NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

October 1 – December 31, 1997

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A. TELESCOPE USAGE

The following telescopes have been scheduled for research and maintenance in the following manner during the fourth quarter of 1997.

	140 Foot	12 Meter	VLA	VLBA
Scheduled Observing (hrs)	1833.50	1899.75	1623.20	1140.00
Scheduled Maintenance and Equipment Changes	218.75	84.00	220.90	182.00
Scheduled Tests and Calibration	43.75	161.25	311.80	260.00
Time Lost	121.00	219.75	97.44	25.00
Actual Observing	1712.50	1680.00	1525.76	1115.00

B. THE 140 FOOT OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observers	Programs
B645	Bell, M. (NRC, Herzberg) Vallee, J. (NRC, Herzberg)	Attempt to confirm the 8.665 GHz hyperfine line of $^3He^+$ in several critical sources using frequency switching.
B654	Barnbaum, C. (STScI) Morris, M. (UCLA) Omont, A. (IAP, Paris)	Observations of OH and H_2O masers associated with the extraordinary star, U Equ.
B678	Braatz, J. Greenhill, L. (CFA) Herrnstein, J. Moran, J. (CFA)	A 22 GHz search for high-velocity H_2O maser lines in nearby Seyfert 2 galaxies.
H311	Haisch, K. (Florida) Gottesman, S. (Florida)	A survey of HI in shell elliptical galaxies.
L310	Liszt, H. Bahcall, J. (Princeton)	Search for HI absorption toward 2349-014.
L319	Lockman, F. J. Murphy, E. (Johns Hopkins)	21 cm HI mapping of the galactic plane.

No.	Observers	Programs
M405	Matthews, L. (SUNY) Gallagher, J. (Wisconsin) van Driel, W. (Paris Obs)	An HI survey of southern extreme late-type galaxies in the local supercluster.
M406	Matthews, L. (SUNY) Gallagher, J. (Wisconsin) van Driel, W. (Paris Obs)	An HI survey of flat spiral galaxies in the local volume.
R269	Rupen, M. Holdaway, M.	HI total power observations as bias images to support VLA mosaicing projects.
SETI	Tarter, J. (SETI)	Project Phoenix.
T369	Turner, B.	An astronomical search for the hydrocarbon ion C_2H_3+.
W398	Wootten, H. A. Claussen, M. Wilking, B. (Missouri)	Water maser monitoring of low-luminosity young stellar objects.

The following pulsar programs were conducted during this quarter.

No.	Observers	Programs
A118	Arzoumanian, Z. (Cornell) Nice, D. (Princeton) Taylor, J. (Princeton)	Bimonthly timing of 63 pulsars at 575, 800, and 1650 MHz.
A132	Arzoumanian, Z. (Cornell) Nice, D. (Princeton)	Monitoring at 575 MHz of the evolution of the PSR B1957+20 eclipsing binary system.
B617	Backer, D. (UC, Berkeley) Sallmen, S. (UC, Berkeley) Foster, R. (NRL) Matsakis, D. (NRL)	Pulsar timing array observations at 800 and 1395 MHz.
N018	Nice, D. (Princeton) Thorsett, S. (Princeton)	Monitoring the irregularities in the rotation and orbital motion of an eclipsing binary pulsar, B1744-24A.

The following very long baseline programs were conducted.

