of bandwidth, number of channels, and averaging time is included to make the instrument useful for spectroscopy. It has special signal averaging capabilities built-in to facilitate its use as a pulsar back-end.

A subsystem consisting of two IF to video converters and half of the digital electronics has been in operation for several months. The remaining seven IF to video converters are in various stages of testing and construction. Digital cards for the second half of the system and for spares are all assembled and about 75 percent have been tested.

Seven-Feed, 5 GHz Receiver

The amplifiers on this receiver were recently upgraded to HEMT's. Subsequent tests at the 140-foot were satisfactory except for long-term stability of a few of the detected outputs. During this quarter, several causes of this long term stability were identified and fixed. The major problems included poor contact of the shield of the center conductor of some semi-rigid cables due to an elongated center conductor and the susceptibility of the HEMT amplifier modules to vibration.

Miscellaneous

Construction of L-band VLBA receivers continues, with serial numbers 10 an 11 (the final two) essentially complete. Construction of the S-band receivers has begun. Construction of the 2 to 16 GHz VLBA local oscillators continues. Of the twelve units that we undertook to build this year, six are built and tested, and the remaining six are undergoing final testing.

I. 12-METER ELECTRONICS

Eight Beam Receiver and Hybrid Spectrometer in Use

The 230 GHz, Eight Beam Receiver and the new Hybrid Spectrometer are in now regular use by visiting observers. The first scheduled observations were performed in December. We are steadily ironing out the wrinkles in the system, and the data are rolling in quite reliably. The receiver tunes from approximately 215 to 240 GHz. The beam rotator is also working well; this permits the 2 x 4 array of beams to track parallactic angle, and so keep the mapping grid fixed in an RA / DEC frame as the

source moves in azimuth and elevation. The array of beams can track an arbitrary fixed position angle, allowing the array to take full advantage of the geometry of the source (e.g., by being aligned along the major axis of a galaxy).

All Eight Beam observations are taken through the new Hybrid Spectrometer, giving 192 spectral points, with a maximum of 300 MHz bandwidth, in each of the 8 beams. Two of the 8 beams are also recorded simultaneously through the filter bank system, which has been extremely useful during the test phase in providing an independent check on Hybrid Spectrometer performance. All comparisons between the Hybrid Spectrometer and the filter banks have been extremely favorable.

New Control System Modules Successfully Tested

The 12-meter staff is currently engaged in a program to replace the existing telescope control system with a modern, flexible system. The new control system is modular, with major control and data acquisition functions performed by independent microprocessor-based units. One advantage of this design is that these modules can be developed and tested independently. Several of the most critical modules have now been completed and tested at the telescope. Most notable of these is the Tracking and Antenna Servo system. This system, which controlled by a Motorola 68030 microprocessor running under the VxWorks system, has been successfully tested at the telescope twice, in November and December. The stand-alone system is fully functional, and is able to track both sidereal and ephemeris objects. The optical telescope was used to check accurate tracking of the system. This is the first time that the Kitt Peak 12-meter telescope has been controlled independently of FORTH.

In addition to the servo and tracking system, a status and monitor bus system, and control over frequency synthesizers have been tested. The work yet to be finished involves data acquisition, high level control and the user interface, and system integration. We plan to continue development and testing of the new control system with minimal impact on regular telescope observing time.

New SIS Receivers.

The 12-meter staff, together with the Central Development Laboratory, has been developing a new generation of SIS receiver for the 12-meter telescope. On a time scale of about one year, the Observatory expects to have dual polarization SIS receivers covering all the atmospheric windows available to the 12 meter, from 70 to 360 GHz. Considerable progress on these receivers has been completed in the last quarter. A 4 K, closed cycle refrigerator system and an 8 port cryostat is ready for use on the 12-meter telescope. Also completed are mounts for the mixer blocks and optics, known as "rockets." SIS junctions for the 3 mm and 1.3 mm bands have been produced at the CDL.

The first cryostat is now in the Tucson labs and is being outfitted to go on the telescope in March of 1990. At first, the cryostat will house a 200-260 GHz (1.3 mm), dual polarization mixer set. Eventually, this cryostat will hold 3 mm and 2 mm, dual polarization mixers.

J. VLA ELECTRONICS

Improvements in Antenna Pointing

Antenna pointing errors degrade the performance of synthesis telescopes at both low and high frequencies. At low frequencies strong background sources are randomly located in the primary beam and pointing errors then limit the achievable dynamic range. At high frequencies the pointing errors become a significant fraction of the primary beamwidth so the source being imaged is affected directly. For example, at 44 GHz a 20" pointing error causes a 30 percent change in amplitude. Solar-induced tilts, which used to dominate our pointing errors, have been greatly reduced through external insulation of the antenna yoke and base support.

