NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

January - March 1987

CONTENTS

A. TELESCOPE USAGE

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

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1923.25	1830.50	1859.75	1557.30
Scheduled maintenance and equipment changes	120.75	116.25	82.00	219.80
Scheduled tests and calibrations	100.00	67.25	187.25	372.80
Time lost	199.25	83.00	337.25	-
Actual observing	1724.00	1747.50	1522.50	1445.49

B. 140-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
F-95	Fomalont, E. Ebneter, K. (Berkeley) van Breguel, W. (Berkeley) Ekers, R.	Mapping of Fornax A at 1380 and 1640 MHz.
H-215	Hegyi, J. (Michigan) Kutner, M. (Rensselaer)	Search at 1 cm and 3 cm for small scale anisotropy in the cosmic background radiation.
L-206	Lehto, H. (Virginia) Saslaw, W. (Virginia) Valtonen, M. (Turku) Heeschen, D. Seielstad, G.	Observations at 20 GHz of OJ 287 simultaneous with VLA and Metsahovi observations.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
B-457	Bell, M. (Herzberg) Matthews, H. (Herzberg) Sears, T. (Brookhaven)	An attempt at 1.3 cm to identify the carrier of a linear molecule detected in TMC-1.

No.	Observer(s)	Program
B-458	Bell, M. (Herzberg) Avery, L. (Herzberg) Matthews, H. (Herzberg) Sears, T. (Brookhaven)	Search over the range 21.09 - 21.35 GHz for C_5H in TMC-1.
B-460	Bell, M. (Herzberg) Seaquist, E. (Toronto)	Observations at 18.34 GHz of C_3H_2 in emission in Centaurus A.
C-240	Combes, F. (Meudon) Bogey, M. (de Lille) Destombes, J. (de Lille) Demuynck, C. (de Lille) Encreanaz, P. (Meudon) Gerin, M. (Meudon) Wootten, H. A.	Observations at 1.5 cm to verify the detection of interstellar C_3H_2 and to search for isotopic variants.
C-249	Claussen, M. (Massachusetts) Cobb, M. (Arizona) Kleinmann, S. (Massachusetts)	Observations of 18 cm OH emission in spectral class M stars selected from the IRAS Point Source Catalog.
I-5	Irvine, W. (Massachusetts) Friberg, P. (Chalmers) Hjalmarson, A. (Chalmers) Madden, S. (Massachusetts) Matthews, H. (Herzerg) Ziurys, L. (Massachusetts) Turner, B.	Spectral scan between 19-22 GHz of molecular clouds, particularly the cold clouds TMC-1 and L134N.
L-205	Likkel, L. (UCLA) Morris, M. (UCLA)	OH and H_2O maser observations at 1.3 cm of dense circumstellar shells.
M-256	Madden, S. (Massachusetts) Avery, L. (Herzberg) Irvine, W. (Massachusetts) Matthews, H. (Herzberg)	Multi-transitional study at 18.3 and 21.6 GHz of C_3H_2.
M-261	Madden, S. (Massachusetts) Irvine, W. (Massachusetts) Matthews, H. (Herzberg)	Observations at 1.3 and 1.6 cm of the ^{13}C isotopic species of C_3H_2.
M-263	Matthews, H. (Herzberg) Sears, T. (Brookhaven)	Sensitive search for CH_2NCN at X and K bands.
T-210	Turner, B.	Observations at 1.3 cm for small ring molecules of relevance to C_3H_2.
T-218	Turner, B. Rickard, L. J (Applied Research)	Observations at 18.3 and 21.6 GHz for C_3H_2 in infrared cirus.

No.	Observer(s)	Program
T-225	Tacconi-Garman, L. (Massachusetts) Schloerb, F. (Massachusetts) Claussen, M. (Massachusetts)	Observations at 18 cm of OH in Comet Wilson.
W-228	Wlodarczak, G. (de Lille) Bogey, M. (de Lille) Combes, F. (Millimetrique) Encrenaz, P. (Meudon) Gerin, M. (Ecole Normale Superieure) Wootten, H. A.	Search at 1.5 cm for lines of acetone and HN_2O^+ in the interstellar medium.
Z-54	Ziurys, L. (Massachusetts) Irvine, W. (Massachusetts) Minh, Y. (Massachusetts)	Search at 1.3 cm for protonated CO_2 in dark clouds.

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

A - Arecibo 1000 ft
B - Effelsberg, MPIR 100 m
F - Fort Davis 85 ft
G - Green Bank 140 ft
H - Hat Creek 85 ft
I - Iowa 60 ft
Jb - Jodrell Bank Mk II
Km - Haystack 120 ft
Lb - Bologna 25 m
Lm - Medicina 32 m
M - Nobeyama 45 m
N - NRL Maryland Pt 85 ft
O - Owens Valley 130 ft
R - Crimea USSR 30 m
Sn - Onsala 20 m
So - Onsala 25 m
Wn - Westerbork n=1-27x25 m
Yn - Socorro n=1-27x25 m
Z - Torun 15 m

No.	Observer(s)	Program
B-68V	Bartel, N. (CFA) Boriakoff, V. (Cornell) Cappallo, R. (Haystack) Gwinn, C. (CFA) Ratner, M. (CFA) Shapiro, I. (CFA) Sieber, W. (MPIR, Bonn)	Pulsar astrometry at 18 cm, with telescopes G, O, and Yn.
B-76V	Bartel, N. (CFA) Rupen, M. (CFA) Shapiro, I. (CFA)	Observations at 2.8 cm of the unique new source SN 1986J, with telescopes B, F, G, H, Km, Lm, and O.
F-12V	Flatters, C. (MPIR, Bonn)	Observations at 2.8 cm of the polarization of the quasar 4C 39.25, with telescopes B, F, G, H, Km, Lm, and O.

No.	Observer(s)	Program
F-13V	Fey, A. (Iowa) Cordes, J. (Cornell) Dickey, J. (Minnesota) Mutel, R. (Iowa) Spangler, S. (Iowa)	Measurements at 18 cm of the Galactic distribution of angular broadening at low galactic latitudes, with telescopes B, F, G, H, I, Km, Lb, O, and Yn.
G-52V	Geldzahler, B. (NRL) Fomalont, E.	Second epoch 18 cm observations of the NE radio lobe of Sco X-1, with telescopes F, G, H, N, O, and Yn.
H-31V	Hough, D. (JPL) Readhead, A. (Caltech)	Mapping at 2.8 cm of the superluminal core in the double-lobed quasar 3C 245, with telescopes B, F, G, H, Km, Lm, and O.
J-43V	Johnston, K, (NRL) Wilson, T. (MPIR, Bonn)	Observations at 1.3 cm of methanol masers in W3, NGC 7538, and Orion, with telescopes B, G, Km, and N.
L-45V	Lawrence, C. (Caltech) Booth, R. (Chalmers) Burke, B. (MIT) Jones, D. (JPL) Linfield, R. (JPL) Porcas, R. (MPIR, Bonn) Preston, R. (JPL) Readhead, A. (Caltech) Schilizzi, R. (NFRA)	Strong source survey at 1.3 cm, with telescopes B, G, Km, O, Sn, and Yn.
M-63V	Mutel, R. (Iowa) Phillips, R. (Haystack)	Monitor at 2.8 cm the superluminal motion in BL Lacertae, with telescopes B, F, G, H, Km, and O.
M-81V	Marscher, A. (Boston) Shaffer, D. (Interferometrics)	Observations at 2.8 cm of superluminal motion amid stationary structure in 4C 39.25 with telescopes B, F, G, H, Km, and O.
M-82V	Moran, J. (CFA) Downes, D. (IRAM) Genzel, R. (Berkeley) Greenhill, L. (CFA) Gwinn, C. (CFA) Hirabayashi, H. (Nobeyama) Reid, M. (CFA)	Precise measurements at 1.3 cm of the H_2O maser positions in M33/IC 133, with telescopes B, G, Km, M, O, and Yn.
M-83V	Marscher, A. (Boston) Shaffer, D. (Interferometrics)	Multifrequency observations at 1.3 and 18 cm of 4C 39.25 with telescopes B, G, Jb, Km, Lm, N, O, Sn, and Yn.

No.	Observer(s)	Program
P-66V	Pauliny-Toth, I. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) Zensus, A. (Caltech) Kellermann, K.	Monitoring at 2.8 cm of 3C 454.3, with telescopes B, F, G, H, Km, Lm, and O.
P-76V	Pilbratt, G. (Chalmers) Baath, L. (Chalmers) Nicolson, G. (Hartebeesthoek) Porcas, R. (MPIR, Bonn)	Observations at 18 cm of structural variations and the mass jet in 3C 279, with telescopes A, B, F, G, H, Jb, Km, Lm, N, O, R, So, Wn, Yn, and Z.
S-64V	Spencer, R. (Manchester) Junor, W. (Manchester) Muxlow, T. (Manchester)	Submilliarcsecond mapping at 1.3 cm of the nucleus of M87 with telescopes B, G, Jb, Km, Lm, N, O, Sn, and Yn.
W-44V	Wouterloot, J. (MPIR, Bonn) Diamond, P. (MPIR, Bonn) Henkel, C. (MPIR, Bonn)	Observations at 1.3 cm of the closest H_2O maser, with telescopes G, Km, N, and O.
X-48	van Breugel, W. (Berkeley)	Observations of the double QSO 1145-071, with telescopes G, O, and Yn.
Z-14V	Zensus, A. (Caltech) Biretta, J. (CFA) Cohen, M. (Caltech)	Observations at 2.8 cm of the superluminal motion in 3C 273 and 3C 345, with telescopes B, F, G, H, Km, Lm, and O.
Z-15V	Zheng, X. (Nanjing, China) Moran, J. (CFA) Reid, M. (CFA)	Observations at 18 cm of OH masers toward the cometary nebula G 34.3+0.2, with telescopes F, G, H, Km, O, and Yn.

