NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

April 1, 1992 - June 30, 1992

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A. TELESCOPE USAGE

The following telescopes have been scheduled for research and maintenance in the following manner during the second quarter of 1992.

	140 Foot	12 Meter	VLA
Scheduled observing (hours)	1845.50	1981.25	1663.0
Scheduled maintenance and equipment changes	181.25	--	255.1
Scheduled tests and calibration	159.25	202.75	301.0
Time lost	90.25	229.50	99.6
Actual observing	1755.25	1751.75	1563.4

B. 140 FOOT TELESCOPE

The following line programs were conducted during this quarter.

No.	Observers	Programs
B554	Brown, R.	Observations between 4.8 and 5.0 GHz of recombination lines from QSOs and AGN sources.
B564	Bell, M. (NRC, Herzberg) Avery, L. (NRC, Herzberg) MacLeod, J. (NRC, Herzberg)	Observations at 5.95-6.05 GHz to examine the impact broadening in hydrogen recombination lines with $\Delta_n \leq 17$ in Orion A and W51.
B565	Baan, W. (NAIC) Haschick, A. (Haystack) Burdyuzha, V. (Lebedev) Komberg, B. (Lebedev)	Observations at discrete frequencies in the 1.0-1.45 GHz range of OH masers in IRAS galaxies at high redshifts.
B575	Brown, R. Holdaway, M.	Observations at 4.874-4.897 GHz to investigate the excitation of hydrogen at the galactic center.
F108	Fisher, J. R. Westpfahl, D. (NMIMT)	High spatial and velocity resolution measurements of HI in NGC 5364.
F110	Fuente, A. (Yebes Obs.) Martin-Pintado, J. (Yebes Obs.) Gaume, R. (NRL)	A survey at 23.694-24.139 GHz of ammonia emission towards reflection nebulosities.
G325	Giovanelli, R. (Cornell) Haynes, M. (Cornell) Freudling, W. (ESO)	Continued search at 1.4 GHz for intergalactic HI.
K332	Kalenskii, S. (Lebedev) Val'tts, I. (Lebedev) Slysh, V. (Lebedev)	Search at 28.3 GHz for methanol 4_0-3_1 E masers.

No.	Observers	Programs
L271	Lockman, F. J. Savage, B. (Wisconsin)	Search at 1.4204 GHz for high velocity HI toward QSOs.
S350	Stocke, J. (Colorado/JILA) Carilli, C. Perlman, E. (Colorado/JILA)	A search at 1.127 GHz for HI absorption towards PKS 1413+135.
T293	Turner, B. Rickard, L. (NRL) Xu, L. (Beijing)	A 2 cm study of H_2CO in low-latitude molecular clouds.
W311	Wootten, H. A. Turner, B.	A search at 23 GHz for CH_2D^+ in interstellar space.
X5	Xiang, D. (Purple Mountain Obs.) Turner, B.	Continuation of search at 22.235 GHz for new H_2O masers and the correlation of IRAS objects, outflows, and H_2O masers.

The following pulsar programs were conducted during this quarter.

No.	Observers	Programs
B550	Backer, D. (Berkeley) Van Hook, S. (Berkeley) Foster, R. (NRL) Sallmen, S. (Berkeley)	Measurements at 800 and 1330 MHz of the timing of an array of pulsars.
B559	Biggs, J. (NASA/GSFC) Salter, C. Foster, R. (NRL)	Observations at 1420 MHz to monitor pulsar HI absorption spectra.
T312	Taylor, J. (Princeton) Arzoumanian, Z. (Princeton)	Extended timing observations at 400 and 800 MHz of particular pulsars.

The following very long baseline programs were conducted and the stations used are coded as follows.

A	-	Arecibo 300 m	Lb	-	Bologna 25 m
B	-	Effelsburg MPIR 100 m	Lm	-	Medicina 32 m
Ca	-	Cambridge	No	-	Noto, Sicily 32 m
Dc	-	Canberra DSS43 64 m	O	-	Owens Valley 130 ft
Dm	-	Goldstone DSS14 64 m	R	-	Crimea USSR 30 m
Ds	-	Madrid DSS63 64 m	Sn	-	Onsala 20 m
E	-	Hartebeesthoek 26 m	T	-	Torun 15 m
G	-	Green Bank 140 ft	VLBA	-	All available VLBA 25 m
Jb	-	Jodrell Bank MK 8x120 ft	Wn	-	Westerbork n=1-14x26 m
Jm	-	Jodrell Bank 76 m	Yn	-	Socorro n=1-27x25 m
Jn	-	Merlin Array	Puschino		
Ki	-	Haystack 46 m	Defford		
Km	-	Haystack 120 ft	Simeiz		

No.	Observers	Programs
M342	Menten, K. (CFA) Reid, M. (CFA) Moran, J. (CFA) Walmsley, C. M. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Pratap, P. (CFA)	VLBI observations of the strong 6.6 GHz methanol masers, with telescopes G, B, and Ki.
GA6	Alberdi, A. (IAP, Granada) Marcaide, J. (IAP, Granada) Elosegui, P. (CFA) Gomez, J. (IAP, Granada) Marscher, A. (Boston) Zhang, Y. (Boston) Shaffer, D. (Interferometrics)	Observations at 1.3 cm monitoring the superluminal radio source 4C 39.25, with telescopes B, Sn, Lm, No, Km, G, Y_{27}, and VLBA.
GB13	Kus, A. (Chalmers, Onsala) Booth, R. (Chalmers, Onsala) Wilkinson, P. (Manchester)	Observations at 3.6 cm of cores of steep spectrum, compact QSO 3C 380, second epoch, with telescopes B, Sn, Lm, G, and VLBA.
GB8	Bloom, S. (Boston) Marscher, A. (Boston) Gear, W. (Edinburgh)	Observations at VLBI-JCMT-ROSAT-GRO 1.3 cm of strong millimeter sources, with telescopes G, Sn, Lm, B, No, Jb, Km, Y_1, and VLBA.
GG8	Ghosh, T. (NFRA) Rao, A. P. (TIFR)	Observations at 50 cm of extragalactic sources to map the distribution of interstellar scattering at low latitudes, with telescopes B, Jb, Wn, T, Lm, G, O, and VLBA.
GG10	Garrett, M. (NRAL) Wilkinson, P. (NRAL) Porcas, R. (MPIR, Bonn) Walsh, D. (NRAL)	Global observations at 18 cm for the third image of the gravitational lens 0957+561, with telescopes Jm, B, Wn, G, Ds, Dm, and Y_{27}.
GG11	Giovanni, G. (Bologna) Parma, P. (Bologna) Venturi, T. (Bologna) Marcaide, J. (IAP, Granada) Wehrle, A. (JPL)	Observations at 6 cm of low power (FR-1) radio galaxies 3C 272.1 and 0206+35, with telescopes B, Wn, Jb, Lb, No, G, Y_{27}, and VLBA.
GH2	Hewitt, J. (MIT) Ellithorpe, J. (MIT) Turner, E. (Princeton)	VLBI imaging at 6 cm of the components of the probable gravitational lens MG0414+0534, with telescopes B, Lb, Ki, G, Y_{27}, and VLBA.
GJ3	Junor, W. Biretta, J. Reid, M. (CFA)	Observations at 18 cm of the evolution of M87, with telescopes Z, Wn, B, Sn, No, Jb, Km, G, A, E, R, Deff, Pusc, Y_{27}, and VLBA.
GJ4	Junor, W. Biretta, J. Muxlow, T. (NRAL)	Observations at 1.3 cm of the structure and evolution on light-month scales in the nucleus of M87, with telescopes B, Lm, No, Sn, Km, G, Y_{27}, and VLBA.

No.	Observers	Programs
GK5	Krickbaum, T. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Standke, K. (MPIR, Bonn) Schalinski, C. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. A.	First epoch, high-dynamic range 1.3 cm VLBI observations of double lobed Cygnus A, with telescopes B, Sn, Lm, No, Km, G, Y_{27}, and VLBA.
GL4	Lestrade, J-F. (Meudon) Phillips, R. (Haystack) Gabuzda, D. (Calgary) Preston, R. (JPL)	Phase-referenced VLBI observations at 6 cm of RS CVn stars for HIPPARCOS, with telescopes Lm, B, Km, G, Y_{27}, and O.
GP9	Patnaik, A. (Manchester) Browne, I. (Manchester) Porcas, R. (MPIR, Bonn)	Observations at 6 cm of three small separation gravitational lens systems, with telescopes Jn, Jb, Wn, B, Lb, No, Sn, Y_{27}, G, A, and VLBA.
GV9	Readhead, A. (Caltech) Vermeulen, R. (Caltech) Conway, J. Backer, D. (Berkeley)	Monitoring of the core and inner jet of 3C 84 at 22 GHz, with telescopes B, Lb, No, Sn, G, Km, Y_1, R, and VLBA.
GV10	Vermeulen, R. (Caltech) Xu, W. (Caltech) Cohen, M. (Caltech) Readhead, A. (Caltech) Pearson, T. (Caltech) Wilkinson, P. (Manchester) Polatidis, A. (Manchester)	A second-epoch, 6 cm snapshot survey of superluminal motion of sixteen candidates, with telescopes B, Jn, Lb, No, Sn, Wn, G, Ki, Ca, Y_1, and VLBA.
GW5	Wilkinson, P. (NRAL) Patnaik, A. (NRAL) Browne, I. (NRAL) Henstock, D. (NRAL) Readhead, A. (Caltech) Vermeulen, R. (Caltech) Pearson, T. (Caltech) Cohen, M. (Caltech)	A 6 cm snapshot survey of flat-spectrum sources, with telescopes B, Jb, Lb, No, Sn, Wn, G, Ki, Ca, Y_1, and VLBA.
GW6	Wehrle, A. (IPAC/Caltech) Unwin, S. (Caltech) Abraham, Z. (Univ. Sao Paulo) Zensus, J. A. Urry, C. (STScI) Madejski, G. (NASA/GSFC) Carrara, E. (Univ. Sao Paulo)	Coordinated 1.3 and 6 cm VLBI, ultraviolet, X-ray, and gamma-ray observations, with telescopes E, B, Sn, Lb, No, Wn, Jb, Ki, G, Y_1, and VLBA.
GX3	Xu, W. (Caltech) Readhead, A. (Caltech) Conway, J. Unwin, S. (Caltech) Wilkinson, P. (Manchester) Polatidis, A. (Manchester)	Observations at 50 cm to study a possible new class of active galaxy with S-shaped symmetric structure, with telescopes B, Jb, Lb, No, Sn, Wn, Km, G, and VLBA.