An important pointing problem being investigated now 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 believed to be 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. Testing of the stability of the redesigned tilt-meter units show a long-term stability of about 3 arcseconds. Eight units have been fabricated and tested. Two VLA antennas have been outfitted with two sets of tilt-meters on each antenna. Engineering testing of these four units installed on the antenna are complete. Further system testing will continue through 1990.

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 low frequencies is required to better understand the type of algorithm needed. To do this, we are equipping the current 25-meter antennas with simple dipole-type feeds. Note that if every 25-meter antenna had such a feed the entire 3C and 4C catalog could be mapped at 75 MHz with the same resolution as the original 1400 MHz aperture synthesis catalog done at Cambridge. The cost of this outfitting is very modest.

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.

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 most of the coherent RFI between antennas. However, the remainder still limits use of the 327 MHz system, so enclosing the radiating components with RFI shields is necessary.

Four prototype RFI enclosures for the vertex mounted "B" racks have been installed and tested. The remaining RFI enclosures have not been procured due to an increase in cost by a factor of two. These RFI enclosures eliminate the remaining antenna-generated interference at 327 MHz. There is still some locally generated RFI noticeable at 75 MHz. An in-house design for a new RFI enclosure has started.

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 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 HEMT amplifiers as those used on the VLBA, 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 Green Bank 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 past year, resulting in a system temperature of about 35 K. Two more systems modifications of this type are scheduled for 1990.

High Time Resolution Processor

We have been planning for some time to instrument the VLA with a high time resolution processor (HTRP). The system is planned for observations of the time varying phenomena like flare stars, pulsars etc., and monitoring radio frequency interference (RFI). As an intermediate step, a system has been designed that will utilize existing components such as the analog sum phased array outputs of the VLA, and VLBI MK III IDF-Video converter system, used as tunable filters with selectable bandwidths. This would provide 14 pairs of RCP and LCP frequency signals from the phased array VLA. Total power detectors and cross multipliers are used to measure all four products with integration period of 25 microsececonds to 5 milliseconds. Prototype of these circuits have been tested and components for the mass production are on order. The data acquisition system is a 64-channel multiplexer and a 12 bit analog to digital converter with maximum sampling rate of 100,000 samples/sec, installed in a 386-based 20 MHz clock speed personal computer with 140 MB hard disk. The data acquisition system has been used to obtain 2-channel phased array VLA signals for developing software and understanding the system stability problems. Fabrication of the interfacing subsystem was started in the second quarter of this year and was completed during the fourth quarter. The fabrication of the 64-channel system has started.

K. AIPS

The overhauled version of the AIPS code was finally formally released as the 15OCT89 version. The purpose of this overhaul was to create more efficient code and a better coding environment; these goals have been achieved. The code is now in a standard version of Fortran 77, with a preprocessor to handle included source code files and to do some character processing. Starting with this release, all user sites are required to sign a User Agreement for AIPS; this is a no-cost item for sites engaged in basic research in astronomy. The most important reason for this is to require that all user sites obtain their copies of the AIPS code directly from the NRAO.

The most recent release of AIPS has been successfully installed on SUN workstations (both the model 3s and the Sparcstations) with the most recent revisions of the operating system and compiler.

In order to provide a quicker response to problems, the AIPS group is trying a new program whereby one member of the programming staff is designated to the task of fixing bugs as they are discovered by users. This tour of duty currently lasts for two weeks, after which time he resumes his normal duties. The program has, so far, been successful. Its continuance will depend upon a positive review in the next quarter.

Most of the recent development in AIPS has been in the calibration package for interferometer data. This is now complete for VLA data; and most of the functions required for the reduction of VLBI data, in particular from the VLBA, are also available. The compressed data format, which can reduce disk storage requirements by a factor of 2 to 3, is now supported by all of the calibration tasks. It may be used in all cases except those few experiments requiring high spectral dynamic range or high dynamic range images.

L. VLA COMPUTER

On October 16 the DEC10 SYSTEM was finally turned off. This general purpose computer served the VLA for almost 15 years. Several DEC10 peripherals were moved to the AOC for use on two VAX 780 systems. The LP27 line printer is now available for text output. The Dicomed film recorder was moved to the AOC and is connected to the YUCCA Convex C1. This film recorder will be available for production use in January 1990. VLA data reduction at the site is limited to the OUTBAX VAX 750 machine. Since most data reduction will now be done at the AOC, duplicate archive data tapes are made and sent to the AOC daily. Original data archive tapes are stored at the VLA site and are not to be used except for making copies.