C. 300-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
A-82	Aller, H. (Michigan) Aller, M. (Michigan) Payne, H.	Observations at 880, 1400, and 2700 MHz of low frequency variable sources.
O-32	O'Dea, C. Balonek, T. (Colgate) Dent, W. (Massachusetts) Kinzel, W. (Massachusetts)	Polarization and flux density measurements of variable sources at 2695 MHz.
S-300	Spoelstra, T. (NFRA) Verschuur, G. (unaffiliated)	Observations at 408 and 610 MHz of the linear polarization of galactic radio emission.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
B-471	Baan, W. (Arecibo) Haschick, A. (Haystack) Henkel, C. (MPIR, Bonn)	Observations at 18 cm for OH in selected IRAS galaxies.
H-222	Haynes, M. (Cornell) Dunphy, J. (MIT) Giovanelli, R. (Arecibo) Magri, C. (Cornell) McLeod, B. (Cornell)	Observations of HI in selected Sa, Sc, and possible dwarf galaxies.
K-301	Kerr, F. (Maryland) Henning, P. (Maryland)	Pilot search for galaxies behind the Milky Way by the study of HI.
T-224	Tifft, W. (Arizona) Cocke, W. (Arizona)	Observations at 21 cm of quantization and time variability in galaxy redshifts.
R-234	Richter, O-G. (STScI)	Survey of HI at all right ascensions between $-19 < \delta < 0$.

The following pulsar program was conducted during this quarter.

No.	Observer(s)	Program
B-442	Backer, D. (Berkeley) Clifton, T. (Berkeley) Foster, R. (Berkeley Heiles, C. (Berkeley) Kulkarni, S. (Caltech) Rand, R. (Caltech) Werthimer, D. (Berkeley)	Real-time fast pulsar search of the galactic plane at 390, 825, and 1400 MHz.

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

No.	Observer(s)	Program
B-454	Bowyer, S. (Berkley) Backer, D. (Berkeley) Berezin, A. (Berkeley) Clifton, T. (Berkeley) Kulkarni, S. (Caltech) Werthimer, D. (Berkeley)	Observations at 390, 825, 1400, and 2695 MHz for narrow-band radio signals of extra-terrestrial origin.

D. 12-METER OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
B-446	Black, J. (Arizona) Bernath, P. (Arizona)	A search for interstellar MgH.
B-461	Backer, D. (Berkeley) Plambeck, R. (Berkeley) Wright, M. (Berkeley) Carlstrom, J. (Berkeley) Rogers, A. (Haystack)	VLBI at 100 GHz
B-469	Barvainis, R. Clemens, D. (Arizona)	Study of the polarimetry of dust emission at 1 mm.
C-243	Churchwell, E. (Wisconsin) Woods, R. (Wisconsin)	Observations of interstellar SO^+ (J=11/2-9/2).
E-53	Evans, N. (Texas) Serabyn, G. (MPIR, Bonn) Gusten, R. (MPIR, Bonn)	CS J=5-4 observations of the neutral disk in the galactic center.
F-99	Feldman, P. (Herzberg) Nakanaga, T. (unaffiliated) Amano, T. (Herzberg) Saito, S. (Nagoya, Japan)	Search for protonated H_2S (SH^+_3) in interstellar clouds.
G-292	Gordon, M.	0.87 mm observations of compact HII regions.
G-295	Gordon, M. Jewell, P. Salter, C. (IRAM)	Observations of dust emission in HII regions.
H-187	Hollis, J. M. (NASA/GSFC) Snyder, L. (Illinois)	Search for the 1-0 line of NaH.
H-227	Hollis, J. M. (NASA/GSFC) Churchwell, E. (Wisconsin) DeLucia, F. (Duke) Herbst, E. (Duke)	Search for the confirming P(3,2) transition of hydronium (H_3O^+).
H-228	Huggins, P. (New York) Healy, A. (New York) Nyman, L. (CFA)	Study of silicon depletion in oxygen-rich circumstellar envelopes.

No.	Observer(s)	Program
H-231	Ho, P. (CFA) Turner, J. (UCLA) Martin, R. (Arizona) Hora, J. (Arizona)	J=3-2 CO study of nearby external galaxies.
J-119	Jaffe, D. (Texas) Lugten, J. (Berkeley) Stacey, G. (Berkeley) Genzel, R. (MPIR, Bonn) Stutzki, J. (MPIR, Bonn) Harris, A. (MPIR, Bonn) Howe, J. (Texas)	CO 2-1 observations of strong CO 7-6 sources.
L-211	Lada, C. (Arizona) Adams, F. (Berkeley) Walker, C. K. (Arizona)	1 mm continuum observations of T Tauri stars
L-215	Lada, C. (Arizona) Young, E. (Arizona) Walker, C. K. (Arizona) Maloney, P. (Arizona)	Search for infall around candidate protostars.
M-266	Muhleman, D. (Caltech) Dulk, G. (Colorado) Berge, G. (Caltech) Spencer, M. (Caltech)	Study of CO isotope ratio in the atmosphere of Venus/Saturn.
M-268	Myers, P. (CFA) Fuller, G. (Berkeley) Terebey, S. (Caltech)	Study of internal motions in star-forming cores.
S-307	Sahai, R. (Onsala)	Survey of SiO and CS (V=10) J=6-5 lines: inner envelopes of red giants.
S-310	Schwartz, P. (NRL) Mozurkewich, D. (NRL)	Study of broad CO wings in IRAS sources.
T-194	Turner, B. Ziurys, L. (Massachusetts)	Search for interstellar NaH.
T-213	Thronson, H. (Wyoming) Maloney, P. (Arizona) Walker, C. K. (Arizona) Walker, C. E. (Arizona)	Study of 1.3 mm continuum emisison from galaxies.
T-215	Turner, B. Steimle, T. (Arizona)	Search for interstellar CaH.

No.	Observer(s)	Program
T-223	Turner, B.	Study of hot, vibrationally excited molecules.
W-221	Wannier, P. (Gothenburg) Sahai, R. (Onsala) Andersson, B. (Gothenburg)	Study of red giant stars in transition.
W-222	Wannier, P. (Gothenburg) Andersson, B. (Gothenburg) Johnson, H. (Indiana)	Survey of carbon stars.
W-224	Walker, C. K. (Arizona) Lada, C. (Arizona) Young, E. (Arizona) Maloney, P. (Arizona)	Proposal to map the infall velocity field around IRAS 1629A.
Z-60	Ziurys, L. (Massachusetts)	Confirmation of a detection of interstellar PN.
Z-62	Ziurys, L. (Massachusetts) Blake, G. (Berkeley)	Search for vibrationally excited molecular ions.

E. VLA OBSERVING PROGRAMS

No.	Observer(s)	Program
AA-59	Alexander, P. (MRAO) Baldwin, J. (MRAO) Warner, P. (MRAO)	Energetics of the radio halo in A2256 and A2319. 90 cm.
AA-62	Anantharamaiah, K.	Recombination line and continuum towards W44. 20 and 90 cm line.
AA-63	Appleton, P. (Iowa State) van Gorkom, J. Ghigo, F. (Minnesota) Struck-Marcell, C. (Iowa State)	HI observations of Arp 143 (NGC 2445/4). 20 cm line.
AA-64	Antonucci, R. (STScI) Barvainis, R.	Testing the synchrotron hypothesis for quasar infrared emission. 1.3, 2 and 6 cm.
AA-65	Andre, P. (CEN Saclay) Montmerle, T. (CEN Saclay) Feigelson, E. (Penn State)	Detailed study of three young radio stars in the Ophiuchi cloud. 6 and 20 cm.