No.	Observers	Programs
GZ8	Zensus, J. A. Unwin, S. (Caltech) Wehrle, A. (JPL)	Monitoring at 1.3 and 6 cm of the parsec-scale jet structure of 3C 345, with telescopes B, Sn, Lm, No, Wn, Jb, Ca, R, G, Y_1, Ki, and VLBA.
UAH9	Chen, G. (MIT)	Observations at 18 cm of MG1131+0456, with telescopes B, G, and Y_{27}.
UAH10	Bartel, N. (CFA)	Observations at 1.3 cm of reference sources near Sgr A, with telescopes G, Y_{27}, and VLBA.
UAH11	Lebach, D. (CFA) Bartel, N. (CFA) Ratner, M. (CFA) Shapiro, I. (CFA)	Observations of reference sources 6 cm near λAnd(2337+46), with telescopes Km, G, Y_{27}, and OV-VLBA.

C. 12 METER TELESCOPE

The following line programs were conducted during this quarter.

No.	Observers	Programs
B552	Brown, R. Vanden Bout, P.	Study of CO and CI in Z = 2.286 galaxy IRAS 10214+4724.
B562	Balonek, T. (Colgate) Dent, W. (Massachusetts) Huergo, J. (Colgate) Tripoli, R. (Cornell) Godlin, S. (Vassar)	Study of the evolution of extragalactic radio sources at millimeter wavelengths.
B567	Brown, R. Vanden Bout, P.	Study of CO emission at high redshift.
B574	Butner, H. (NASA/Ames) Lada, E. (CFA)	Testing the linewidth-size relationship in low-mass, dense cores.
B578	Brown, R. Vanden Bout, P.	Search for CI at high redshift.
B579	Blitz, L. (Maryland) Helfer, T. (Maryland) Spergel, D. (Princeton)	Study of dense gas in external galaxies.
C273	Clancy, R. T. (Colorado) Muhleman, D. (Caltech)	Microwave spectroscopy of the terrestrial mesosphere.
D171	Dickel, J. (Illinois) Milne, D. (Australia Telescope)	Study of CO emission associated with SNRs in spiral galaxies.
D172	Dickey, J. (Minnesota) Kazes, I. (Paris Obs.)	Calibrating the Tully-Fisher relation in CO.

No.	Observers	Programs
D173	Digel, S. (CFA) de Geus, E. (Maryland)	CO observations of a quiescent GMC in the far outer galaxy.
G321	Gordon, M. Martin-Pintado, J. (Yebes Obs.)	Monitoring program for the RRL maser in MWC 349.
H280	Hogg, D.	A search for CO in compact planetary nebulae.
H282	Hogg, D.	Study of the interaction of spirals and the X-ray gas in the hydra cluster.
L268	Liszt, H.	Study of galactic CO emission toward extragalactic millimeter-wave continuum sources.
L269	Liszt, H. Burton, W. B. (Leiden)	Study of high-velocity molecular gas near Sgr A*.
L270	Liszt, H.	Study of CO emission toward/around ρ Oph.
L272	Liszt, H.	Observations of Michigan 160 and NGC 4151.
M338	McMullin, J. (Maryland) Mundy, L. (Maryland)	Probing large-scale structure and molecular depletions in IRAS 05338-0624.
M340	Mizuno, D. (Rensselaer) Kutner, M. (Rensselaer) Verter, F. (NASA/GSFC)	Study of the response of GMCs in M31 to the spiral shock.
M343	McMullin, J. (Maryland) Mundy, L. (Maryland)	Probing the nature of the SiO emission in the Serpens molecular cloud.
M345	Mead, K. (Union College) Kutner, M. (Rensselaer) Carey, S. (Rensselaer)	Continuation of CO mapping of the outer galaxy.
M346	McMullin, J. (Maryland) Mundy, L. (Maryland)	CS and CO observations of the extremely young stellar system, IRAS 4.
P160	Pound, M. (Maryland) Blitz, L. (Maryland)	A search for proto-brown dwarfs.
T306	Turner, B.	Search for singly deuterated complex molecules as test of grain chemistry.
T311	Thompson, R. (Penn State)	CO observations of ultrasoft X-ray emitting active galactic nuclei.
W310	Wootten, H. A. Loren, R. (unaffiliated) André, P. (CNRS, France)	Are oxygen-rich grain molecules responsible for SO and SiO enhancements?
W312	Wootten, H. A. Turner, B.	A search for CH_2D^+ in interstellar space.

No.	Observers	Programs
W314	Williams, J. (Berkeley) Blitz, L. (Maryland)	Continued mapping of a GMC in the outer galaxy.
W317	Wootten, H. A. Sahai, R. (Chalmers, Onsala)	Observations of interrupted mass loss in evolved stars.
Z91	Ziurys, L. (Arizona State)	A renewed study of interstellar $HCNH^+$.
Z92	Ziurys, L. (Arizona State) Snyder, L. (Illinois) Hollis, J. M. (NASA/GSFC)	Confirmation of interstellar HNO.
Z98	Ziurys, L. (Arizona State) Barclay, W. (Arizona State) Anderson, M. (Arizona State)	Confirmation of interstellar MgOH.
Z99	Ziurys, L. (Arizona State) Barclay, W. (Arizona State) Anderson, M. (Arizona State) Apponi, A. (Arizona State) Yoder, T. (Arizona State) Vogelson, C. (Arizona State) Pascarelle, S. (Arizona State)	Proposal to complete a 270-300 GHz spectral-line survey of Orion.

D. VERY LARGE ARRAY TELESCOPE

No.	Observers	Programs
AA133	Alexander, P. (Cambridge) Blundell, K. (Cambridge) Pooley, G. (Cambridge) Riley, J. (Cambridge) Liu, R. (Cambridge)	ENLRs and asymmetries in radio sources. 2, 3.8, 6 cm.
AA140	Aschwanden, M. (NASA/GSFC) Bastian, T. Benz, A. (ETH, Zurich) White, S. (Maryland)	CoMStOC 92. 3.8, 6, 20 cm.
AA142	Altenhoff, W. (MPIR, Bonn) Johnston, K. (NRL) Webster, W. (NASA/GSFC) Seidelman, P. (USNO)	Physical properties of asteroids. 1.3, 3.8 cm.
AB414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring radio stars HD193793 and P Cygni. 2, 6 cm.

No.	Observers	Programs
AB456	Burke, B. (MIT) Hewitt, J. (MIT) Roberts, D. (Brandeis)	Monitoring 0957+561 A,B. 6 cm.
AB608	Biretta, J. Perley, R.	Search for superluminal motion in kiloparsec scale jets: 3C 273, 3C 279. 2 and 6 cm line.
AB621	Bahcall, J. (Princeton) van Gorkom, J. (Columbia) Jannuzi, B. (Princeton) Schneider, D. (Princeton)	Low redshift Ly α clouds. 20 cm line.
AB633	Burns, J. (New Mexico State) Perley, R. Gisler, G. (Los Alamos)	Imaging the cluster radio halo in Abell 2255. 20 and 90 cm.
AB634	Baudry, A. (Bordeaux Obs.) Brouillet, N. (Bordeaux Obs.) Henkel, C. (MPIR, Bonn) Klein, U. (MPIR, Bonn)	Position and kinematics of H_2O masers in inner nucleus of M82. 1.3 cm line.
AB636	Bastian, T. Nitta, N. (Lockheed) Vourlidas, A. (NMIMT)	Solar active regions: Structure and preflare phase. 2, 3.8, 6, 20, and 90 cm.
AB637	Bastian, T. Gary, D. (Caltech) Nitta, N. (Lockheed) Kiplinger, A. (Colorado) Dulk, G. (Colorado)	Solar flares: Microwave imaging with high time resolution. 2, 3.8, and 6 cm.
AB651	Bosma, A. (Marseille Obs.) Knapp, G. (Princeton) Athanassoula, L. (Marseille Obs.) van Gorkom, J. (Columbia) Gunn, J. (Princeton)	Disk/halo ratio and spiral structure. 20 cm line.
AB652	Briggs, F. (Pittsburgh) Turnshek, D. (Pittsburgh) Hazard, C. (Pittsburgh)	Search for extended neutral H in galaxies at z=3.4. 90 cm line.
AB653	Brown, A. (Colorado) Skinner, S. (Colorado) Walter, F. (SUNY)	Naked T Tauri stars in Sco OB2 association. 3.8 cm.
AC295	Churchwell, E. (Wisconsin) Kurtz, S. (Wisconsin) Guilloteau, S. (IRAM) Zavagno, A. (Marseille Obs.) Wood, D.	Statistics of UC HII regions. 1.3 cm.