The replacement program for the DEC10 OBSERV program has been in use since last summer. This new OBSERVE program is still under development but is available on any NRAO VAX machine. Development of a PC version continues and should be available soon. Once users are happy with the design the PC version will be converted to run on our Unix machines. The VLA computer division is committed to providing a flexible and easy to use OBSERVE program. Users have complained about the complex interface and the execution speed of the current release. Efforts are being made to address both of these issues.

Workstations are becoming a major part of the AOC computing environment. There are now four SUN 3/60 workstations for image display and four Sparcstations for program development, and a fifth on order. In addition, two scientific staff members have Sparcstations in their office. Most of these systems run diskless using our Convex C1 as a disk and compute server. It is clear that in the near future Unix based workstations will play a major role in NRAO computing. One objective for this coming year will be to replace our ageing VAX 780's with a powerful disk server. This will provide increased support for the growing number of workstations and allow the Convex C1's to be used more fully as compute servers. Software efforts in the coming year will increasingly be designed around the distributed computing model, with standards such as Unix and X Windows providing the framework for future development.

M. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

The Fort Davis, TX antenna observed "first light' in early December. In October the first three-site VLBA network (Pie Town, Kitt Peak, and Los Alamos) yielded MK II fringes at 18 cm in a test run. Both Pie Town and Kitt Peak sites participated in November's 3.6 and 18 cm Network observations and Pie Town supported Crustal Dynamics observations during October and December. Also in December, the first four antennas were formally accepted from their manufacturer after correction of all outstanding punch-list items.

Outfitting was completed at the Fort Davis, TX site during the last quarter. Testing and debugging continues at Fort Davis. Outfitting at the North Liberty, IA antenna is scheduled to start in February, weather permitting. At the Owens Valley, CA site, erection of the antenna is almost complete. At Brewster, WA erection of the antenna is about 50 percent complete and scheduled for completion in April. At St.

Croix, VI the site preparation has been halted due to the aftermath of Hurricane Hugo causing delays. At Hancock, NH construction of the antenna foundation and building continue. Completion of site preparation at Hancock is scheduled for May 1990. At the Mauna Kea, HI site, acquisition problems have been substantively resolved. Construction drawings and specifications are being completed for submission to local authorities for approval and for the construction bid package.

Electronics

As 1989 closes, the major part of the electronic construction scheduled for the year is complete. The plans called for electronics racks through serial #9 to be completed, and of these only the ninth A and B-racks require some further wiring which will be finished by the end of January. The plan also called for completion of D-racks through #8, and the last of these will require about another four weeks to finish. Modules are largely complete except for the Baseband Converter modules of the D-racks. The first of these to be built by NRAO from the Haystack design was tested in August of this year. It was found that final adjustment took longer than expected, and that the sideband isolation of the baseband mixer fell about 2 dB short of the desired specification. These problems were in part due to use of some capacitors with inadequate tolerances, which are now being replaced. Some further selection of matched components in the mixers will be necessary, so a little more manpower and time is required than had been anticipated.

In the area of front ends, construction of 1.5 GHz units through #11 has been completed. This is the total required for the array, including one spare. Front ends for 2.3 GHz have been redesigned to incorporate a larger refrigerator unit (CTI model 350) since the small refrigerator used with the prototype unit has proved to be marginal in cooling capacity with the large polarizer needed at 2.3 GHz. The first of the new 2.3 GHz units is being completed as the year closes, and parts for two more have been obtained from the year's funding. Production of front ends for 8.4 and 23 GHz is keeping well ahead of outfitting requirements, and the design of the front end for 43 GHz is well advanced. The first 43 GHz unit should be ready for installation on an antenna by March 1990.

Construction for 1990 will complete the A-, B-, and C-racks, and the front ends for 4.6 and 23 GHz. These will include units for all ten antennas plus one spare set for the laboratory test system. During the final month of 1989, some time has been spent on placing orders for those items of the 1990 construction that require the longest lead times in procurement.