No.	Observer(s)	Program
AA-66	Anantharamaiah, K. Payne, H. Erickson, W. (Maryland)	Recombination lines from cold gas towards Cas A. 90 cm line.
AB-129	Burke, B. (MIT) Hewitt, J. (Haystack) Roberts, D. (Brandeis)	Monitoring time variations in 0957+561. 6 cm.
AB-343	Bosma, A. (Marseille) Carignan, C. (Kapteyn Lab) Marcelin, M. (Marseille) Athanassoula, E. (Marseille)	NGC 300. 20 cm line.
AB-377	Bicknell, G. (Mt. Stromlo) Carter, D. (Mt. Stromlo) Killeen, N.	NGC 3557. 6 and 20 cm.
AB-396	Braun, R. Walterbos, R. (Leiden) Brinks, E. (ESO)	The interstellar medium of M31. 20 cm line.
AB-405	Brown, A. (Colorado)	Bipolar flow source IRS7 and other PMS radio sources in Corona Australis. 1.3, 2, 6 and 18 cm.
AB-407	Bally, J. (Bell Labs) Stark, A. (Bell Labs) Wilson, R. (Bell Labs) Yusef-Zadeh, F. (NASA/GSFC)	Survey of ten degrees near the galactic center. 6 and 20 cm.
AB-414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring flux of HD 193793 and P Cygni. 2 and 6 cm.
AB-419	Braun, R. Liszt, H.	Wide-field imaging of four galactic HII region complexes. 20 cm.
AB-421	Boyle, B. (Edinburgh) Mead, A. (Edinburgh) Miller, L. (Royal Obs.) Peacock, J. (Royal Obs.) Shanks, T. (Durham)	Radio properties of a faint optically-selected QSO sample. 20 cm.
AB-423	Barthel, P. (Caltech) Lonsdale, C. (Haystack) Miley, G. (STScI)	Radio morphologies of low-redshift quasars at 15 GHz. 2 cm.
AB-424	Bertout, C. (Berkeley) Cabrit, S. (Massachusetts)	The ionized wind of Lk H alpha 234. 1.3, 6 and 20 cm.

No.	Observer(s)	Program
AB-425	Bertout, C. (Berkeley) Roland, J. (IAP, Paris) Andre, P. (IAP, Paris)	Radio emission from young stellar objects. 1.3, 6 and 20 cm.
AB-429	Barsony, M. (Caltech)	Bipolar flow core source S87. 2 and 6 cm.
AB-430	Bookbinder, J. (Colorado) Walter, F. (Colorado) Linsky, J. (Colorado)	Search for magnetic dynamos in early F dwarf stars. 6 cm.
AC-166	Carilli, C. (MIT) Dreher, J. (MIT) Perley, R.	Further studies of Cygnus A. 2 cm.
AC-168	Casertano, S. (Princeton) van Gorkom, J.	Search for late-type disk galaxies with extended HI envelopes. 20 cm line.
AC-172	Caganoff, S. (Mt. Stromlo) Bicknell, J. (Mt. Stromlo) Ekers, R.	Relationship between optical and radio properties of powerful extragalactic radio sources. 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. 6 cm.
AC-177	Campbell, B. (New Mexico)	Survey of young stellar objects in the southern galactic plane. 6 cm.
AC-178	Caillault, J-P. (Colorado) Patterson, J. (Columbia)	Variability of V471 Tau. 6 cm.
AC-179	Chanmugam. G. (Louisiana State) Bastian, T. (Colorado) Dulk, G. (Colorado)	Radio emission from magnetized cataclysmic variables. 2, 6 and 20 cm.
AC-180	Claussen, M. (Massachusetts) Wilking, B. (Missouri)	Water masers associated with the Rho Ophiuchus protostar. 1.3 cm.
AC-183	Coleman, P. (Groningen) Surdej, J. (Liege) Turnshek, D. (STScI) Briggs, F. (Pittsburgh)	Broad absorption line QSOs. 2, 6 and 20 cm.

No.	Observer(s)	Program
AC-185	Cohen, N. (Bentley College) Feldman, P. (Herzberg) Costain, C. (Herzberg)	Survey of precision-radial-velocity stars. 6, 20 and 90 cm.
AD-188	Drake, S. (NASA/GSFC) Simon, T. (Hawaii) Florkowski, D. (USNO) Stencel, R. (Colorado) Bookbinder, J. (Colorado) Linsky, J. (Colorado)	Variability of emission in three M supergiants: Alpha Ori, Alpha Sco A, and Alpha 1 Her. 2 and 6 cm.
AD-193	Drake, S. (NASA/GSFC) Simon, T. (NASA/GSFC)	A survey of pre-main sequence stars in the open cluster NGC 2264. 2, 6 and 20 cm.
AE-48	Evans, N. (Texas) Kutner, M. (Rensselaer) Mundy, L. (Caltech)	Embedded continuum sources in the S140 molecular cloud. 2 cm.
AF-123	Fomalont, E. Sanders, W. (New Mexico State)	Stellar radio luminosity function. 6 cm.
AF-128	Fiedler, R. (NRL) Dennison, B. (VPI & SU) Johnston, K. (NRL)	Refractive scintillation in CTA 26. 20 and 90 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-142	Fabbiano, G. (CFA) Gioia, I. (CFA)	Early type galaxies observed with Einstein. 6 cm.
AG-145	Geldzahler, B. (NRL) Schwartz, P. (NRL) Gear, W. (Queen Mary College) Ade, P. (Queen Mary College) Robson, E. (Preston Polytech) Nolt, I. (Oregon) Smith, M. (Royal Obs.)	Simultaneous multifrequency observations of blazars. 1.3, 2, 6, 20 and 90 cm.
AG-224	Gaume, R. (Michigan) Mutel, R. (Iowa)	Evidence of supernova induced star formation? 6 cm line.
AG-226	Gunn, J. (Princeton) Knapp, G. (Princeton) van Gorkom, J.	Measurement of the thickness of the HI disks in the edge-on spiral galaxies NGC 891/4565/7814. 20 cm line.
AG-228	Gregorini, L. (Bologna)	Sample of dust lane galaxies observed at infrared wavelengths. 6 cm.

No.	Observer(s)	Program
AG-230	Gottesman, S. (Florida) Hunter, J. (Florida) Hawarden, T. (Royal Obs.)	The peculiar ellipsoidal galaxy NGC 660. 21 cm line.
AG-234	Garcia-Barreto, J. (UNAM) Pismis, P. (UNAM)	Emission from the barred galaxy NGC 4314. 2 cm.
AG-235	Gaume, R. (Michigan) Claussen, M. (Massachusetts)	Cometary HII regions: water masers and ammonia emission. 1.3 cm line.
AG-236	Glendenning, B. (Toronto) Kronberg, P. (Toronto)	HI observations of NGC 2146a. 2, 6 and 21 cm line.
AG-237	Gottesman, S. (Florida) Hunter, J. (Florida) Erickson, L. (Florida)	HI observations of small galaxy groups near NGC 3893 and NGC 4111. 20 cm line.
AG-240	Gopal-Krishna (TIFR)	CTD 93. 2 and 6 cm.
AG-241	Green, D. (MRAO)	G 92.4+1.4: Bubble or SNR? 90 cm.
AG-243	Giovannini, G. (Bologna) Feretti, L. (Bologna)	The extended source near Coma A. 90 cm.
AH-195	Hjellming, R. Davis, R. (NRAL)	Recurring nova RS Oph. 2 and 6 cm.
AH-218	Ho, P. (Harvard) Heiles, C. (Berkeley)	Survey for OH emission in magnetic(?) disk-like structures. 18 cm line.
AH-231	Hummel, E. (MIPR, Bonn) Jorsater, S. (ESO) Lindblad, P. (Stockholm Obs.) Sandqvist, A. (Stockholm Obs.)	The central region of NGC 613, a peculiar radio source. 2 cm.
AH-233	Hollis, J. M. (NASA/GSFC) Brown, R. Kafatos, M. (George Mason) Michalitsianos, A. (NASA/GSFC)	An attempt to detect radio emission from the Sirius Binary system. 6 and 20 cm.
AH-248	Hummel, E. (MPIR, Bonn) Giave, R. (MPIR, Bonn) Krause, M. (MPIR, Bonn) Beck, R. (MPIR, Bonn)	High resolution polarization observations of IC 342. 6 and 20 cm.
AH-250	Helfand, D. (Columbia) Becker, R. (Calif., Davis)	Survey of the galactic plane near l = 0. 90 cm.

No.	Observer(s)	Program
AH-252	Hummel, E. (MPIR, Bonn) Schlickeiser, R. (MPIR, Bonn) Lesch, H. (MPIR, Bonn) Wielebinski, R. (MPIR, Bonn)	Linear polarization measurement of the radio halo of NGC 4631. 20 cm.
AH-254	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Groningen) Seaquist. E. (Toronto)	Radio observations of three pre-1987 and bright 1987 Novae to complement extensive infrared observations. 1.3, 2, 6 and 20 cm.
AH-255	Haynes, M. (Cornell) Giovanelli, R. (Cornell)	HI near extragalactic HII regions. 20 cm line.
AH-256	Harris, H. (USNO) Monet, D. (USNO) Ables, H. (USNO)	QSOs behind globular clusters. 6 cm.
AH-257	Heaton, B. (Kent) Little, L. (Kent)	Molecular outflow source G35.2N. 2 cm.
AH-258	Helfand, D. (Columbia) Yusef-Zadeh, F. (NASA/GSFC) Seiradakis, J. (Thessalonika) Becker, R. (Calif., Davis)	The extended galactic plane radio source 1952+28: extragalactic or galactic? 20 cm.
AH-259	Helfer, H. (Rochester) Woodward, C. (Rochester)	Structure of the M8 Hourglass and G25.4-0.2s. 6 cm line.
AI-30	Inoue, M. (Nobeyama) Fomalont, E. Tsuboi, M. (Nobeyama) Morris, M. (UCLA) Yusef-Zadeh, F. (NASA/GSFC) Tabara, H. (Utsunomiya) Kato, T. (Utsunomiya)	Peculiar magnetic fields in the galactic center region. 2 cm.
AJ-140	Jaffe, W. (STScI) Owen, T. (SUNY) Caldwell, J. (SUNY)	Thermal radiation from Titan. 2 cm.
AK-117	Kundu, M. (Maryland) Schmahl, E. (Maryland) Hurford, G. (Caltech) Gary, D. (Caltech) Dulk, G. (Colorado) Bastian, T. (Colorado) Lang, K. (Tufts) Willson, R. (Tufts)	Simultaneous observations of solar hard X-ray microbursts. 20 cm.