No.	Observers	Programs
AC306	Churchwell, E. (Wisconsin) Walmsley, C. (MPIR, Bonn) Cesaroni, R. (Arcetri) Hofner, P. (Wisconsin) Wood, D.	New NH_3 maser toward G9.62+0.19. 1.3 cm line.
AC307	Chengalur, J. (Cornell) Salpeter, E. (Cornell) Terzian, Y. (Cornell)	Binary galaxies. 20 cm line.
AC315	Carilli, C. Dwarakanath, K. Goss, W. M. van Gorkom, J. (Columbia)	Search for 21 cm absorption by the warm neutral interstellar medium. 20 cm line.
AC316	Carilli, C. Owen, F. Harris, D. (CFA)	Polarimetric imaging of two high redshift radio galaxies. 3.8, and 6 cm.
AC319	Crutcher, R. (Illinois) Goodman, A. (Berkeley) Heiles, C. (Berkeley) Troland, T. (Kentucky)	Linear polarization of the 18 cm OH lines in W22. 20 cm line.
AC320	Cote, S. (Mt. Stromlo) Carignan, C. (Montreal) Freeman, K. (Mt. Stromlo)	HI kinematics of dwarf irregulars in Sculptor and Centaurus groups. 20 cm line.
AD267	Drake, S. (NASA/GSFC) Linsky, J. (Colorado)	Single-dish, low-flux density "radio stars": Are they real sources? 3.8 cm.
AD275	Dwarakanath, K.	GEETEE sources. 20 and 90 cm.
AD280	de Pater, I. (Berkeley) Dickel, J. (Illinois) Silva, A. (Berkeley)	Saturn at 1.3 and 90 cm. 1.3 and 90 cm.
AD283	Dulk, G. (Colorado) Bruner, M. (Lockheed) Leblanc, Y. (Meudon) Bastian, T.	Joint microwave/soft X-ray observations of fine structures in active regions. 2, 3.8, 6, and 20 cm
AD285	Dahlem, M. (Hamburger Sternwarte) Lesch, H. (MPIR, Bonn) Hummel, E. (Royal Obs.)	Magnetic fields in NGC 5426/27. 20 cm.
AD286	Deeg, H. (New Mexico) Brinks, E. Duric, N. (New Mexico) Klein, U. (MPIR, Bonn) Skillman, E. (Minnesota)	Radio spectra of blue compact dwarf galaxies. 1.3, 2, 3.8, and 90 cm.

No.	Observers	Programs
AD287	Deeg, H. (New Mexico) Brinks, E. Klein, U. (MPIR, Bonn)	Radio spectra of low surface brightness galaxies. 3.8 and 20 cm.
AD288	Drake, S. (NASA/GSFC) Linsky, J. (Colorado) Stewart, R. (CSIRO) Bastian, T.	Magnetic BP stars. 3.8 cm.
AD289	Dubner, G. (IAFE, Argentina) Giacani, E. (IAR, Buenos Aires) Winkler, P. F. (Middlebury) Goss, W. M.	Imaging of the SNR 3C 400.2. 90 cm.
AD291	de Pater, I. (Berkeley) Palmer, P. (Chicago) Snyder, L. (Illinois)	OH and H_2CO emission from comet Shoemaker-Levy. 6 cm line.
AD292	Dwarakanath, K. van Gorkom, J. (Columbia) Raychaudhury, S. (CFA) Guhathakurtha, P. (Princeton)	HI imaging of clusters of galaxies. 20 cm line.
AF211	Fiedler, R. (NRL) Dennison, B. (VPI&SU) Johnston, K. (NRL) Hjellming, R.	Extreme scattering events/target of opportunity. All centimeter.
AF217	Frail, D. Kulkarni, S. (Caltech) Thorsett, S. (Caltech)	Young pulsar in G5.4-1.2. 20 cm.
AF219	Freeman, K. (Mt. Stromlo) Carignan, C. (Montreal)	HI kinematics of NGC 24 and NGC 45. 20 cm line.
AF220	Frail, D. Kassim, N. (NRL) Weiler, K. (NRL) Dwarakanath, K.	Further studies of 2 PSR-SNR associations. 20 and 90 cm line.
AF222	Leone, F. (Catania) Umana, G. (IdR, Bologna)	Survey of radio-emitting, magnetic, chemically peculiar stars. 6 cm.
AF224	Navarro, J. (Caltech) Kulkarni, S. (Caltech) de Bruyn, G. (NFRA) Frail, D.	Millisecond pulsar candidate. 20 and 90 cm.
AF228	Foster, R. (NRL) Tavani, M. (Princeton)	Search for pulsed emission from LSI +61 303. 20 cm.

No.	Observers	Programs
AG330	Gomez, Y. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Moran, J. (CFA)	Water masers outside the OH velocity range in OH/IR stars. 1.3 cm line.
AG340	Goss, W. M. Wood, D.	Sickle (G0.18-0.04) and Pistol (G0.15-0.05). 3.8 cm line.
AG343	Giovannini, G. (IdR, Bologna) Feretti, L. (IdR, Bologna) Boehringer, H. (MPIfEP, Garching) Schwarz, R. (MPIfEP, Garching)	Halo sources in A2255 and A2319. 20 and 90 cm.
AG344	Giovannini, G. (IdR, Bologna) Feretti, L. (IdR, Bologna) Boehringer, H. (MPIfEP, Garching) Schwarz, R. (MPIfEP, Garching)	Cluster radio halo candidates. 20 and 90 cm.
AG345	Garay, G. (Chile) Lizano, S. (Mexico/UNAM) Gomez, Y. (Mexico/UNAM)	Cometary compact HII regions: Bow shock or champagne flows? 3.8 cm line.
AH390	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Calgary) Seaquist, E. (Toronto)	Monitoring radio novae. 3.8, 6, and 20 cm.
AH424	Han, X. (NMIMT) Hjellming, R.	The radio remnant of the 1989 outburst of V404 Cyg. 3.8 and 6 cm.
AH437	Hewitt, J. (MIT) Turner, E. (Princeton) Chen, G. (MIT) Angelus, A. (MIT)	Monitoring the "Einstein Ring" gravitation lens MG1131+0456. 3.8 and 6 cm.
AH453	Huang, Z. (Virginia) Thuan, T. (Virginia)	HI distribution and kinematics of blue compact dwarf galaxies. 20 cm line.
AH456	Henning, P. (NFRA) Sancisi, R. (Groningen/Kapteyn)	HI near the elliptical galaxy NGC 4472. 20 cm line.
AH457	Heikkila, B. (New Mexico State) Webber, W. (New Mexico State) Burns, J. (New Mexico State) Walterbos, R. (New Mexico State) Duric, N. (New Mexico)	Survey of edge-on spiral galaxies at 90 and 20 cm. 90 cm.
AH461	Hibbard, J. (Columbia) van Gorkom, J. (Columbia)	The fate of gas in interacting/merging galaxies. 20 cm line.
AJ216	Joncas, G. (Laval) Green, D. (Cambridge)	Investigation of promising sources from the DRAO galactic plane survey. 3.8, 6, and 20 cm.

No.	Observers	Programs
AK285	Koo, B-C. (CFA) Yun, M. (Harvard) Ho, P. (Harvard) Kumar, P. (NCAR) Heiles, C. (Calif., Berkeley)	Structure of HII region G5.48-0.24. 6 and 20 cm.
AK294	Katz-Stone, D. (Minnesota) Rudnick, L. (Minnesota) Anderson, M. (Minnesota) Leahy, J. (Manchester) Lonsdale, C. (Haystack) O'Donoghue, A. (St. Lawrence)	Evolution of the relativistic electrons in extragalactic radio sources. 3.8 and 20 cm.
AK297	Kastner, J. (Haystack) Weintraub, D. (Vanderbilt) Kurtz, S. (Wisconsin)	Physics nature of CRL 2136 and its associated H_2O maser. 1.3, 2, 3.8, and 6 cm line.
AK298	Kellermann, K. Sramek, R. Green, R. (KPNO-NOAO) Schmidt, M. (Caltech) Shaffer, D. (Interferometrics)	Measurement of radio structures of quasars in BQS sample. 6 cm.
AK302	Krishna, G. (TIFR)	Snapshots of 34 ultra-steep spectrum radio sources from Ooty sample. 6 cm.
AL150	Lestrade, J-P. (JPL) Preston, R. (JPL)	Statistical properties of RSCVn stars. 6 cm.
AL251	Langston, G.	Gravitational lens 2016+112. 3.8 and 6 cm.
AL252	Ledlow, M. (New Mexico) Owen, F.	Radio galaxies in rich clusters. 20 cm.
AL256	La Franca, F. (IdR, Bologna) Cristiani, S. (Padova Obs) Gregorini, L. (IdR, Bologna) de Ruiter, H. (IdR, Bologna) Owen, F.	Complete sample of optically selected quasars: B=19.4 to z=3.3. 6 cm.
AL258	Lo, K. (Illinois) Sargent, W. (Caltech) Engargiola, G. (Illinois)	HI mapping of three faint dwarf irregular galaxies. 20 cm line.
AL260	Lang, K. (Tufts) Willson, R. (Tufts) Kile, J. (Tufts)	CoMStOC '92. 2, 3.8, 6, and 20 cm.
AL261	Lang, K. (Tufts) Willson, R. (Tufts) Kile, J. (Tufts)	High-resolution studies of solar flares. 2, 3.8, 20, and 90 cm.