No.	Observers	Programs
B673	Briggs, F. (Groningen/Kapteyn) Carilli, C. de Bruyn, A. G. (NFRA) Vermeulen, R. (NFRA) Moore, C. (Groningen/Kapteyn)	VLBI of HI 21 cm absorbers at z=0.7 and 0.25.
BC066	Claussen, M., *et al.*	Water masers in the elliptical galaxy NGC 1052.
GR017	Rupen, M., *et al.*	VLBI imaging of supernova 1993J in M81.
V014	Unwin, S. (Caltech) Wehrle, A. (IPAC/JPL/Caltech)	Probing sub-parsec scales in the active galaxy MKN 421.
V085	Schilizzi, R. (NFRA) de Bruyn, A. G. (NFRA) Snellen, I. (Leiden) Miley, G. (Leiden) Rottgering, H. (Leiden) van Langevelde, H. (NFRA) Fanti, C. (Bologna) Fanti, R. (Bologna)	A VSOP morphological and spectral study of GPS galaxies.
V330	Preston, R. (JPL) Pearson, T. (Caltech) Readhead, A. (Caltech) Murphy, D. (JPL) Meier, D. (JPL) Jones, D. (JPL) Hirabayashi, H. (ISAS, Japan) Kobayashi, H. (ISAS, Japan) Inoue, M. (NRO, Japan)	The Pearson-Readhead survey from space.
VSOP	Tests/VSOG	HALCA in-orbit checkout.

C. THE 12 METER OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observers	Programs
A134	Ali, B. (Rochester) Raines, S. (Rochester) Goetz, J. (Rochester) Pipher, J. (Rochester) Marvel, K. (Caltech)	Search for shocked SiO emission in Cep A.

No.	Observers	Programs
B682	Balser, D. McMullin, J.	Constraining stellar evolution mixing theories.
B688	Butner, H. (Arizona) Charnley, S. (NASA/Ames)	Study of deuterium chemistry in Class O sources.
C308	Crosthwaite, L. (UCLA) Turner, J. (UCLA)	CO mapping of interaction structures in the Leo Triplet.
C315	Crosthwaite, L. (UCLA) Turner, J. (UCLA)	Large scale CO mapping of spiral galaxies.
C316	Clancy, R. T. (SSI, Boulder) Sandor, B. (JPL)	Mars climate studies and spacecraft support.
C317	Clark, F. (Hanscom/AFGL) Carey, S. (Hanscom/AFGL) Egan, M. (Hanscom/AFGL) Kuchar, T. (Hanscom/AFGL)	Molecular search for MSX dark clouds.
CC08	Conway, J. (Chalmers, Onsala) Booth, R. (Chalmers, Onsala) Wiklind, T. (Chalmers, Onsala)	CO (1-0) absorption and millimeter continuum observations of 1413+135.
CD08	Doeleman, S. (Haystack) Barvainis, R. (Haystack) Lonsdale, C. (Haystack) Greenhill, L. (CFA)	86 GHz imaging of the SiO masers in the Orion-KL nebula.
CD09	Doeleman, S. (Haystack) Predmore, C. R. (Massachusetts)	Test of ^{29}SiO V=0 J=2-1 maser detection.
CG05	Gomez, J-L. (IAP, Granada) Marscher, A. (Boston) Alberdi, A. (IAP, Granada)	Comparison of observed and simulated relativistic jets: 86 GHz mapping of the radio galaxy 3C120.
CJ03	Junor, W. (New Mexico) Biretta, J. (STScI)	Close to the edge: within 30 r_g of the supermassive core of M87.