No.	Observer(s)	Program
AK-150	Kundu, M. (Maryland) Jackson, P. (Maryland) White, S. (Maryland)	Complete sample of nearby flare stars. 6 and 20 cm.
AK-156	Knapp, G. (Princeton) van Gorkom, J.	HI rotation curve of the Sombrero galaxy NGC 4594. 20 cm line.
AK-159	Kassim, N. (Maryland) Baum, S. (Maryland)	Two peculiar SNRs with evidence for steep spectrum components. 2, 6, 20 and 90 cm.
AK-161	Kim, K. (Toronto) Landecker, T. (DRAO) Kronberg, P. (Toronto)	Polarization observation of background sources near the OA184 SNR. 6, 18, 20, 21 and 22 cm.
AK-162	Kassim, N. (Maryland) Erickson, W. (Maryland)	New SNR candidates. 90 cm.
AK-167	Keto, E. (Harvard) Ho, P. (Harvard) Haschick, A. (Haystack)	The expanding molecular shell around W33-main. 1.3 cm line.
AL-112	Lake, G. (Bell Labs) Schommer, R. (Rutgers) van Gorkom, J.	Rotation curves of dwarf galaxies. 20 cm line.
AL-127	Lang, K. (Tufts) Willson, R. (Tufts)	Narrow band emission from the dwarf M flare stars YZ Cmi, AD Leo and UV Ceti. 6 and 20 cm.
AL-130	Lehto, H. (Virginia) Heeschen, D. Seielstad, G. Valtonen, M. (Turku) Saslaw, W. (Virginia)	Simultaneous observations of OJ287 with Green Bank and Metsahovi. 1.3 and 2 cm.
AL-134	Little, L. (Kent) Heaton, B. (Kent)	The dense molecular core of G34.3+0.1. 1.3 cm line.
AL-136	Lyne, A. (NRAL) Brown, R. Goss, W. M.	Search for SNRs near two young pulsars. 6 and 20 cm.
AL-150	Lestrade, J-P. (JPL) Preston, R. (JPL)	Statistical properties of RSCVn stars. 6 cm.

No.	Observer(s)	Program
AM-172	Menten, K. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Walmsley, C. M. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Wadiak, E. J. Johnston, K. (NRL)	A compact methanol emission region in Orion. 1.3 cm line.
AM-188	Menon, T. (British Columbia) Hickson, P. (British Columbia)	Luminosity functions of radio galaxies in compact groups. 6 and 20 cm.
AM-194	Migenes, V. (Pennsylvania) Johnston, K. (NRL) Pauls, T. (NRL) Wilson, T. (MPIR, Bonn)	High resolution maps of the (3,2) hyperfine transition of NH3. 1.3 cm line.
AM-195	Myers, P. (CFA) Terebey, S. (NCAR) Rodriguez, L. (UNAM) Cruz-Gonzalez, I. (UNAM)	Radio continuum from IRAS sources embedded in dense molecular cores. 6 cm.
AM-196	Magri, C. (Cornell) Haynes, M. (Cornell)	Star formation in normal spiral galaxies. 20 cm.
AM-197	Mollenhoff, C. (MPIA, Heidelberg) Bender, R. (MPIA, Heidelberg) Hummel, E. (MPIR, Bonn)	Dust-lane ellipticals. 20 cm.
AM-198	Mazzarella, J. (Michigan) Aller, H. (Michigan) Gaume, R. (Michigan)	Continuum structures in four double nucleus Markarian galaxies. 2 and 6 cm.
AM-201	Miley, G. (STScI) Chambers, K. (Johns Hopkins) van Breugel, W. (Berkeley)	Ultra steep spectrum sources. 2 cm.
AM-202	Mitchell, K. (NASA/GSFC) Koo, D. (STScI)	Detection of bright and faint optically selected quasar samples. 20 cm.
AM-203	Moran, J. (CFA) Reid, M. (CFA)	Observation of the HII0 alpha line toward W3(OH). 6 cm line.
AM-204	Muhleman, D. (Caltech) Berge, G. (Caltech) Linfield, R. (JPL) Jones, D. (JPL)	Astrometric measurements of Neptune/Triton system. 2 cm.
AO-62	O'Donoghue, A. (NMIMT) Owen, F. Eilek, J. (NMIMT)	Wide angle tail sources. 6 cm.

No.	Observer(s)	Program
AP-114	Pedelty, J. (Minnesota) Rudnick, L. (Minnesota) Spinrad, H. (Berkeley) van Breugel, W. (Berkeley)	Extended extranuclear emission line gas in 3C 337. 2 cm.
AP-123	Pedlar, A. (NRAL) Anantharamaiah, K. van Gorkom, J. Ekers, R.	Continuum and recombination line observations of the galactic center. 90 cm.
AP-126	Palmer, P. (Chicago) de Pater, I. (Calif.) Snyder, L. (Illinois)	Search for OH emission from Comet Wilson (19861). 18 cm line.
AP-128	Pottasch, S. (Groningen) Zijlstra, A. Bignell, R. C.	Position measurements for two stellar OH masers. 2, 6, 18 and 20 cm line.
AR-152	Roser, H. (MPIA, Heidelberg) Perley, R.	The hotspot in Pictor A. 2, 6, and 20 cm.
AR-156	Richter, O-G. (STScI) van Gorkom, J. Ferguson, H. (Johns Hopkins) Huchtmeier, W. (MPIR, Bonn) Whitmore, B. (STScI)	The HI content of NGC 3312 and other galaxies in the Hydra I cluster. 20 cm line.
AR-158	Rudolph, A. (Chicago) Palmer, P. (Chicago) Ho, P. (Harvard)	Ammonia in HH7-11IR. 1.3 cm line.
AS-80	Sramek, R. van der Hulst, J. (NFRA) Weiler, K. (NRL)	Monitoring supernovae SN 1980 in NGC 6946 and SN 1979c in M100. 2, 6 and 20 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-280	Seaquist, E. (Toronto)	Expansion of the compact nebula Vy2-2. 2 cm line.
AS-282	Spangler, S. (Iowa) Lazio, J. (Iowa) Cordes, J. (Cornell) Mutel, R. (Iowa)	Studies of rotation measure fluctuations in the Cygnus region. 6 cm.
AS-283	Sancisi, R. (Kapteyn Lab) van Gorkom, J. van Albada, T. (Kapteyn Lab)	The size of the dark halo of the spiral galaxy NGC 3198. 20 cm line.

No.	Observer(s)	Program
AS-285	Surdej, J. (Liege) Courvoisier, T. (ESO) Kayser, R. (Hamburg Obs.) Kellermann, K. Kuhr, H. (MPIA, Heidelberg) Refsdal, S. (Hamburg Obs.) Swings, J. (Liege) Borgeest, U. (Hamburg Obs.)	The most luminous quasars - search for gravitationally lensed objects. 6 cm.
AS-289	Schweizer, F. (DTM) Phillips, M. (CTIO) van Gorkom, J.	A search for HI in elliptical galaxy IC 2006. 21 cm line.
AT-60	Taylor, A. (Groningen) Seaquist, E. (Toronto) Kenyon, S. (SAO)	Radio-optical-uv monitoring of symbiotic stars. 1.3, 2, 6 and 20 cm.
AT-81	Tacconi-Garman, L. (Massachusetts) Young, J. (Massachusetts) Ball, R. (Caltech)	The search for a neutral hydrogen bar in NGC 6946. 20 cm line.
AT-82	Terebey, S. (Caltech) Vogel, S. (Caltech) Myers, P. (CFA)	A search for water masers near young low mass stars. 1.3 cm line.
AT-83	Turner, J. (UCLA) Ho, P. (Harvard) Beck, S. (Northeastern)	Lifetimes of nuclear starbursts. 1.3 cm.
AT-84	Torrelles, J. (Andalucia) Marcaide, J. (Andalucia) Ho, P. (Harvard) Szczepanski, J. (MIT) Rodriguez, L. (UNAM) Canto, J. (UNAM)	Ammonia temperatures of supersonic molecular outflows: NGC 2404 and MonR2. 1.3 cm line.
AT-85	Turner, B. Rickard, L. (NRL) Kazes, I. (Meudon) Bottinelli, L. (Meudon) Guguenheim, L. (Meudon) Le Squerin, A. (Meudon) Fraix-Burnet, D. (Meudon) Patey, I. (Meudon)	Possible time variations of the OH megamaser in UGC 8696. 18 cm line.
AU-29	Uson, J. Bagri, D. Anantharamaiah, K.	Search for redshifted HI radiation from Zel'dovich pancakes. 90 cm line.