No.	Observers	Programs
AL268	Lehto, H. (Turku) Nilsson, K. (Turku) Valtonen, M. (Turku)	0241+011. The largest quasar? 3.5 and 6 cm.
AM336	Miley, G. (Leiden) Rottgering, H. (Leiden) Chambers, K. (Hawaii)	Study of radio galaxies z > 2. 2, 3.8, and 20 cm.
AM345	Mirabel, I. (CNRS, France) Rodriguez, L. (Mexico/UNAM) Cordier, B. (CNRS, France) Paul, J. (CNRS, France) Lebrun, F. (CNRS, France)	1E 1740.7-2942. 3.8, 6, and 20 cm.
AM356	Mangum, J. (Texas) Wootten, H. A.	Study of young stellar objects in DR21(OH). 1.3 cm line.
AM360	McMullin, J. (Maryland) Mundy, L. (Maryland)	Survey of young stellar objects. 1.3, 2, and 3.8 cm.
AM361	Maloney, P. (NASA/Ames) Skillman, E. (Minnesota)	HI imaging of clumpy irregular galaxies. 20 cm line.
AM362	McHardy, I. (Southampton) Green, A. (Southampton) Branduardi-Raymont, G. (U. College London) Mason, K. (U. College London) Merrifield, M. (Toronto)	Deep radio survey of an extended ROSAT deep X-ray survey area. 20 cm.
AM365	McMahon, P. (Columbia) Richter, O-G. (STScI) van Gorkom, J. (Columbia) Ferguson, H. (Cambridge)	HI survey of the Hydra I cluster. 20 cm line.
AM367	Mehringer, D. (Chicago) Palmer, P. (Chicago) Goss, W. M. Yusef-Zadeh, F. (Northwestern)	W51 star-forming region. 3.8, 6, and 20 cm line.
AM369	Mehringer, D. (Chicago) Palmer, P. (Chicago) Yusef-Zadeh, F. (Northwestern) Goss, W. M.	Search for H_2O masers in Sgr B1 and G0.6-0.0. 1.3 cm line.
AN058	Navarro, J. (Caltech) Kulkarni, S. (Caltech) Vasisht, G. (Caltech) Tanaka, Y. (ISAS, Japan) Nagase, F. (ISAS, Japan) Frail, D. Strom, R. (NFRA)	Monitoring quiescent LMXBs. 20 cm.

No.	Observers	Programs
AO107	Oren, A. (Calif., San Diego) Wolfe, A. (Calif., San Diego)	Faraday rotation in a sample of HST selected QSOs. 6 and 20 cm.
AP214	Pedlar, A. (Manchester) Longley, D. (Manchester) Kukula, M. (Manchester) Baum, S. (STScI) O'Dea, C. (STScI)	NGC 4151. 2 cm.
AP216	Puche, D. Westpfahl, D. (NMIMT) Carignan, C. (Montreal)	Dwarf galaxy DDO 47. 20 cm line.
AP217	Puche, D. Westpfahl, D. (NMIMT) Brinks, E.	Nearby dwarf galaxies. 20 cm line.
AP224	Pedelty, J. (NASA/GSFC) Odegard, N. (GSC/GSFC) Dickel, J. (Illinois) Pisarski, R. (NASA/GSFC)	P-band mapping of the Cygnus loop SNR. 90 cm.
AP225	Phookun, B. (Maryland) Mundy, L. (Maryland)	NGC 5713, NGC 3162 and NGC 3675: HI observations of one-armed spiral galaxies. 20 cm line.
AP228	Puche, D. Westpfahl, D. (NMIMT) Brinks, E. Deeg, H-J. (New Mexico)	The energy balance in two nearby dwarf galaxies. 3.8, 6, 20, and 90 cm.
AP230	Payne, T. (New Mexico State) Neidig, D. (NSO)	Search for radio emission from solar Ellerman bombs. 2, 3.8, 6, and 20 cm.
AP233	Pedlar, A. (Manchester) Axon, D. (Manchester) Kukula, M. (Manchester) Unger, S. (RGO) Baum, S. (STScI) O'Dea, C. (STScI)	Observations of the CFA Seyfert sample at 8 GHz. 3.8 cm.
AP236	Perlman, E. (Colorado) Stocke, J. (Colorado) Burns, J. (New Mexico State)	Evolution of radio galaxies: the distant cluster sample. 20 cm.
AR240	Ratner, M. (CFA) Lebach, D. (CFA) Bartel, N. (CFA) Shapiro, I. (CFA)	Reference star search for NASA gyroscope relativity experiment. 3.8 cm.
AR251	Rupen, M. Lees, J. (Princeton) Knapp, J. (Princeton) van Gorkom, J. (Columbia)	HI emission from elliptical galaxies. 20 cm line.

No.	Observers	Programs
AR255	Rucinski, S. (York U.)	Contact binary stars. 3.8 cm.
AR262	Rowan-Robinson, M. (Queen Mary) Sopp, H. (Queen Mary) Lawrence, A. (Queen Mary) McMahon, R. (Cambridge)	Nature of ultra-luminous infrared galaxies. 2 and 6 cm.
AR265	Rodriguez, L. (Mexico/UNAM) Anglada, G. (Barcelona) Estalella, R. (Barcelona)	Spectral index of IRAS 16293-2422B. 1.3 and 2 cm.
AR266	Richter, O. (STScI) Saha, A. (STScI) Hoessel, J. (Wisconsin)	UGC-A86 and UGC-A92: Local group galaxies or companions of IC 342. 20 cm line.
AR267	Reid, M. (CFA) Readhead, A. (Caltech)	Measurement of the trigonometric parallax of the galactic center. 1.3 cm.
AR268	Rodriguez, L. (Mexico/UNAM) Curiel, S. (CFA)	Radio monitoring of the outburst in SVS13. 3.8 and 6 cm.
AR269	Ratner, M. (CFA) Lebach, D. (CFA) Bartel, N. (CFA) Shapiro, I. (CFA)	Reference-star search: Extension to binary and multiple stars. 3.8 cm.
AS333	Sramek, R. Weiler, K. (NRL) van der Hulst, J. (Groningen/Kapteyn) van Dyk, S. (NRL) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2 and 6 cm.
AS437	Seaquist, E. (Toronto) Odegard, N. (GSC/GSFC)	Synchrotron emission from galactic superwinds. 6 and 20 cm.
AS450	Sahai, R. (Chalmers, Onsala) Claussen, M. (NRL)	Time variation of the enigmatic radio source in IRC+10216. 1.3, 2, and 3.8 cm.
AS458	Szomoru, A. (Groningen/Kapteyn) van Gorkom, J. (Columbia) Gregg, M. (Mt. Stromlo)	High-resolution observations of HI selected void galaxies. 20 cm line.
AS459	Strom, K. (Massachusetts) Rodriguez, L. (Mexico/UNAM)	Ammonia associated with the dense stellar cluster IRAS 05338-0624. 1.3 cm line.
AS464	Schmahl, E. (NASA/GSFC) Gopalswamy, N. (Maryland) Kundu, M. (Maryland) White, S. (Maryland) Canfield, R. (Hawaii) de La Beaujardiere, J-F. (Hawaii)	Identification of precipitation sites in solar flares. 2, 3.8, 6, and 20 cm.

No.	Observers	Programs
AS467	Schmelz, J. (ARC/GSFC) Strong, K. (Lockheed) Holman, G. (NASA/GSFC)	CoMStOC '92. 3.8, 6, and 20 cm.
AS468	Smith, B. (Texas) Wallin, J. (NRL)	HI mapping of the interacting galaxy pair NGC 7714/5. 20 cm line.
AS471	Sukumar, S. (DRAO) Allen, R. (STScI) Tilanus, R. (Caltech)	Radio polarization of face-on spirals NGC 5236 and NGC 4321. 6 and 20 cm.
AT109	Torrelles, J. (IAA, Granada) Gomez, J. (CFA) Verdes-Montenegro, L. (IAA, Granada) Rodriguez, L. (Mexico/UNAM) Gomez, Y. (Mexico/UNAM) Roth, M. (Las Campanas Obs.) Tapia, M. (Mexico/UNAM)	Southern blister HII region GM24. 1.3 cm line.
AT127	Thorsett, S. (Caltech) Taylor, J. (Princeton) Hankins, T. (NMIMT) Stinebring, D. (Oberlin)	Timing fast pulsars. 6, 20, and 90 cm.
AT132	Taylor, J. (Princeton) Thorsett, S. (Caltech) McKinnon, M. (NMIMT)	A test for binary pulsar orbital stability. 90 cm.
AT134	Taylor, A. (Calgary) Dougherty, S. (Calgary)	Monitoring of radio variable Be stars. 3.8 cm.
AT137	Taylor, C. (Minnesota) Brinks, E. Skillman, E. (Minnesota)	High-resolution study of intergalactic HI clouds. 20 cm line.
AT140	Taylor, G. (Arcetri) Schulman, E. (Michigan) Morris, M. (Calif., Los Angeles) Catarzi, M. (Arcetri) Cesaroni, R. (Arcetri)	Search for H_2O masers near galactic center. 1.3 cm line.
AT143	te Lintel Hekkert, P. (Mt. Stromlo) Habing, H. (Leiden) Blommaert, J. (Leiden) Dejonghe, H. (RUG Obs.) Rich, M. (Columbia) Winnberg, A. (Chalmers, Onsala)	OH/IR stars: 1612 MHz survey of galactic plane. 18 cm line.
AU044	Umana, G. (IdR, Bologna) Trigilio, C. (IdR, Bologna) Hjellming, R. Catalano, S. (Catania) Frasca, A. (IdR, Bologna)	Algol-type systems: RZ Cas. 1.3, 2, 3.8, 6, and 20 cm.