No.	Observers	Programs
CK05	Krichbaum, T. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Greve, A. (IRAM) Grewing, M. (IRAM) Wardle, J. (Brandeis) Roberts, D. (Brandeis) Brown, L. (Connecticut) Holdaway, M. Zenzus, J. A.	Polarization imaging of 3C454.3 and 3C279 at 86 GHz.
CK06	Krichbaum, T. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Kraus, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Greve, A. (IRAM) Ungerechts, H. (IRAM) Grewing, M. (IRAM) Phillips, R. (Haystack)	86 GHz VLBI monitoring of BL Lac after a major optical outburst.
CP01	Porcas, R. (MPIR, Bonn) Rioja, M. (NFRA) Graham, D. (MPIR, Bonn) Machalski, J. (Krakow U.)	Investigation of the quasar pair 1308+326/1308+328 at 86 GHz.
CP02	Polatidis, A. (Chalmers, Onsala) Murphy, D. (JPL) Conway, J. (Chalmers, Onsala)	Coordinated monitoring of 1928+738 with VSOP and millimeter-VLBI.
CR05	Rantakyrö, F. (Bologna) Bååth, L. (Halmstad U.)	Investigation of the rapid structural variability in CTA 102.
CR06	Rantakyrö, F. (Bologna) Conway, J. (Chalmers, Onsala) Bååth, L. (Halmstad U.) Evans, A. (Caltech)	Continuing millimeter-VLBI plus VSOP monitoring of 3C273 and 3C279.
E65	Evans, A. (Caltech) Sanders, D. (Hawaii) Mazzarella, J. (Caltech)	CO (1-0) observations of powerful FRII radio galaxies detected by IRAS.
G367	Gensheimer, P. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Mauersberger, R. (Arizona)	$C^{34}S$ observations of ρ Ophiuchi B.
H323	Hunter, D. (Lowell Obs) Walker, C. K. (Arizona)	Study of the extent of molecular gas around the irregular galaxy NGC 4449.

No.	Observers	Programs
J129	Jewell, P. (Royal Obs) Walker, C. K. (Arizona) Glenn, J. (Caltech)	A study of SiO masers in evolved stars—polarization properties.
K358	Kuan, Y. (SA/IAA, Taiwan) Snyder, L. (Illinois) Charnley, S. (NASA, Ames) Ohishi, M. (Nobeyama Obs)	Gas grain chemistry: search for interstellar complex organic molecules.
L328	Liszt, H. Lucas, R. (IRAM)	Study of Cas A radio continuum and CO emission.
M413	Mauersberger, R. (Arizona) Sobolev, A. (Yekatarinburg U.) Cragg, D. (Monash U.) Johns, K. (Monash U.) Godfrey, P. (Monash U.)	Study of CH_3OD masers in star-forming regions.
M414	Mangum, J. Wootten, H. A.	Study of the kinetic temperature structure within NGC 2024.
M415	Mangum, J. Bontemps, S. (Stockholm Obs) André, P. (CNRS, France)	A survey of outflows in protostars.
M417	Mundy, L. (Maryland)	Study of spectral lines toward TW Hydra.
O46	Ohashi, N. (CFA) Ho, P. (CFA) Moriarty-Schieven, G. (Royal Obs) Butner, H. (Arizona)	CS (5-4) observations of starless cores in Taurus.
S424	Sage, L. (Maryland) Welch, G. (St. Mary's U.) Mitchell, G. (St. Mary's U.)	Study of molecular absorption lines in the spectrum of NRAO 150.
S426	Sandor, B. (JPL) Clancy, R. T. (SSI, Boulder)	Earth atmosphere studies.
S427	Smith, B. (IPAC) Struck, C. (Iowa State)	Study of molecular gas in bridge/ring galaxy pairs.
S428	Strelnitski, V. (M. Mitchell Obs) Benson, P. (Wellesley College) Gordon, M. Holder, B. (Wesleyan U.) Jorgenson, R. (Puget Sound U.)	Simultaneous monitoring of MWC 349 in millimeter hydrogen recombination lines and in optical domain.