No.	Observer(s)	Program
AV-96	van der Hulst, J. (NFRA) Sramek, R. Weiler, K. (NRL)	Monitoring radio supernova in NGC 4258. 6 and 20 cm.
AV-137	van Buren, D. (Colorado) Fich, M. (Waterloo)	The expanding neutral shell associated with the HII region Sharpless 156. 20 cm line.
AV-138	van Buren, D. (Colorado)	High resolution mapping of MI-67, a rapidly expanding shell of ejecta from the WR star BAC 209. 2 cm.
AV-140	van Gorkom, J. Weinberg, D. (Princeton) Knapp, G. (Princeton)	HI line emission from the interacting E/SO galaxies NGC 4105/6. 20 cm line.
AV-141	Velusamy, T. (TIFR) Venugopal, V. (TIFR)	Mapping SNRs G18.95-1.1 and G54.4-0.3. 6 and 20 cm.
AV-142	Vogel, S. (Caltech) Carlstrom, J. (Berkeley)	NH_3 and continuum observations of a very massive young object in Sgr B2. 1.3 and 2 cm line.
AV-144	van der Hulst, J. (NFRA) Skillman, E. (NFRA) Bothun, G. (Michigan)	HI in low surface brightness spiral galaxies. 20 cm line.
AW-161	Whiteoak, J. (CSIRO) Gardner, F. (CSIRO)	Observations of the large scale H2 ^{13}CO clouds in SGR B2. 6 cm line.
AW-174	Wootten, H. A. Mundy, L. (Caltech) Wilking, B. (Missouri) Loren, R. (Texas)	Investigation of the structure of the Protostar 16293-2422. 1.3 cm line.
AW-175	Wouterloot, J. (MPIR, Bonn) Henkel, C. (MPIR, Bonn)	The closest H_2O maser. 1.3 cm line.
AW-176	Wood, D. (Wisconsin) Churchwell, E. (Wisconsin)	H66 α and ammonia spectral line observations of arc shaped ultracompact HII regions. 1.3 cm line.
AW-177	Wadiak, E. J. Wilson, T. (MPIR, Bonn) Rood, R. (Virginia)	H_2CO emission in Rho Ophiuchi B. 2 cm line.
AW-178	Wadiak, E. J. Wilson, T. (MPIR, Bonn) Rood, R. (Virginia)	H_2CO emission in Rho Ophiuchi B. 6 cm line.

No.	Observer(s)	Program
AW-180	Wadiak, E. J. Wootten, H. A.	The distribution of excited H_2CO in OMC1. 2 cm line.
AY-15	Yusef-Zadeh, F. (NASA/GSFC) Morris, M. (UCLA) Seiradakis, J. (Thessaloniki) Lasenby, A. (MRAO) Wielebinski, R. (MPIR, Bonn) Klein, U. (MPIR, Bonn)	The polarized lobe at b 0 near the galactic center. 6 and 20 cm.
AY-16	Yin, Q. (Peking) Xu, W. (Peking)	Optically clumpy galaxies. 6 cm.
AZ-30	Zijlstra, A. Bignell, R. C.	Identification of a suspected radio galaxy. 2 cm.

F. SCIENTIFIC HIGHLIGHTS

Cygnus A Counterjet

The effect of having additional computing power for processing VLA data has been graphically demonstrated by the recent reanalysis of existing data for the classical double-lobed radio galaxy, Cygnus A. Previous image enhancement techniques, limited only by available computing time on the NRAO VAX computers, were able to establish the existence of the very faint thin line of emission tracing the energy flow from the galaxy's central core to one of the filamentary lobes. As now processed with the newly available Convex C1 mini-supercomputer, however, a very faint counterjet appears to be oppositely directed toward the galaxy's other lobe. In spite of the fact that the dynamic range of the new images was only a modest 4000:1, the capacity of the Convex C-1 to compute many more components in the CLEAN image deconvolution algorithm that is used to correct for incomplete measurements seems to have been the key factor in the image improvement. The counterjet appears to be at least a factor of four fainter than the original jet and the radial brightness variations (knots) in both jets are not symmetric.

Investigators: R. Perley (NRAO), C. Carilli (MIT), J. Dreher (MIT)

C_3H_2 in Infrared Cirrus

A search for cyclopropenylidene, the only presently identified organic ring molecule in the interstellar medium, was directed toward several of the infrared cirrus clouds that were discovered by the IRAS experiment. The ubiquitous molecule was found in almost every cirrus cloud surveyed by the 140-foot telescope, primarily detected in the 18 GHz transition. The search was carried out at selected positions only in these very extended cirrus features. The C_3H_2 line at 21.5 GHz, which is commonly seen in absorption in dark clouds, was only detected at one cirrus location. C_3H_2 may originate in the cirrus environment as a result of the destruction of large molecules such as PAHs, polycyclic aromatic hydrocarbons. The observation of C_3H_2 may

potentially test the relative importance of either small dust grains or PAHs for producing the 12 μm flux that is detected from the infrared cirrus.

Investigators: B. Turner (NRAO) and L. J Rickard (NRL)

Polarized Dust Emission

Thermal dust emission, detected at 1.3 mm wavelength from the Orion molecular cloud, appears to be polarized at the few percent level. The preliminary measurements were made with a recently developed polarimeter attached to the 12-meter telescope. The polarization mechanism is due to anisotropic radiation from non-spherical spinning grains which are aligned in magnetic fields. Whereas optical and near infrared detections of polarization by dust in absorption have previously sampled field directions in the general interstellar medium, the millimeter emission detections come from the densest parts of the molecular cloud core where the optical/infrared radiation is screened from view.

Two positions in OMC-1 exhibited small polarization levels, but W51, which is more distant, showed no significant effect. Future detailed maps will be required in order to investigate actual dust grain characteristics and magnetic field alignments.

Investigators: R. Barvainis (NRAO) and D. Clemens (Arizona)

Gigantic HI Plume

VLA observations of the neutral hydrogen in the "Ring" galaxy Arp 143 (= NGC 2445/4) have uncovered the presence of a completely unexpected enormous appendage extending at least 200 kpc from the galaxy. The appearance of the ring itself is thought to be the result of a collision between galaxies, and the HI observations were undertaken in order to investigate the dynamics of the interaction and possible causes of the extended starburst phenomenon that is occurring in the ring. The low surface brightness linear plume was detected with the most compact D configuration of the VLA. Its width, comparable to the diameter of NGC 2445, does not vary appreciably over its full extent. Near its outer extremity it is interrupted by an almost perfectly formed superbubble of expanding HI, roughly 20 kpc in diameter.

Investigators: P. N. Appleton (Iowa State), J. van Gorkom (NRAO), F. K. Ghigo (Minnesota), and C. Struck-Marcell (Iowa State).

Low-Frequency Carbon Recombination Lines

Highly excited recombination lines of carbon detected in absorption towards Cas A at very low frequencies (25-80 MHz) using the 300-foot telescope have now been mapped in emission at 332 MHz using the new P-band system of the VLA. The occurrence of an emission line in front of the strong background source Cas A clearly indicates that it is stimulated emission. The line is ~0.2 percent of the continuum and required a spectral dynamic range of ~10,000:1. The similarity of the spatial structure of line emission to that of 21-cm HI absorption towards Cas A suggests that the carbon lines arise in cold HI clouds in the Perseus Arm. These lines promise to become a good diagnostic of ionization conditions in HI clouds.

Investigators: K. R. Anantharamaiah (NRAO), H. E. Payne (NRAO), and W. C. Erickson (Maryland)

G. PUBLICATIONS

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

H. CHARLOTTESVILLE ELECTRONICS

Neptune/Voyager Project

Work started during June 1985 on the further development and construction of thirty 8.4 GHz receivers for use on the VLA for reception of television pictures of Neptune during a brief period centered on August 24, 1989. This work is supported by JPL/NASA and is described in the Management Plan for the VLA-GDSCC Telemetry Array Project (March 15, 1985).

The first production receiver utilizing FET amplifiers was delivered to the VLA in February 1986. The latest receiver (No. 13) was delivered March 1987, and all thirty are scheduled to be completed by the end of 1987.

During 1986 the decision was made to use HEMT amplifiers instead of FET amplifiers because of a significant improvement in system sensitivity. The receiver noise temperatures dropped from $\sim$ 32 K with GASFET amplifiers to $\sim$ 14 K with HEMT amplifiers. Adding 15 K for antenna temperature, a system sensitivity improvement of 2.1 dB is achieved with HEMT's.

L-Band HEMT Amplifier Development

A program to retrofit NRAO designed L-band FET amplifiers with Fujitsu HEMT devices has begun. The improvement in amplifier noise performance by going to HEMT's is about a factor of two. Initial measurements indicate amplifier noise of 3-5 K in the 1.2-1.8 GHz frequency range.

About 100 of these amplifiers using FET devices are in use at NRAO in L-band receivers at Green Bank and the VLA. They are also used as I.F. amplifiers in millimeter-wave receivers at the 12-m telescope. The current plan is to retrofit the amplifiers in the Green Bank L-band receiver; this should decrease the system temperature on the telescope by as much as 5 K. The installation of these amplifiers in SIS mixer receivers at the 12-m is also a high priority, since the improvement in receiver performance should be significant because of the loss in the mixer ahead of the I.F. amplifier. Improvements of $\sim$ 20 K in receiver noise temperature should be attainable. Retrofits in other areas will occur if the improvement in performance warrants the effort.

23 GHz HEMT/FET Amplifier Development

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

Future amplifiers will use HEMT's and be shipped to the VLA at the rate of two per month.