No.	Observers	Programs
AU047	Uson, J. Bagri, D. Cornwell, T.	Two Zel'dovich pancakes. 90 cm line.
AV190	van Moorsel, G. (ESO, Garching) Sparke, L. (Wisconsin) Schwarz, U. (Groningen)	HI study of the peculiar galaxy NGC 3718. 20 cm line.
AV193	van der Hucht, K. (Utrecht) Williams, P. (Royal Obs.) Spoelstra, T. (NFRA)	Wolf-Rayet object WR125. 2, 6, and 20 cm.
AV194	van Breugel, W. (LLNL) McCarthy, P. (Carnegie Obs.) Kapahi, V. (GMRT/TIFR)	Distant radio galaxy studies in the southern hemisphere. 3.8 cm.
AV195	van Gorkom, J. (Columbia) van der Hulst, J. (Groningen/Kapteyn) Kasow, S. (Hunter College)	HI imaging of Centaurus A. 20 cm line.
AW249	Wills, B. (Texas) Shastri, P. (Berkeley)	Core variability in lobe-dominated quasars. 6 cm.
AW298	Wallin, J. (NRL) Higdon, J. (Texas) Appleton, P. (Iowa State)	Ring galaxy AM1354-250 HI. 20 cm line.
AW313	White, S. (Maryland) Kundu, M. (Maryland) Gopalswamy, N. (Maryland)	CoMStOC '92. 2, 3.8, 6, and 20 cm.
AW314	White, S. (Maryland) Lim, J. (Maryland) Kundu, M. (Maryland)	Magnetic fields on M dwarf stars. 2 and 3.5 cm.
AW316	Womble, D. (Calif., San Diego) Carilli, C. Dickey, J. (Minnesota) Bowen, D. (STScI)	Probing the extent of disk galaxies: QSO absorption vs. HI emission. 20 cm line.
AW319	Wood, D.	Sulfur dioxide absorption toward compact HII regions. 1.3 and 3.8 cm line.
AW321	Wood, D. Adler, D. Goss, W. M.	High-resolution study of anomalous helium abundance variations in W3. 3.8 cm line.
AW323	Wood, D.	An ammonia line study of G5.89-0.39. 1.3 cm line.
AW327	White, S. (Maryland) Lim, J. (Maryland) Pallavicini, R. (Arcetri)	Search for polarization inversion on weak-line T Tauri stars. 2 and 6 cm.

No.	Observers	Programs
AW337	Wootten, H. A. Benson, P. (Wellesley)	Water maser in 16234-2417. 1.3 cm line.
AY045	Yin, Q-F. Heeschen, D.	Supernovae in MKN 297. 3.8, 6, and 20 cm.
AZ044	Zhao, J-H. Ekers, R. (Australia Telescope) Goss, W. M. Lo, K. (Illinois) Narayan, R. (Arizona)	Flux density variations in Sgr A. 3.8, 6, and 20 cm.
AZ053	Zhao, J-H. Carilli, C. Anantharamaiah, K. (Raman Institute) van Gorkom, J. (Columbia)	Seyfert NGC 1068. 3.8, 6, 20, and 90 cm.
AZ055	Zhao, J-H. Goss, W. M. Dwarakanath, K. Fang, L. (Princeton) Bi, H. (MPIfEP, Garching)	Search for HI absorption toward cooling flows of clusters of galaxies. 20 cm line.
AZ056	Zhao, J-H. Goss, W. M. Anantharamaiah, K. (Raman Institute)	Radio-recombination lines from starburst nuclei of nearby galaxies. 3.8 cm line.
GE003	Elosegui, P. (CFA) Marcaide, J. (Valencia) Guirado, J. (IAA, Granada) Alberdi, A. (IAA, Granada) Shapiro, I. (CFA) Ratner, M. (CFA)	3C 345 phase-referenced to NRAO 512. 1.3 cm.
GR002	Brown, L. (Brandeis) Roberts, D. (Brandeis) Ochs, M. (Brandeis) Wardle, J. (Brandeis)	Polarization of 3C 273. 3.8 and 6 cm.
GR003	Roberts, D. (Brandeis) Brown, L. (Brandeis) Ochs, M. (Brandeis) Wardle, J. (Brandeis)	Polarization of 3C 345. 3.8 and 6 cm.
UB002	Bartel, N. (CFA) Chandler, J. (CFA) Ratner, M. (CFA) Shapiro, I. (CFA)	Gravitational redshift test via pulsar VLBI astrometry. 18 cm.
UB004	Bartel, N. (CFA) Wolszczan, A. (Princeton)	PSR 1257+129 astrometry. 18 cm.

No.	Observers	Programs
UG004	Gwinn, C. (Santa Barbara) Diamond, P. Desai, K.	OH masers in W49N. 18 cm.
UT002	Taylor, A. (Calgary)	X-ray binaries LS I +61d303 and Cyg X-3. 6 cm.

E. VERY LONG BASELINE ARRAY TELESCOPE

No.	Observers	Programs
BL001	Lestrade, J-F. (JPL/Meudon) Jones, D. (JPL) Preston, R. (JPL) Phillips, R. (Haystack) Gabuzda, D. (Calgary)	Astrometry of 12 radio stars. 4 cm.
BP001	Phillips, R. (Haystack) Titus, M. (Haystack) Lestrade, J. (Meudon)	VLBI observations of O supergiants. 3.8, 20 cm.
BR001	Reid, M. (CFA) Readhead, A. (Caltech)	Measurement of the trigonometric parallax of the galactic center: Choosing reference sources. 3.8 cm.

F. SCIENTIFIC HIGHLIGHTS

Green Bank

Neutral hydrogen absorption has been found in the spectrum of the BL Lac object PKS 1413+135. The absorption feature is the strongest found for objects of intermediate and high redshift. The line, at a redshift of 0.26, appears at 1127 MHz where interference is very troublesome and was isolated using interference excision techniques and the spectral processor.

Investigators: J. T. Stocke (Colorado), C. L. Carilli (NRAO), and E. Perlman (Colorado)

Tucson

Chemistry and Mass Loss of S Stars -- With a surface C/O abundance ratio near unity and enrichment of s-process elements, S stars are a relatively rare class of asymptotic giant branch stars. Observers have undertaken a millimeter-wave survey with the 12 Meter Telescope in order to accurately determine mass loss rates and chemistry of the circumstellar envelopes surrounding many of these stars. Of the 27 objects surveyed for carbon monoxide emission, 11 where detected. The six brightest CO objects were then searched for SiO and HCN emission. Of these six, five were found in the SiO J=2-1, v=0 line and three clearly detected in HCN. These results imply a circumstellar envelope with a C/O ratio about 1, which is complementary to the surface abundances. These results also imply that the S-star phase might be as long as that for the carbon stars. Chemical models are being calculated to explore this further. The observers also examined all the CO detected stars for SiO J=2-1; v=1 maser emission. A total of 80 percent of these objects were found to be SiO maser sources.

Investigators: J. H. Bieging (U. Arizona), W. B. Latter (NRAO)

Socorro

Twisted Jet in Markarian 501 -- The puzzling radio continuum structure of the one-sided core-jet in the BL Lactertae object, Mrk 501, previously imaged with global VLBI, EVN, and VLA observations has been augmented with new VLBA data. The VLBA observations provide crucial data in the 10 to 100 milliarcseconds resolution range, which allows the details of the structural twisting to be followed more clearly. The VLBA data consists of a 16-hour track with antennas at NL, LA, PT, KP, plus one VLA antenna observing at 4992 MHz. The new map of the inner 100 milliarcseconds of Mrk 501 reveals that the jet emanates from the core (peak flux = 0.7 Jy/beam) and gradually snakes through more than a 90° turn as its flux density steadily decreases to its weakest detectable level (0.15% of the peak). The structural twist of the jet and other properties of Mrk 501 will be interpreted within the context of several possible models for the pronounced observed curvature.

Investigators: J. M. Wrobel (NRAO), J. E. Conway (NRAO)

3C 295 Hotspots at VLBA Resolution -- VLBA observations of hotspots in the lobes of the radio source 3C 295 have provided a 20 milliarcsecond resolution view of their structure. Only one of the hotspots had previously been resolved with VLA observations and the new VLBA observations reveal a remarkable contrast in morphology between the two hotspots in the opposing radio lobes. The northwest hotspot is round with an elongated central component (size 40 mas x 60 mas) as opposed to the "S" shaped structure of the southeastern hotspot. Nevertheless, the radio spectrum of both hotspots, obtained when combining VLA, Merlin, and VLBA data, is consistent with an uncommonly steep spectral index (‘ ~ 1.0) for both hotspots over the 2 cm - 20 cm radio spectral region. The morphological and spectral properties of radio lobe hotspots are important diagnostics for the physics of particle acceleration at the sites where radio jets impact the external medium.