No.	Observers	Programs
S429	Strelnitski, V. (M. Mitchell Obs) Benson, P. (Wellesley College) Gordon, M. Holder, B. (Wesleyan U.) Jorgenson, R. (Puget Sound U.)	Simultaneous monitoring of MWC 349 in millimeter hydrogen recombination lines and in optical domain.
S431	Shah, R. (Virginia) Wootten, H. A.	Observations of deutero-ammonia in galactic molecular cores.
T371	Turner, B.	How big can molecules get in translucent clouds? More complex species.
W394	Womack, M. (St. Cloud State)	Study of carbon chemistry in short-period Comets Encke and P/SW 1.
W401	Womack, M. (St. Cloud State) Stern, S. A. (SWRI)	First search for molecules in the lunar atmosphere.
W402	Watt, S. (Maryland) Mundy, L. (Maryland)	Molecular and dust evolution during the formation of high mass stars.
W403	Wolf-Chase, G. (UC, Riverside) Barsony, M. (UC, Riverside)	1.3 millimeter continuum mapping of star-forming cores in the Mon OB1 dark cloud.
W404	Williams, J. (CFA) Myers, P. (CFA)	CS (3-2) observations of the infalling gas around three young stellar clusters.
Z150	Ziurys, L. (Arizona) Apponi, A. (Arizona) Pesch, T. (Arizona) Guélin, M. (IRAM)	Confirmation of AlNC in IRC+10216.
Z151	Ziurys, L. (Arizona) Apponi, A. (Arizona) Pesch, T. (Arizona)	A search for interstellar KS: abundances of the heavier elements.
Z152	Ziurys, L. (Arizona) Apponi, A. (Arizona) Pesch, T. (Arizona) Guélin, M. (IRAM)	Confirmation of circumstellar/interstellar sodium compounds: NaS and NaCCH.
Z156	Zhang, Q. Bergin, E. (CFA) Wilner, D. (CFA)	CN observations of circumstellar disks.

D. THE VERY LARGE ARRAY OBSERVING PROGRAMS

The fourth quarter of 1997 was spent in the following configurations: DnC configuration from October 1 to October 28; and D configuration from October 28 to December 31.

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

No.	Observers	Programs
AA212	Anantharamaiah, K. (Raman Institute) Mohan, R. (IIA, Bangalore) Goss, W. M. Subrahmanyan, R. (Raman Institute)	Radio spectrum of PKS 1830-211. 1.3, 2, 3.6, 6, 20, 90 cm
AA213	Andre, P. (CNRS, France) Motte, F. (CNRS, France) Bontemps, S. (Stockholm Obs)	Follow-up spectral index study of radio detected protostellar clumps. 2, 3.6, 6 cm
AB832	Bowen, D. (Royal Obs) Lane, W. (Groningen/Kapteyn) Briggs, F. (Groningen/Kapteyn) Pettini, M. (RGO)	HI in M61, a nearby galaxy with absorption of a background quasar. 20 cm line
AB833	de Blok, E. (Groningen/Kapteyn) Verheijen, M. (Groningen/Kapteyn)	HI in low surface brightness galaxy UGC 128. 20 cm line
AB839	Brogan, C. (Kentucky) Troland, T. (Kentucky) Roberts, D. (Illinois) Crutcher, R. (Illinois)	VLA DnC OH Zeeman observations toward M17. 20 cm line
AB840	Beck, R. (MPIR, Bonn) Shoutenkov, V. (Lebedev) Shukurov, A. (Newcastle) Sokoloff, D. (Moscow/SSAI)	Magnetic fields in barred galaxies. 3.6 cm
AB841	Brand, J. (Bologna) Wouterloot, J. (Bonn U.)	NH_3 and H_20 observations of Wb89-234. 1.3 cm line
AB842	Brogan, C. (Kentucky) Troland, T. (Kentucky) Roberts, D. (Illinois) Crutcher, R. (Illinois)	VLA DnC H110 recombination line observation toward M17. 6 cm line
AB843	Bastian, T. Chiuderi-Drago, F. (Florence) Alissandrakis, C. (Athens)	Search for linearly polarized radiation in solar active regions. 3.6, 6 cm line
AB846	Balser, D. De Pree, C. (Agnes Scott College) Goss, W.M.	^{4}He imaging of galactic HII regions. 3.6 cm line
AB847	Becker, R. (UC, Davis) White, R. (STScI) Laurent-Muehleisen, S. (LLNL)	Radio-selected BAL quasars. 3.6, 20 cm
AB865	Bennett, P. (Colorado/JILA)	VV Cephei.