43 GHz HEMT Amplifier Development

A program to develop an amplifier at 43 GHz for possible VLBA and Green Bank use has started. Initial work entails complete characterization of the HEMT devices at 22 GHz with waveguide adjustable tuners specially developed in Charlottesville for optimization of amplifier performance at cryogenic temperatures. When the design of the test equipment has been proven, it will be reproduced for 43 GHz measurements. It is hoped to have a prototype amplifier design for 43 GHz by the end of 1987.

Hybrid Spectrometer

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

A prototype of one-eighth of the system has been built and is being tested in Tucson. Construction of the final system is underway in Charlottesville and Tucson, and testing of the final system should commence towards the end of 1987.

Superconducting (SIS) Millimeter-Wave Mixer Development

SIS mixers for the millimeter-wave region are now widely accepted as giving the best performance for radio astronomy receivers. Although NRAO supports its Schottky mixers in existing receivers, the main thrust of development by the millimeter-wave group in Charlottesville is towards the manufacturer of good, reliable SIS mixers for the frequency range 70-360 GHz. This development includes design and testing of SIS mixers and junctions at NRAO. The devices tested have been the result of SIS device fabrication through a contract with the University of Virginia, a joint study agreement with IBM (Watson Research Laboratory) and, finally, devices produced by Hypres under a contract with NRL.

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

We have recently tested some inductively shunted SIS junctions designed by us and fabricated by IBM. While the I-V curves are not exceptional, the integral tuning structure makes these mixers particularly good in the broadband (DSB) mode. At 115 GHz and 2.5 K, T_R = 52 K DSB in the lab test receiver. Similar results are obtained over the 90-116 GHz band. The mixer itself has T_M = 10 K DSB, and L = -0.1 dB DSB. Clearly, most of the 52 K is from input losses and the 14 K I.F. noise temperature in our lab setup. On the 12-m telescope, with a 2 K HEMT amplifier, this mixer would give T_R = 45 K DSB in the present receiver, and T_R < 20 K DSB if the room temperature lens and beam-splitter losses can be reduced. Tuned for true SSB

operation, this mixer gives receiver noise temperatures about 10% lower than the present Hypres junctions.

The IBM devices are $Nb/Nb_2O_5/Pb$-In-Au edge-junctions. Increasing the operating temperature from 2.5 K to 4.2 K degrades T_R by about 20 percent (cf. 5% for Nb/Al-Al_2O_3/Nb junctions -- Hypres, UVA -- and by 50-100 percent for all-lead junctions -- NBS and old IBM).

We have just completed DC tests on the first junctions made under joint project with UVA. These are Nb/Al-Al_2O_3/Nb devices, similar to the Hypres junctions. The first 4 micron x 4 micron test junctions had extremely sharp I-V curves. Based on recent tests on Hypres junctions, it should be possible to heat these to 150° C for prolonged periods (e.g., for bonding), and even to 200° C for a few minutes. Storage at room temperature in the open atmosphere causes no degradation. The present mask set contains mixers for 90-120 GHz and 230 GHz, as well as special circuits for characterizing the material.

Schottky Diode, Millimeter-Wave Mixer Development

Several fixed-tuned mixers have been developed for the new 280-320 GHz receiver on the 12-m telescope. One of the broader band units gives a receiver temperature around 1600 K over the frequency range 280-305 GHz. A number of 200-240 GHz mixers are being fabricated for the four-beam (eventually eight-beam) 230 GHz receiver on the 12-m telescope and for the 225 GHz site testing receivers (see below). The mixers with the best cryogenic performance are being kept for the multi-beam receiver, and the less good ones are being used for the site-testing receivers.

Site Testing Receivers

The first three of four compact, room-temperature, 225 GHz radiometers for millimeter array site testing have been delivered to the VLA. These radiometers have a DSB noise temperature of $\approx$1500 K. The remaining unit is under construction.

The plan is to locate these site testing receivers at the VLA, Mt. Baldy, Mauna Kea, and Kitt Peak.

Millimeter Local Oscillator Sources

A new waveguide tripler design for the new 290-310 GHz receiver is being evaluated. The hope is that this tripler will cover 280-360 GHz, thereby superseding the old quasi-optical tripler.

Three new 200-280 GHz triplers have been fabricated for use on the 230 GHz multi-beam receiver and the site testing receivers. Using the scanning electron microscope at the University of Virginia, we have been able to achieve good reproducibility from one tripler to the next.

I. GREEN BANK ELECTRONICS

Adaptive Array Receiver

The Adaptive Array Receiver is designed to increase the effective hour angle tracking range of the 300-ft antenna and minimize the scan loss when compared with a single feed receiver. It provides frequency coverage over the 400-500 MHz band with instantaneous bandwidths of 5 to 10 MHz. A 2 x 8 array of feeds will be used. With this array, we predict the efficiency will be one-half of the on-axis value at ± 15 feet offset (± 27 minutes tracking time). This compares to ±5.5 feet (± 10 minutes) with a single feed. The FET amplifiers, voltage-controlled phase-shifters, and feeds have been prototyped and the machine shop has started replication of the mechanical components. The receiver box mechanical design and the interfaces to the 300-ft control system have yet to be done.

300-ft Spectral Processor

For some time now a new spectrometer for the 300-ft telescope has been in the design and contruction phase. Dubbed the Spectral Processor, it is intended to satisfy many of the needs of both the spectral line and pulsar communities. The major goals of this project are the following:

1. Adequate frequency resolution and bandwidth for spectroscopy (<=1024 points, <=40 MHz).
2. Adequate time and frequency resolution for pulsar observations (>=12.8 sec, 4 IF channels at 256 frequency points each).
3. Real-time dedispersion, stokes parameter calculation, and faraday rotation correction capabilities.
4. RFI rejection and tolerance.
5. Two effectively independent spectrometers with multiple inputs.
6. Flexibility in many respects.

The primary goal of this project is to have a usable instrument turned over to the users as soon as possible. The immediate goal, however, is to design and build half the system, i.e., one spectrometer plus control, in order to run system tests. A short summary of our progress follows:

Complete: ADC's, Buffer Memory, Window Multiplier, initial FFT module, Timing Generator.

In progress: ADC Interface, making 11 copies of the FFT module, Controller, Accumulator, and eight IF to Video converters.

To be done: Real Correction, Square or Cross Multiply, rack design, and control and analysis software.

Deferred: Stokes Multiplier, and Faraday Correction. (To be designed and built after initial system is turned over to the users>)

The shortage of RE money has forced us to make some schedule compromises that will adversely affect the efficiency of construction. However, it is still hoped that the system will be ready for use in the late 1988.

2-5 GHz Receivers

HEMT amplifiers with a noise temperature in the range of 8-13 Kelvin have recently been installed in the 4.5 - 5.0 GHz section of this receiver. The new HEMT's replace FET amplifiers having a noise temperature of 14-20 K across the band. Measurements on the 140-ft indicate system temperatures ranging from 25 to 30 Kelvin. Beam maps for channels A and B (right and left hand circular polarization) reveal a clean pattern with scattered noise about 20 dB down from beam center. A plot of the difference between the channel A and B maps indicates no definitive pattern. With a system temperature about a factor of two less than the previous receiver at 6 cm and clean intrinsic dual-circular polarization, this new receiver will be a major improvement to the 6 cm VLBI scheduled for the 140-ft in June.

The 2.9-3.4 GHz section of this receiver is now equippped with variable noise injection in both channels. The noise injection for each channel can be adjusted independently to provide uncorrelated noise in the range from 0 to 50 K continuously. The noise injection can be turned on and off by the computer at the 140-ft. The benefits of such noise injection are still in the experimental stage; however, it is available for general use. Please note that when not in use, this noise is isolated from the receiver by greater than 100 dB and will not affect the performance of this receiver.

Beam Splittter for 140-ft Cassegrain

The 140-ft Cassegrain beam splitting system has now been successfully used for several observations in which the two upconverter-masers simultaneously receive at the same or different frequencies in the 8 to 25 GHz range. Orthogonal linear polarizations are currently available; an IF polarimeter will be used to expand polarization capability to opposite sense circulars.

Aperture efficiency and system noise temperature are not seriously degraded by inclusion of the splitter and feed reflectors. Performance is summarized in Table 1. The decrease in efficiency at the highest frequencies may be the result of splitter surface tolerance loss; if this is so, it will become more apparent as additional measurements over the full frequency range become available.

There is a small pointing differential variation in right ascension and declination between the two receiver beams as the telescope changes position. Table 2 shows the maximum pointing differential at 8 GHz. Pointings taken at 19-24 GHz are in reasonable agreement.

TABLE 1: Beam Splitter In-Out Comparison

Frequency (GHz)	System Temperature Increase (K)	Aperture Efficiency Decrease (percent)
8.0	3	3.8
19.1	2	2.0
24.0	2	11.2

TABLE 2: 8 GHz Pointing Differential (B Rx - A Rx)

Zenith Distance (degree)	Maximum Differential Pointing (arc sec)
0 - 30	15
0 - 60	20
0 - 80	35

J. TUCSON ELECTRONICS

Receiver Status

During this quarter the replacement of our klystron L.O. systems with Gunn oscillators has been completed. We now have completely solid-state L.O. systems up to 370 GHz. The status of the various receivers is summarized below.