Investigators: G. Taylor (Arcetri Observatory), R. A. Perley (NRAO)

G. 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 telescopes during the reporting period.

H. CENTRAL DEVELOPMENT LABORATORY

Amplifier Development

The development of the 8-10 GHz amplifier was completed and the production of 8-10 GHz, 12-18 GHz, and 38-45 GHz amplifiers continued. A summary of amplifier deliveries in this quarter is given in the table below:

FREQUENCY BANDS	NUMBER OF AMPLIFIERS
8-10	4
12-18	10
38-45	3
Grand Total	17

Development of the 18-22 GHz and the 22-26.5 GHz amplifiers is in progress. A test fixture for evaluation of a Cuflon microstrip and waveguide-to-microstrip transition in the 60-90 GHz band has been designed and is under construction. A new set of dewar transition lines has been tested at room temperature and cryogenic testing is under way. Work has begun on FET evaluation fixtures for cryogenic S-parameters and noise parameters measurements.

Superconducting (SIS) Millimeter-Wave Mixer Development

Work continues on the tunerless 200-300 GHz SIS mixers. These will be used on the new 260-300 GHz receivers and on the 8-beam SIS receiver now being designed in Tucson. For use in the 260-300 GHz band, it is now clear that the performance will be greatly improved by using a magnetic bias field on the junctions to suppress unwanted Josephson effects. Without magnetic bias, the mixers must be operated with reduced LO power to avoid Josephson mixing. The receiver noise temperature measured in the laboratory increases with frequency from ~70 K to ~150 K DSB over 270-300 GHz. With magnetic bias we expect noise temperatures in the range 50-80 K. A graduate student from UVa is helping us develop magnetic bias systems for our laboratory test receiver and for telescope receiver inserts.

A biasing instability, mentioned in the last quarterly report, limits the lower operating frequency of the present 200-300 GHz tunerless mixers. This is understood in terms of the RF embedding admittance (seen by the junction conductance) which becomes inductive at the low end of the band. Under this condition, a single SIS junction can exhibit negative DC (and IF) output conductance. For a series array of junctions, it is suspected that this can be an unstable situation in which the individual junctions become unequally biased and ultimately reach one of a number of possible stable dynamic states in which the junctions are unequally biased. We are now developing an improved tunerless mixer designed to prevent this situation and allow wider useable frequency band.

Work continues on the four 270-300 GHz receiver inserts. These are due to be delivered to Tucson in September.

During this quarter, we have built (or rebuilt) and tested a total of 16 SIS mixers operating from 90-300 GHz. This includes five 3-mm mixers made to our design at the University of Illinois for the BIMA interferometer.

OVLBI Earth Station Project

Work continued during the quarter on the detailed design phase, with progress in the various subsystems described in the following paragraphs.

In the optics subsystem, the design and geometry had already been finalized at the start of the quarter, so work proceeded on the detailed design of the X- and Ku-band corrugated feed horns and their associated waveguide transitions to the front-end dewars. The horns were both submitted for in-house fabrication. The Ku-band horn was completed and tested on the antenna range. Preliminary results show a close correspondence between the expected and actual antenna radiation patterns. Specifications have been written for the hyperboloidal subreflector and ellipsoidal tertiary mirror. These specifications define the surface shapes, tolerances, material properties, and operating conditions of the reflectors. Parts continue to be tested for eventual assembly of the X- and Ku-band receiver front-ends.

In the two-way timing subsystem, testing of some transmitter components continued.

In the wideband data subsystem, the Costas loop prototype was completed and partly tested. Complete testing awaits a QPSK modulator of sufficient quality which is on order. Circuitry for generating random test data and driving the modulator has been constructed. Plans for performance testing have been formulated. Preliminary design of the decoder design was completed, and detailed design is in progress. Information has been gathered on fiber optic links for remote data recording, though no design decisions have yet been made. The delivery of VLBA recorders from a contractor is behind schedule and is now expected in mid-July. However, this does not affect the overall project schedule.

The computer control subsystem has had significant changes. We have abandoned the real-time operating system originally selected (Venix) and will instead use VxWorks, which is also used for real-time control of VLBA stations. The main reason for this is that porting of the VLBA code to a new system proved much more difficult than anticipated. Also, a second programmer is being hired to augment the development team. This person is expected to join us early in July.

The 13.7 m antenna is undergoing detailed study of its pointing accuracy as a summer student project. This is expected to result in refinement of the pointing correction coefficients, an understanding of the accuracy with which atmospheric refraction can be corrected at low elevations and possibly identification of any problems that need correction. Meanwhile, a

decision has been made to proceed with upgrading of the main reflector surface by replacing one-third of its panels (24 out of 72). Holographic measurements show that this will improve the rms accuracy by nearly a factor of two, which will increase the 15 GHz gain by about 1 dB. This is feasible because the antenna's original manufacturer (ESSCO) is able to provide replacement panels at a reasonable cost.

In administrative matters, information on the uplink transmitters was submitted to NSF's frequency manager in order to begin the process of obtaining the required frequency assignments. It will be reviewed by the Spectrum Planning Subcommittee of the NTIA (Department of Commerce). No difficulty is expected since the frequencies comply with national and international allocations.

The project manager attended the international meetings on orbiting VLBI held in Calgary, Alberta in early May. This included a VSOP symposium and the 14th semi-annual Radioastron meeting.

Electromagnetic Support

A GBT wideband linear taper horn prototype was measured on the antenna test range at Green Bank. The horn has good E- and H-plane symmetry with a taper between -15 dB and -16.3 dB at 15 degrees in the 12-18 GHz range. The worst cross-polarization is -28 dB. The input VSWR has not been measured as a new rectangular-to-circular transition is needed.

A second prototype of the profile horn for the 1.15-1.73, 1.73-2.65, and 2.65-3.95 GHz bands was designed. This feed would have 0.090 inch thin vanes at L-band. A prototype was built at C-band and measured. Within measurement errors, this feed has characteristics just like a previous version with thicker vanes.

An analysis was done on the performance of the GBT resulting from deformations of the main reflector and feed support arm due to gravity at different elevation angles. The amount of subreflector translation that is required for recovering the gain loss due to gravity-induced deformation was also calculated. The increase in spillover due to the removal of a few panels around the periphery of the GBT, as proposed by RSi, was studied.

I. GREEN BANK ELECTRONICS

Green Bank Telescope

1. General--Antenna analysis software was used to analyze the effect of gravitational deformations of the best-fit paraboloid and feed arm for the latest available Loral design. The results indicated that the subreflector must be moved to compensate for those deformations at frequencies above a few gigahertz. If the subreflector is placed properly, however, the overall loss can be kept below two percent. Gravitational deformations will not be a major problem if they are repeatable.

2. GBT Active Surface--The First Article Inspection of the production actuators was witnessed during this quarter. Vendor personnel were trained in the use of equipment that NRAO supplied and sample testing of production actuators was continued. Control modules were extensively tested for emission that would cause radio-frequency interference. In addition, a screened enclosure with sufficient attenuation to meet CCIR 224-5, (Harmful Interference Limits) was designed. The assembly, test, and debugging of a small-scale version of the GBT active surface was complete. This prototype includes four panels, nine actuators, cables, control modules, and control computers with sufficient software to run a variety of tests. The actuators were taken from the production line, the control modules are pre-production prototypes, and the computing hardware is configured as in the finished system. Positioning accuracy is generally one mil (0.001-inch) peak or better. Software was written to close the loop with the laser pointing system for a complete system test.

3. GBT Servo System--Progress in the GBT Servo system development, including hardware and software requirements and design documents detailing RSi's designs, was monitored. These efforts included monthly status reviews, the monitoring of safety and servo analyses, and the selection of critical servo components. Servo components were tested for radio-frequency interference (RFI). Subsequently, adequate shielding designs and recommended RFI reduction procedures were provided to the servo contractor.

A first-cut definition of the computer interface between Monitor and Control computers and RSi's Servo system was developed.

4. GBT Monitor and Control--Work progressed on the electronics system analyses and designs, to develop software, modify software drivers and hardware to support NRAO's Standard Interface Bus from the Motorola MV147 computer at 57.6 kilobaud. Design efforts for a general-purpose digital interface were continued.

5. GBT Receivers--The prime focus receivers and the K-band gregorian receiver are currently being designed and constructed.

A block diagram level design of the 18-26.5 GHz receiver was completed during this period. All components have been ordered and most received. The layout of the dewar is complete, with the dewar canister ready to be machined. Layout of the remainder of the receiver package will be completed by mid-July. Waveguide test transitions and prototypes of the vacuum window and thermal transitions are being fabricated in the machine shop. Design of auxiliary control circuitry and the monitor/control interface is underway. Microwave switches needed for the Local Oscillator and Test Tone Routers were selected and ordered. The second prototype quadridged OMT was constructed and tested. This unit was designed using a finite-element analysis package. The isolation proved to be poor, and the reason is not fully understood. It may be related to the larger relative width of the ridges. The likely cause of high-Q resonances observed in all the quadridged OMTs was determined. A design approach that seems likely to reduce the number of these in the passband is now being pursued. A linear taper prototype feed for 12 to 18 GHz was fabricated and tested. Its performance is adequate except near the high end of the band. The problem is with a higher-order mode in the input circular waveguide, encountered because an existing rectangular to circular transition was used in the tests. A more suitable transition and throat section is being fabricated.