No.	Observers	Programs
AC308	Condon, J. Cotton, W. Perley, R.	All sky survey. 20 cm
AC487	Cartwright, J. (Caltech) Padin, S. (Caltech) Pearson, T. (Caltech) Readhead, A. (Caltech) Shepherd, M. (Caltech)	VLA survey of CBI microwave background fields. 3.6 cm
AD405	Dickey, J. (Minnesota)	HI absorption of linear polarization of galactic nonthermal background. 20 cm line
AD406	Donaldson, S. (Maryland) Mundy, L. (Maryland)	Material distribution during the formation of high mass stars. 2, 3.6 cm
AD407	Di Francesco, J. (CFA) Myers, P. (CFA) Wilner, D. (CFA) Mardones, D. (CFA) Williams, J. (CFA)	The structure and dynamics of infall in a small star-forming cluster. 0.7, 1.3 cm line
AD408	Dubner, G. (IAFE) Frail, D. Giacani, E. (IAFE) Goss, W.M. Holdaway, M. Velazquez, P. (IAFE)	Study of centrally influenced supernova remnants. 20, 90 cm
AE114	Edge, A. (Cambridge)	Central galaxy of Abell 2390. 0.7, 2, 6, 20 cm
AF317	Fabian, A. (Cambridge) DiMatteo, T. (Cambridge) Rees, M. (Cambridge) Carilli, C.	Nearby x-ray emitting ellipticals. 0.7, 1.3, 3.6 cm
AF318	Florkowski, D. (USNO)	Monitoring the radio emission from the Wolf-Rayet binary HD 192641. 0.7, 2, 6, 20 cm
AF321	Frail, D. Goss, W. M.	Identifying new pulsar wind nebulae. 3.6, 6, 20 cm
AF326	Frail, D. Kulkarni, S. (Caltech)	Search for radio counterparts of gamma ray bursters with BeppoSAX. 20 cm
AF328	Feretti, L. (Bologna) Giovannini, G. (Bologna) Arnaud, M. (CNRS, France) Rusco-Femiano, R. (IAS, Frascati)	Cluster-wide radio halo in A2163. 6, 20 cm

No.	Observers	Programs
AF329	Franx, M. (Groningen/Kapteyn) van Gorkom, J. (Columbia) Carilli, C.	CO in the most distant galaxy at z=4.92. 0.7 cm line
AF331	Frail, D. Seaquist, E. (Toronto)	New epoch studies of nova remnant GK Per 1901. 6 cm
AF332	Florkowski, D. (USNO)	Monitoring the radio emission from Wolf-Rayet binary HD 192641. 1.3, 2, 3.6, 6 cm
AG465	Goss, W. M. Dhawan, V. Rodriguez, L. (Mexico/UNAM) Frail, D.	Target of opportunity: HI observations of a future outburst in GRS 1915+2475. 20 cm
AG518	Garcia-Sanchez, J. (Barcelona) Paredes, J. (Barcelona) Preston, R. (JPL) Jones, D. (JPL)	Multi-frequency observations of selected RS CVn binaries. 2, 3.6, 6, 20 cm
AG524	Gao, Y. (Illinois) Lo, K. Y. (Illinois) Gruendl, R. (Illinois) Hwang, C-Y. (IAA, Taiwan)	Pre-starbursts in early merging or pre-merging luminous IR galaxies. 20 cm line
AG525	Goldschmidt, P. (Imperial College) Kukula, M. (Edinburgh) Dunlop, J. (Edinburgh) Miller, L. (Oxford)	Fraction of radio loud quasars in optically selected surveys. 6 cm
AH577	Halpern, J. (Columbia)	Identification of high energy galactic gamma ray sources. 20, 90 cm
AH603	Harper, G. (Colorado/JILA) Brown, A. (Colorado/JILA) Bennett, P. (Colorado/JILA) Hummel, C. (USNO) Walder, R. (SFIT, ETH)	Radio modulation of Zeta Aur's orbitally varying HII region. 3.6, 6 cm
AH604	Haarsma, D. (Haverford) Hewitt, J. (MIT) Lehar, J. (CFA) Burke, B. (MIT)	Monitoring gravitational lens 0957+561. 3.6, 6 cm
AH622	Hunter, D. (Lowell Obs)	Star formation in normal irregular galaxies. 20 cm line
AH623	Hunter, D. (Lowell Obs) Lynds, R. (KPNO-NOAO) O'Neil, E. (KPNO-NOAO)	Gas in blue compact dwarf VII Zw 403. 20 cm line