70-115 GHz Schottky Mixer Receiver

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

The Bolometer Receiver

The bolometer receiver was tested on the telescope in February and the sensitivity was measured at 2.5 Jy/sec at the very best. In view of the limited manpower available for receiver support, we have decided that we cannot justify continued support of the bolometer system. The 230 GHz mixer system achieves sensitivities of around 6 Jy/sec in a narrow frequency band. This narrow band mode of observation has advantages both in interpretation of the data and in reducing the atmospheric noise contributions that can be a severe limitation in the broadband bolometer system.

The 200-270 GHz Schottky Mixer Receiver

This receiver has been in full time use during this quarter. The new Gunn oscillator L.O. system provides sufficient power to drive the two receiver channels over the 200-270 GHz frequency range. The noise temperature of the receiver is unchanged, varying from 500 K S.S.B. to 1000 K S.S.B. over the band.

270 GHz-305 GHz Schottky Mixer Receiver

This new frequency range is being covered for this observing season by a single channel receiver. Components from the 200-270 GHz have been modified to operate in this band, but the L.O. power is only sufficient to operate one receiver channel. Noise temperatures of around 2000 K S.S.B. are obtained, a higher value than was hoped for. The L.O. source for this receiver is a Gunn oscillator driving a tripler.

330-370 GHz Receiver

This receiver has also been updated to have a Gunn oscillator as the L.O. source. In this case a quadrupler, manufactured by Millitech Corporation is used as the frequency multiplier. The noise temperatures of this single channel receiver varies across the band between 1600 K S.S.B. and 3000 K S.S.B.

The Multifeed 230 GHz Receiver

This prototype four-feed receiver will be tested on the telescope in April. If successful the receiver will be expanded to eight channels. The prototype four-feed receiver has been tested in the laboratory and performs satisfactorily.

The 90-115 GHz SIS Receiver

This receiver now uses mixers with niobium junctions, giving a receiver noise temperature of less than 100 K S.S.B. at 115 GHz. During the next quarter we hope to further reduce this figure with new junctions and replacement of the GASFET I.F. amplifiers with HEMT amplifiers.

Other Electronic Equipment

VLBI Equipment

To facilitate VLBI experiments, a dichroic system has been fabricated for the 12-m telescope. A dichroic plate in front of the subreflector reflects the 6 cm signal to a room temperature HEMT prime receiver. The 3 mm signal is transmitted through the plate to the normal Cassegrain focus. This system will enable simultaneous observation at 6 cm and 3 mm during the course of a VLBI experiment.

The Hybrid Spectrometer

In view of the severe budget restrictions for this year, we have elected to produce a simplified version of the I.F. processor for the spectrometer. The

processor will not be computer controlled but will support a dual channel receiver with 600 MHz of bandwidth per channel, or an eight channel receiver with 300 MHz of bandwidth per channel.

K. VLA ELECTRONICS

Improvements In Antenna Pointing

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

When the VLA antennas are heated by the sun at low-elevation angle, differential temperatures of up to 5°C have been observed across the antenna structure. Under these conditions the pedestal and yoke of the antenna can bend significantly and cause pointing errors of up to one arc min. This problem is being cured by coating the critical parts of the antenna structure with insulation to reduce the temperature differentials. Twenty-seven antennas currently have insulation installed and coating of the last antenna will be finished this next 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 will start during the 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% 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 a 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).

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.

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

VLA 8-GHz Receivers

Feeds and front-ends covering the frequency range 8.0-8.8 GHz will be installed on the VLA primarily to augment the NASA/JPL DSN reception of the Voyager signal from Neptune at 8415 MHz. Other scientific benefits include the provision of an additional frequency for measurements of continuous spectra and joint observations with the VLB array. Finally, the 8.4 GHz front-ends would enable the VLA to be used in planetary radar experiments with the Goldstone transmitter. The NRAO Central Development Laboratory has developed this front-end which is presently using GaAs FET amplifiers. Improved HEMT (High Electron Mobility Transistor) amplifiers were incorporated into the third system this quarter.

Twelve 8.4 GHz front-ends have been received from the Central Development Laboratory in Charlottesville and have been installed on eight Antennas. Interferometer and phased-up sum measurements with these antennas on Voyager II have been completed with the appropriate signal-to-noise ratio, and other test programs are continuing.

JPL has provided funding for this project and antennas being overhauled will be outfitted with X-band feed towers. Installation of the remaining 25 X-band systems will continue through 1988.

RFI Improvements

The sensitivity of the 327 MHz and 75 MHz systems will be limited partly be radio-frequency interference locally generated at each antenna. Modifications to various modules to reduce this interference and increase the instantaneous useable bandwidth was investigated. A modification to allow the Monitor and Control system to free run eliminated the coherent RFI between antennas.

Three RFI enclosures for the vertex mounted "B" racks have been installed and tested. The remaining RFI enclosure will be installed during the first part of the next quarter, eliminating the remaining locally generated interference at 327 MHz. There is still some locally generated RFI noticeable at 75 MHz. A method to reduce this interference is being investigated.

Water-Vapor Radiometers

The development of a system to measure the total precipitable water in a path through the atmosphere will serve three purposes. First, the radiometer developed in this project can be used as a prototype of the device which is required at each VLBA station. Second, the radiometer can be used at the VLA to provide estimates of the extinction, giving corrections for observations at 1.3 cm and serving as a historical record of the quality of the VLA site. Finally, if a reliable system can be built at a sufficiently low cost, it would be attractive to add it 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 1/2 hour. Instead of one region per u-v track, 20-30 regions can be studied at once. This is a very significant step forward.

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

those ortho lines are particularly important spectroscopic tools for understanding some of the underlying physics.

A new "A" rack has been fabricated, including a revised dewar layout. This new dewar assembly will contain a new 1.3 cm GaAs FET amplifier or HEMT amplifier presently under development at the Central Development Laboratory. This amplifier will reduce the system temperature to 150 K and increase the bandwidth above and below the current bandwidth of 22.0-24.0 GHz. Also a 5 GHz GaAs FET being developed in the GB Electronics Division will be used to replace present 5 GHz paramps. The new "A" rack has been installed on three antennas. Testing of this system is to continue during the next quarter.

1.3-1.7 GHz T_{sys} Improvements

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

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

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

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

A VLBA front-end receiver dewar assembly has been received from the Green Bank Electronics Division. This dewar assembly, along with a VLBA polarizer, was installed on VLA Antenna 23. Satisfactory testing of this receiver was completed during the last quarter.

L. AIPS

A large amount of new software was developed for AIPS during the quarter. The AIPS group concentrated on the calibration package, developing a more user-friendly interface. The new task CLCAL, which is like the VLA's GTBCAL, was developed to handle the concatenatation, referencing, smoothing, and application of solution tables to the calibration. Existing tasks had their inputs simplified, including better naming and better handling of defaults. New tasks to determine baseline-based calibration (BLCAL), to compute atmospheric and gain model calibration corrections

(CLCOR), and to plot averaged cross-power spectra (POSSM) were developed. The source file format was generalized and FILLR was made more portable and more proficient in its handling of spectral-line data. Many minor bugs were also corrected.

A significant number of new tasks were submitted to the AIPS group. From the NRAO staff came PRFPL to plot averaged spectra, BDEPO to calculate beam depolarization due to rotation measure gradients, STFUN to calculate structure-function images, and REMAG to replace magic-value blanks with a user selected constant. From outside NRAO came DFTPL to plot the direct Fourier transform of point-source visibility data as a function of time and LWPLA and LWPLF to display plot files on Apple LaserWriters. An outside group also provided a novel means for supporting ARGS TV displays from within AIPS. With some help from Europe, WSLOD now works as advertised in translating WSRT uv data into AIPS.

To improve performance, a new convolution subroutine package was developed and added to CONVL and VM. A better FFT routine, for VAXes, was also added. Input to IIS Model 70 and 75 TVs is now buffered for improved performance and the IVAS TV display now works on the Convex with full support for IVAS release 2.0. Our support for UNIX systems, especially SUNs, also continues to improve. Fully revised editions of Going AIPS, the AIPS programmer manuals, were completed and sent to Green Bank for printing. They include new chapters on calibration and on software directories and tools. Like the new Cookbook, these editions are chapter based and three-ring binders are being prepared.

M. CHARLOTTESVILLE COMPUTER DIVISION

Supercomputer Workshops

Twin workshops on supercomputing were held on January 20 and 21, 1987, in Socorro and at the VLA site. They were sponsored by the NRAO and held in cooperation with Cray Research and the National Science Foundation's Division of Astronomical Sciences and the Division of Advanced Scientific Computing. The two one-day workshops addressed separate but related areas.

The first workshop was dedicated to attaching high performance output peripherals to supercomputers. For example, high performance imaging, such as 4 k by 4 images at subsecond display rates, was one of the topics. All groups active in this area were invited to attend, most of them presenting a short paper describing their work. Cray personnel gave their views on this type of interfacing and described their work on the BI and VME bus.

The second workshop was dedicated to the support of the AIPS image processing and astronomical data reduction package on the various supercomputer facilities around the country. There are about eight centers (all Crays) that are considering some level of support. Personnel from each center described their interest and plans, and a number of common issues were discussed. A Cray representative was present.