There will be two, essentially identical, standard NRAO front-end boxes called prime focus receivers Nos. 1 and 2. Receiver No. 1 will contain four frequency bands--two high bands: 680-920 MHz and 510-690 MHz and two low bands: 385-520 MHz and 290-395 MHz. Receiver No. 2 will be identical, except that the 680-920 MHz band will be replaced by a 910-1230 MHz band. Remote switching will allow the observer to use any one of the four bands, providing the necessary feed change has been made. Pending the development of dual-frequency feeds, the user will have the capability of observing at one high band and one low band simultaneously. A preliminary design for the receiver No. 1 dewar was completed. A concept of how the dewar will mount in the front end has been worked out but requires more drafting to complete the details. A preliminary design for the 680-920 MHz feed was completed. A prototype of this feed scaled to 5.441 GHz is nearing completion in the machine shop. When that is completed, radiation patterns on the prototype feed will be performed to obtain co-polar and cross-polar patterns to determine if the existing design is acceptable. EMS Corporation is fabricating the OMT for the 680-920 MHz receiving band. Initial testing of the device at EMS is expected within a few weeks. Final testing requires a rectangular to circular adapter, which has been designed and is presently under construction at Green Bank. Alternative block diagrams of the receivers have been drawn and are being analyzed to pick the best options. Various dielectric foams for use on window vacuum seals were tested to find an alternative to the obsolete Emerson Cumings PS1.04 material. Radva polystyrene foam has the lowest loss characteristics, even lower than PS1.04, but may outgas too much for use where large pieces are required (such as the 680-920 MHz band). It should be adequate for higher frequency bands where the dewar input waveguide windows are smaller (such as in the secondary focus receivers). Tests on Dow Chemical extruded polystyrene foam at 800 MHz indicate an acceptable noise contribution of about 0.3 degrees kelvin, and acceptable outgassing in a piece the size required in the 680-920 receiver. A study of how the receiver should be integrated with the monitor and control system has been started.

140 Foot Telescope

The aging control computer in th MKIII VLBI terminal was replaced by a modern, PC-based unit running a new version of the control software.

Site Computing

Fifteen SUN workstations were installed at various locations on site and integrated into the "Thin-net" LAN on the second floor of the Jansky Lab.

Navy Operations

Construction and testing of hardware for the Hawaii S/X receiver has progressed significantly. Testing of the cryogenic dewar has been completed. The dewar exhibited a noise temperature of less than 10 degrees kelvin for the S-band channels and less than 13 degrees kelvin for the X-band channels. Corresponding gain was about 30 dB for both the S- and X-band channels. These values compare favorably with those obtained previously in the dewars installed on the 85-ft antenna receivers at Green Bank. The dual-frequency feed for the Hawaii receiver was tested. The S-band efficiency was found to be greater than 65 percent while at X-band it was greater than 60 percent. These numbers are also close to those obtained for the feeds on the 85-ft antennas. The dewar and feed have been installed in the front-end box. The Hawaii receiver backend is being modified to provide Mark III IF outputs (in addition to VLBA IF outputs). This represents an additional requirement, and the effort is about 50 percent completed.

System tests are currently being done on the recording system. It is identical to the VLBA recording system. This system will be used in Hawaii.

VLBA

Of the VLBA front-ends constructed in Green Bank, all but two of the 7 mm front-ends have been completed and shipped. The tenth 7 mm front-end (SN #10) is currently being tested and will be shipped to Socorro in mid-July. The components for another 7 mm front-end are present and ready for assembly.

Checkout of the system and individual baseband converters was continued, with several modifications implemented in the Green Bank and Hawaii terminals.

J. SOCORRO ELECTRONICS

RFI Improvements

Radio-frequency interference (RFI) locally generated at each VLA antenna partially limits the sensitivity of the 74 MHz and 327 MHz receiver. Twelve antennas outfitted with RFI shielded enclosures over the vertex room B-rack produce no RFI at 327 MHz and reduced RFI at 74 MHz. Outfitting additional antennas awaits funding.

In April installation in all VLA antennas 1200-1730 MHz bandpass filters which eliminate the appearance of external 1710-1850 MHz fixed microwave signals in the 1490-1350 MHz observing range was completed.

Frequency Coordination

In June the Electronics Division assumed the frequency coordination task from the staff scientist. Frequency coordination attempts to prevent or at least minimize RFI to VLA and VLBA observation from government and non-government transmitters before and after their initial installation. The National Science Foundation's Electromagnetic Spectrum Manager alerts us to government installations and operations. However, unlike the notification by non-government users required by the National Radio Quiet Zone, the VLA-VLBA frequency coordinator must maintain an informal network and use commercial sources to obtain timely information on non-government transmitters. Mitigation involves negotiations with operator/owners and/or with the FCC. In June the FCC was petitioned to deny applications for four TV transmitters to protect 611 MHz observing at the Los Alamos, North Liberty, and Owens Valley VLBA sites.

1.3 - 1.7 GHz T_{sys} Improvements

At the end of this quarter fourteen VLA antennas are outfitted with the improved (30 K vs 55 K T_{sys}) VLBA-style 20 cm front ends. Construction continues with 1992 funds for eleven more front ends, the last of which will be installed in second quarter 1993. With 1993 funds, we expect to complete the front ends for the remaining three antennas plus two spares.

43 GHz Tests of VLA Antenna

Antenna aperture efficiency and pointing errors are the critical factors to determine whether to add 43 GHz receiving systems to the VLA. In May electronics and engineering services divisions installed on antenna 14 a VLBA 43 GHz front end with a feed optimized for the VLA antenna optics. Tests by the scientific staff during June and July will measure the antenna performance.

K. TUCSON ELECTRONICS

2 mm SIS Receiver

The new 2 mm SIS receiver was used successfully for about two weeks of visitor observing in late May and early June. The receiver performed very well and all the observers who used it came away with good data. The only real difficultly encountered was an occasional oscillation in the output IF. The oscillation typically occurred for a few minutes at a time when the ambient temperature reached a certain level. This problem is subtle; however, we expect to solve it shortly.

The receiver tunes from ~130 to 170 GHz. Receiver noise temperatures are ~80 K (DSB) at mid-band. Although these mixers give quite good performance, even lower noise mixers should be available from the NRAO Central Development Laboratory within the coming year. Current system temperatures (T_R^* scale) were 400-800 K during good weather and at middle elevation angles. By proper tuning of the mixer backshorts, it was possible to reject the image sideband by more than 20 dB at all the frequencies attempted. The 2 mm receiver will be scheduled for routine observations beginning this autumn.

270-300 GHz SIS Mixers

We expect to receive new SIS mixers covering the 270-300 GHz band sometime this autumn. The mixers and receiver inserts are being developed by the Central Development Laboratory in Charlottesville. They will be tunerless mixers, and we are anticipating rather good performance from them. The new mixers will be incorporated into the 1 mm SIS package that currently includes a dual polarization mixer covering 200 to 270 GHz. Two orthogonal polarization channels will be available in the new 270-300 GHz set. Using the quasi-optical image dumper that is part of the 1 mm SIS package, observers will be able to observe in a single or double sideband mode. The image band is terminated on a cold stage inside the receiver cryostat to minimize noise.

Observers are invited to apply for observing time with the new 270-300 GHz mixers beginning with the October 1 proposal deadline of this year. The October 1 deadline is for the January 1 to April 1, 1993 observing period. As the deadline approaches, proposers may wish to contact us for noise temperature estimates.

8-Beam, 220-250 GHz SIS Receiver

The upgrade of the 8-beam receiver to its new SIS version is proceeding at a rapid rate. The engineering design work is largely completed, and many of the components have already been fabricated or are in the machine shop at this time. If all goes well, we should be ready to test the upgraded receiver before the end of the year. We hope the receiver will be available to visiting observers in early 1993. The completion and testing schedule is too uncertain to call for observing proposals at this time, however.

Summer Shutdown Activities

A number of enhancements to the 12 Meter Telescope systems are planned during the upcoming summer shutdown period. Summer shutdown begins on July 13 this year and will extend until mid-September. We will be taking several steps this summer to improve the reliability of the backup power systems at the 12 Meter Telescope. Foremost of these is the replacement of the old World War II-vintage GM generator with a new Cummins diesel generator. The Caterpillar diesel generator will be held as a backup. We will also be performing some renovation work on the uninterruptible power system (UPS) and will install some small, auxiliary UPS's to protect some critical electronic and computer systems.

Several significant computer enhancements are planned for this summer, including the replacement of the Sun 3's with Sparc 2 workstations. Observers can anticipate a number of new observing modes to be available by the end of the summer, including a new "on-the-fly" mapping mode.

Some upgrades to the analog portion of the Hybrid Spectrometer are also planned for this summer. These changes should make the spectrometer filter modules more stable. An upgrade to the spectrometer IF processor is also in the works that will make all eight input IF sections of the spectrometer fully computer-tunable. We are also augmenting the filter bank "switcher" module to reduce the number of cabling changes required to change filter banks.

L. AIPS

The 15APR92 release of AIPS is complete and has been distributed to over 40 sites throughout the world. The Network-Smart configuration has been very successful.

The next planned release of AIPS is 15OCT92, in order to distribute the new VLBA software and provide support for the new SUN Solaris operating system. In addition, we hope to provide more support for other computer vendors which use the UNIX Bell operating system.