Data Recording

Checkout of completed production recorders at Haystack Observatory is well underway. In December NRAO authorized a second production run of eight additional systems (seven plus a complete parts kit). This brings the total contracted number of combined acquisition and playback units to twenty-one (nineteen for the VLBA and two for the USNO). Tape drives for this production run, as well as for spare and future systems, are being purchased under an NRAO contract to Honeywell's Test Instrument Division for ten Model 96 tape transports. These include the latest modifications developed jointly with Haystack. Honeywell has completed its first production run of narrow track headstacks for JPL-NASA. If these pass acceptance tests, the following batch, available to the VLBA, is expected in late January. AUI

has issued an RFP to provide operational test quantities of thin base, high resolution magnetic recording tape similar to the D-1 and Super-VHS samples laboratory tested by Haystack. Both domestic and foreign manufacturers have been solicited. Responses are expected by mid-February. Prototype modules for the playback units (PBDs), the bit synchronizer and parallel read boards, are now developed. Their checkout at Haystack is expected in January.

Monitor and Control

During fourth quarter 1989 our primary concern has been with the conversion of the array control software to run under the VxWorks operating system. We are in the final stages of producing a disk resident version of the operating system (the default residence is on a UNIX host). We have converted some of the screen programs to run under VxWorks, using the screen package written in Charlottesville, but are finding performance problems which will have to be corrected. Work is nearing completion on the basic time keeping and antenna pointing task, TIC, and some preliminary effort on the monitor data logging program, LOGER has been made. Our current goal is to try operation of Pie Town under VxWorks in February.

Correlator

Progress toward completion of the correlator hardware continues to be impeded by the inability of the two joint vendors, Hall-Mark Electronics and LSI Logic, to deliver satisfactory prototypes of the "FX" chip. After a month of apparently inconclusive investigation of the failed second prototype, a meeting between NRAO and the two vendors was held on November 7 at the offices of LSI Logic. Discussion of the failure led to a tentative attribution to inadequate power distribution in LSI Logic's standard layout for the on-chip memory--the same logic element in which erroneous address configuration had been identified as causing failure of the first prototype. It was decided to remedy this flaw in a third prototype fabrication, and to begin work in parallel toward transferring the FX chip design to one of several alternative technologies. A regular weekly teleconference involving all parties was established to monitor progress in both these directions.

Both efforts have been receiving apparently serious and competent attention toward expeditious completion. Nevertheless, the recently completed third prototype now appears also to have failed, although the testing and analysis necessary to characterize the new problem are still in process. Work is already well advanced on a "custom structured array" version of the FX chip, which will be essentially similar except that the standard on-chip memory will be replaced by a block which is known to perform satisfactorily in other applications. Delivery of this product in prototype is not expected until near the end of the next calendar quarter--somewhat more than a year behind the original schedule. However, it has been possible to checkout prototype printed circuit boards, despite the lengthy delay in procuring functional FX chips, by utilizing the 24 second-prototype units delivered to NRAO, but at elevated voltage to make some of them fully operable. Correlator software development continued unabated.

Data Processing

The bulk of the software needed for the normal processing of astronomical data from the VLBA is currently available and in routine production use. There are three

general areas which need to be developed: 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).

Software development this quarter consisted of further development of editing and spectroscopic calibration functions and the debugging and making minor improvements to the calibration software. In particular, progress has been made in the processing of MkIII VLBI data which is very similar to VLBA format data.

Talks have started with vendors of minisupercomputers, with benchmarking expected to start later this year.

N. PERSONNEL

New Hires

Biretta, J. A.	Research Associate	10/13/89
Puche, D.	Research Associate	10/16/89
Merrill, D. C.	Structural Engineer I	10/23/89
Hall, R. D.	Assistant Director/GBT Project Mgr.	11/01/89
Seaman, D. M.	Mechanical Engineer I	11/20/89
Andre, P. J.	Research Associate	12/01/89

Terminations

Machalski, J.	Visiting Scientist	12/20/89
Leahy, J. P.	Research Associate	12/22/89
Granlund, J.	Electronics Engineer I	12/29/89
Peery, G. M.	Civil Engineer I	12/29/89

Promotions

Payne, R. R.	to Head/VLA Computer Division	10/01/89
Lagoyda, J. P.	to Business Manager/SOC Operations	11/01/89
Dowling, J. F.	to Assoc. Business Manager/SOC Oper.	11/01/89

Title Change

Hunt, G. C.	to Sr. Systems Analyst/Assoc. Div. Head	11/01/89
Braun, A. O.	to Sr. Sci. Programming Analyst	10/01/89
Brundage, W. D.	to Elec. Engineer/Assoc. Division Head	10/01/89
Porter, W. H.	to Executive Assistant	11/01/89

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