N. VLA COMPUTER DIVISION

Most of the important design decisions for the new on-line system are now complete. Part of this system, preliminary displays of the status of the X-band receivers for use in the Voyager fly-by, is now in use during test observations. The delivery of the backup computer, which was anticipated in March, will now not be received until April. The delay is primarily due to the tape subsystem.

With the addition of additional disk capacity late last year, the management of the disks on the DEC-10 system has been altered to simplify the support for remote observers and to streamline the filling of visibility data for calibration for on-site observers.

With the advent of the compact (C&D) VLA configurations, the computers comprising the Pipeline have been in heavy demand. It can support up to three research projects simultaneously, making up to a thousand images per day. The capacity of the Pipeline for this one function exceeds that of the (more flexible) Convex computer.

The use of the Convex computer at the VLA increased gradually from January, and by mid-March it was loaded to an optimum point with only few CPU cycles spare, but still with sufficient capacity to give good response time.

O. VERY LONG BASELINE ARRAY

Status of Site Preparation

Pie Town, Kitt Peak and Los Alamos

Foundations, buildings, and other site preparations are essentially complete.

North Liberty, IA

Site work, including the antenna foundation, is complete except for the control building. Bids are in for this, and completion is scheduled for August, 1987.

Fort Davis, TX

Grading and excavation are nearly finished. Site work completion is scheduled for August, 1987.

Brewster, WA

Bids are in for the site work and building, and the pre-award meeting with the low bidder has been set up.

Saint Croix, USVI

Site selection is still in progress, objections having been raised by property owners near the formerly chosen site on land of Fairleigh Dickinson University.

Owens Valley, CA

A site has been chosen on City of Los Angeles land leased by Caltech, and negotiation of a sub-lease is under way. Survey and soils tests will be done within the next few weeks.

Mauna Loa, HI

Formal application to the State of Hawaii will shortly be made for the use of a site at 9000 ft. elevation on the north flank of the mountain.

"Northeast Site"

No site has been selected as yet.

Antennas

Negotiations with Radiation Systems, Inc. (RSI) on their proposal to extend the antenna contract for Antennas #5 through #10 at a rate of two antennas per year instead of three, await supplementary information requested from the contractor by NRAO.

Antenna #1 (Pie Town)

The antenna erection schedule has slipped substantially, partly due to unusually poor winter weather. Installation and rough alignment of the surface panels is complete. Precision drilling of holes and mounting of targets for the final precise setting of the surface will be done immediately during the first suitable nighttime weather. The feed cone is on-site, awaiting installation when the antenna is ready. The first focussing and rotation mount (FRM) for the subreflector is complete and will be at the VLA on April 6, to be outfitted during April - May. Because of lateness of the FRM, NRAO personnel will install this unit, since the antenna contractor will have left the site.

Antenna #2 (Kitt Peak)

Antenna erection began in January, and the alidade structure is nearing completion. The upper equipment room, or "vertex room" is now being installed. Sections of the reflector backup structure are being assembled on the ground, and will be hoisted into place when the vertex room is complete.

Antenna #3 (Los Alamos)

Fabrication of the structure is complete, awaiting shipment to the site as soon as erection personnel begin to be available.

Antenna #4 (North Liberty)

Structural fabrication is well along at the contractor's Mexia facility in Texas.

Electronics

No major problems have been found during continuing system tests involving the electronics for the Pie Town Station. Control and monitoring of the equipment via the Station computer is coming into operation satisfactorily as the software is developed.

Progressing on schedule are the 23 and 2.3 GHz front ends for Pie Town, with the former to be completed in June and the latter by October.

The first of the four sets of electronics to be built this year for Stations 2 - 5 is about 75 percent complete.

Prototype testing has resulted in changes in design details of the metal parts of the 1.5 GHz feed. A new set of these parts for the Pie Town unit is expected shortly. A test prototype of the 2.3 GHz/8.4 GHz dichroic reflector material was fabricated and tested satisfactorily.

The first three hydrogen masers being built at Sigma Tau Frequency Standards were largely completed early in the year and testing was started. After a few weeks, several parameters showed evidence of contamination within the maser cavities. Since this probably resulted from a deficient initial bake-out process, the first maser was disassembled, carefully decontaminated, and reassembled. Testing is now being resumed.

Under test are two modifications to improve the mean time between maintenance for the CTI Model 22 refrigerators to be used on most of the VLBA front ends. One is the use of Envex rather than carbon bushings, and the other an improved design of a reciprocating mechanism to eliminate forces that prevent the bushings from seating properly. Two units, one with each change, are now in operation on the new 8.4 GHz front ends on the VLA, and the changes will be incorporated in the VLBA units if effective.

Data Recording

Change Order No. 7 to the Haystack Observatory subcontract was approved in early March, providing funding for additional development and engineering support in connection with completion and testing of the prototype data recording systems, and their installation in the field.

The first Data Acquisition Rack (DAR1), less its Formatter (which is still being tested at Haystack), continues in pre-installation testing in the laboratory at the VLA with other components of the VLBA electronic systems. It now appears that the first Formatter will not be delivered for testing by NRAO before late May, while the first Recorder proper (REC1) will not be available before the end of June. Schedule revisions are being made to minimize the impact of these delays upon early tests of the Pie Town Station.

The analog portions of DAR2 are complete. Stability tests comparing the first and second subsystems are scheduled at the VLA in late summer.

Because of a cut in the expected Project funding for 1988, Haystack was asked to provide a revised proposal for the pre-production phase of the subcontract, specifying one less DAR and one less REC than formerly. It is important that the long-lead items for the units to be built under this phase be authorized as soon as possible.

Monitoring and Control

Site computers for Kitt Peak and Los Alamos have been ordered, with delivery expected in early April.

Development of operator interface programs continued. Those for the synthesizers, baseband converters, front end cryogenics, IF distributors, front end switch control module, and station timing have been completed.

The now relatively small remaining logical gaps in the astronomical observing programs are being filled in. Attacked were an omission in the calculation of sidereal time, the appropriate choice of azimuth direction in the part of the sky which can be observed on either the clockwise or counterclockwise portion of the antenna cable wrap, and the correction of errors associated with the discontinuity of the inverse trig functions. The observing programs were also reorganized as "privileged," so that they cannot easily be accidentally stopped.

The overall logical structures for programs which check monitor values for proper operation during observing have been set up, and work in this area continues.

The MicroVax II, which will serve as the main Monitor/Control computer in the Array Operations Center, was delivered and brought into operation in March. The system consists of CPU, memory, disk, cabinets and connectors from DEC, and tape transports, a laser printer, and terminals from other vendors. This system is adequate for software development and initial operation, but will need further expansion before the array is in full operation. A digital data switch (DPBX) is being wired up so that terminals in the Socorro office will have free access to either the MicroVax or to any Vax at the VLA.

Correlator

The extensive study of the FX correlator concept, begun a year ago, was completed. Original optimistic expectations for this approach to a VLBA correlator were substantially borne out. The Group have developed a conceptual FX design which provides considerably better performance than the previously proposed conventional lag correlator, and at a significant cost reduction.

The results of the FX study were discussed in great detail in February at an FX Correlator Workshop, in which most North American experts in correlator design took part, plus a few from greater distances. VLBA project management endorsed the Correlator Group's recommendation to proceed with final design and, when funds become available, with construction of an FX correlator for the VLBA. The emphasis has thus now shifted to practical design.

Design work has begun with final specification of the correlator modes, which represent trade-offs among IF channels, spectral resolution, and several

multi-processing options. Also started is the gate-array design, which must be fixed before much of the remaining structure can be developed. A possibility under serious consideration is to incorporate the necessary inter-stage storage into the chip which supports the 6 FFT stages required. Design of a dual-purpose chip is planned; in its multiplier/accumulator function, the on-chip storage could be exploited to provide additional mode flexibility. This flexibility, in turn, prompts reconsideration of variable-length FFT operations.

The microprocessor-based simulator system was completed, and has already yielded numerous useful results. Because it can reach levels of integration an order of magnitude beyond that achievable in the software simulator, this system is most useful for detecting very weak artifacts arising from imperfections in signal processing. The most valuable application to date has been the determination of acceptable -- but not yet optimal--tables of the FFT "twiddle factors." Comparison of the microprocessor and software simulators was largely completed, although many minor descrepancies have yet to be reconciled.

Data Processing

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

(1) The preliminary version of the distribution tape has been designed. Software has been written to convert data from the NRAO MkII VLBI correlator into the form of the proposed VLBA distribution tape. This software is partly operational and is being used to read data for developing item 2).

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

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

P. PERSONNEL

New Hires

Diamond, Philip	Systems Scientist	01/13
Viallefond, Francois	Visiting Scientist	01/12
Liu, Zhong-Yi	Visiting Research Associate	01/01
Bailey, Nancyjane	Electronics Engineer I	03/02
White, Steve	Electronics Engineer II	03/16

Terminations

Dorr, Robert	Business Manager/VLA	03/06

Changes in Status

Chase, Dennis	to Telescope Opns. Mgr.	02/01
Retallack, Donald	to Systems Scientist	02/06
Hunt, Gareth	to Head/VLA Computer Div.	02/06
Runion, Gene	to Electronics Engineer II	03/01
Rhodes, Paul	to Technical Support Suprv.	03/01

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