Significant changes were required for proper calibration of polarized VLBI/VLBA experiments. These changes have been made to the 15OCT92 version of AIPS and are currently being tested. A notable AIPS/VLBA milestone has been passed. Correlated VLBA observations have been successfully read into AIPS.

M. SOCORRO COMPUTING

The near-real-time visualization system at the VLA site has been made more robust and is now ready for more extensive testing by observers. It has so far been used very successfully by a number of scientists, primarily in-house staff. Some data reduction may be done afterwards, but it is not yet at the stage where major projects can be processed entirely at the site. This is, however, a facility we plan to provide if there is sufficient demand.

Support was added to the online system for a new 0.7 mm observing band, and the first successful single-dish tests were carried out during this quarter. As the hardware evolves in the next year, the online system will need to be modified accordingly. A new application to run on the site SPARCstation was tested to capture the real-time data flow in a way suitable for single-dish observations and to make it available to offline applications.

In the effort to improve pointing at the VLA, design work has begun for a project to provide "referenced pointing." We expect to be able to test this capability late in the next quarter.

The memory in the Modcomp VLA control computers was successfully increased four-fold to 8MB each early this quarter. No problems with the new chips have been seen. This increase in capacity was necessitated by the networking software used to communicate with the near-real-time imaging SPARCstation, which is now in routine use.

The number of Sun workstations at the AOC continues to increase as new staff arrive and the number of reservable visitor workstations is augmented. There are now seven such systems. Additional peripherals, such as Exabyte tape drives and a high-speed networked PostScript printer, have also been installed. DAT drives have recently been successfully tested with AIPS in Charlottesville, and several are planned for the AOC. As part of the VLBA computing procurement, a replacement for the Dicomed film recorder has been ordered. The system is essentially a duplicate of the one in use at KPNO, a Solitaire connected to a low-end SPARCstation. It will be capable of producing images on 35 mm, 4x5", and Polaroid film.

The high-performance visualization engine, an IBM RS/6000-560 with special graphics hardware and software, has been ordered and is expected to be installed in July. Extensive software development will be needed in order to make the

system useful for astronomical display. This is expected to be ready by early 1993. In addition, the procurement for the high-end UNIX workstations was also recently completed. Delivery of four IBM RS/6000-560 systems to the AOC is expected as a result, also in July. These will be reservable by visitors and in-house staff with major projects. Each will be equipped with 64 MB of memory and 3 gigabytes of disk space.

N. VERY LONG BASELINE ARRAY PROJECT

Antennas and Site Preparation

The first eight VLBA stations are operational: Pie Town, New Mexico; Kitt Peak, Arizona; Los Alamos, New Mexico; Fort Davis, Texas; North Liberty, Iowa; Brewster, Washington; Owens Valley, California; and Hancock, New Hampshire.

At the St. Croix, Virgin Islands site the antenna erection and electronic outfitting is complete. This antenna's operability awaits only an economical Internet connection, which is expected in July. At the Mauna Kea, Hawaii site the antenna erection is mostly complete, with all antenna panels installed. Electrical wiring and mechanical alignment is in progress. Completion of erection is scheduled for August. The antenna control building is complete except for local code compliance approval. NRAO outfitting of the Mauna Kea site is scheduled to start in August and to be completed by the end of 1992.

Electronics

Electronics construction has continued during the quarter, and at this advanced point it is useful to review only the remaining tasks. Three front ends for 43 GHz remain to be completed, as well as three for 14 GHz, and one each for 8.4 and 23 GHz. Of these eight front ends, four will be spares. Fifteen converter modules are awaiting wiring and testing, and 12 of these will be spare units. All of the modules for the Data Acquisition Racks, including spares, have been completed with the exception of the last Baseband Converters. All nine antennas that have been outfitted to date, i.e., all sites except Mauna Kea, now have a full complement of eight Baseband Converters. The prototype Pulse Generator Module has been tested and construction of the remaining units has started. The design of the Phase Calibrator for the Pulse Generator is complete and a prototype of this last module will be tested during the third quarter. This Phase Calibrator will be the last unit to be retrofitted at the antennas. Its purpose is mainly to provide continuity in phase calibration after any interruption of the frequency divider in the pulse generator module. All remaining electronics construction should be completed by the end of the year.

Data Recording

The production of VLBA recorders and playback units continues, with units through serial #32 (PBD #15) either shipped or awaiting final testing at Haystack Observatory. Eight more units are largely completed at the AOC, with shipments to antenna sites to start in mid-July. The production of the eleven units in Haystack's fourth and final production run is well under way, with the first shipments planned for mid-November. A mechanical upgrade to the tape path to reduce stress on thin tape has been developed by Haystack and installed on one transport at each site (except Mauna Kea, St.Croix, and Hancock).

The thin tape reliability tests started in the first quarter continued in the second quarter. These tests will continue at least through September. If the thin tape does not pass qualification by then, NRAO will delay procurement of a VLBA tape inventory until a fix can be made. In the meantime standard thick tape will be used as a temporary measure to allow early VLBA operations. NRAO and Haystack Observatory are now attempting to collect as many as possible of the thick tapes which are distributed at various Network and correlator sites.

Monitor and Control

During second quarter 1992 additional enhancements were made to the on-line software system. The band-switchable pulse cal is now supported, and a first version of automatic tape track allocation has been implemented. The code for producing correlator logs, pointing data, etc., from the station monitor logs has been considerably improved, including adding support for holography data collection. Work is progressing toward inserting relevant log data into the Ingres database. A major revision in table formats was made, which is believed to be minimally sufficient to support the VLBA correlator processing.

Correlator

Construction of the correlator culminated during this quarter with the detection of the first interference fringes from an astronomical source on May 6. This event was the first full end-to-end operation of the VLBA instrument--observed at VLBA stations under remote control from the Array Operations Center, recorded and reproduced in VLBA format on the VLBA recording system, correlated, and the results loaded into AIPS for analysis.

This correlation used data taken on April 6--one month earlier--in the third correlator test observation. Two previous sessions failed to produce usable test data because hitherto unused modes (principally the VLBA format) and functions were being exercised for the first time. Single-dish "self-spectra" were obtained on April 15. The search for cross-spectra began on April 20, and lasted an intense 16 days. Fringes were detected in an emission-line source--by far the most convenient target for fringe searching in an FX correlator, since successful correlation can be detected directly by inspection of the cross-spectral power, without any "eyeball integration" of a fringe signal or post-correlation processing.

Subsequent test correlations increased the array size processed to five stations, a limit imposed by the availability of playback drives. Simultaneous correlation of a two- and a three-station array, observing different sources at different times, was also demonstrated. Fringes from continuum sources were detected as well. These test correlations represent major milestones in completion of the correlator and evidence substantial progress over a wide range of correlator subsystems, but did not in fact constitute a large fraction of the group's efforts.

Hardware development concentrated instead on the "mode/model" check-out initiated in the last quarter, verifying the combined performance of the delay tracking, deformatting, data segmentation, and fringe rotation processes, and their timing relationships. All VLBA-format (de-)multi-plexing modes have now been validated for Nyquist-sampled and for twice-oversampled data, for a fixed 512-point FFT size. These tests implicitly include much of the correlator's overlapped-transform mechanism as well. Extensive preparations for testing the decoding and processing of Mark 3 format were nearly completed. Only the special cases for high spectral resolution remain to be completed after moving the correlator to Socorro.

Another test performed with specialized test fixtures simulated a lengthy "blank sky" integration. The root-mean-square cross-correlated noise was observed to decrease proportionally to the square root of the integration time, over a period of at least 12 hours, before showing any sign of levelling out--far better performance than necessary for any normal correlator operation.

The output transversal filter was completed and tested extensively. Successful filtering operation and data transfer--including use of the specialized high-performance interface--were demonstrated. Integration of the filter into the correlator system was suspended until after moving to Socorro, however. The spare filter board was also completed.

Software testing accelerated with the availability of a functioning data path through the entire correlator system. While much of this code had been tested extensively in stand-alone simulations, the initial exercise of actual hardware control exposed the anticipated assortment of minor bugs. It is a tribute to the software team's careful coding and to the automated management of software development that these bugs were detected, identified, and corrected extremely rapidly--most within the 16-day first-fringe search effort.

Procurement was finally completed for driver software to support DAT and Exabyte tape drives, and intermediate disk storage, on the high-performance interface for the archive and distribution systems. The software has now been tested

extensively, writing data at up to the specified 500 kB/s rate onto three different tape drives. This removes the last barrier to the final procurement of tape drives for the correlator's back end.

At the end of the last day of the quarter, the correlator was shut down for the last time in Charlottesville to be dismantled for shipment to Socorro. Two of the five correlator group members transferring with the correlator departed during the final weeks of June.

O. PERSONNEL

New Hires

Macknik, L.	Deputy Assistant Director--Green Bank	04/27/92
Holstine, M.	Plant Engineer	05/11/92
Best, M.	Electronics Engineer II	06/01/92
Shannon, P.	Systems Analyst	06/10/92
Haynes, M.	Visiting Scientist	06/10/92

Terminations

Crane, P.	Associate Scientist	05/29/92
Porcas, R.	Visiting Scientist	06/26/92

Staff Changes

delGiudice, W.	to Mechanical Engineer, Special Projects	04/01/92
Ruff, J.	to Head/VLA Engineering Services	04/01/92
Hogg, D.	to Assistant Director--Green Bank	05/19/92
Seielstad, G.	to Scientist	05/19/92
Valente, M.	to Electronics Engineer II	05/20/92

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