No.	Observers	Programs
AH624	Hatchell, J. (Manchester) Millar, T. (Manchester) Fuller, G. (Manchester)	SiO in hot cores associated with UC HII regions. 0.7 cm line
AH625	Hankins, P. (NMIMT) Weatherall, J. (NMIMT) Moffett, D. (Tasmania)	Emission bandwidth of the crab pulsar pulses. 2, 3.6, 6, 20 cm
AH626	Henning, P. (New Mexico) Rivers, A. (New Mexico) Kraan-Korteweg, R. (Paris Obs) Lahav, O. (Cambridge) Burton, W. B. (Leiden)	Galaxies discovered by the Dwingeloo HI survey. 20 cm line
AH628	Hjellming, R. Mioduszewski, A. Rupen, M.	Radio and x-ray activity in galactic black holes. 2, 3.6, 6, 20 cm
AH629	Hofner, P. (NAIC) Kurtz, S. (Mexico/UNAM) Stecklum, B. (Thuringian State Obs) Henning, T. (Jena U.)	Remnant accretion disk and outflow from Herschel 36. 0.7, 1.3, 2 cm line
AH631	Hirano, N. (Hitotsubashi) Umemoto, T. (NAO, Japan) Mikami, H. (NAO, Japan) Kamazaki, T. (NAO, Japan)	Search for protostellar candidates in dark cloud Barnard 1. 3.6, 6 cm
AH646	Halkides, D. (AAO) Bryant, J. (Agnes Scott College) Reddy, N. (Texas) van Zee, L.	Interacting galaxies NGC 2805, NGC 2814, NGC 2820, and IC 2458. 20 cm line
AI070	Ishwara-Chandra, C. (NCRA, India) Saikia, D. (NCRA, India) Kapahi, V. (NCRA, India)	Spectra of objects from the Molongolo survey. 2 cm
AJ259	Jura, M. (UCLA) Turner, J. (UCLA) Van Dyk, S. (UCLA)	Dust in the egg nebula. 1.3, 2 cm
AJ260	Jura, M. (UCLA) Turner, J. (UCLA) Van Dyk, S. (UCLA)	Dust disk in the red rectangle. 0.7, 1.3, 2 cm

No.	Observers	Programs
AK438	Keohane, J. (Minnesota) Rudnick, L. (Minnesota) Koralesky, B. (Minnesota) Petre, R. (NASA/GSFC) Gotthelf, E. (NASA/GSFC) Allen, G. (NASA/GSFC)	Enhanced shock acceleration in the supernova remnant IC 443. 3.6, 6 cm
AK446	Kawabe, R. (NAO, Japan) Ohta, K. (Kyoto) Yamada, T. (Kyoto) Kohno, K. (NAO, Japan) Nakanshi, K. (Kyoto) Akiyama, M. (Kyoto)	CO(2-1) imaging of third highest redshift quasar BR1202-0725. 0.7 cm line
AK448	Koralesky, B. (Minnesota) Green, A. (Sydney) Frail, D. Goss, W. M.	SNR/molecular cloud interactions - 1720 MHz masers. 20 cm line
AK450	Kurtz, S. (Mexico/UNAM) Hofner, P. (NAIC) Watson, A. (New Mexico State)	Imaging the extended continuum emission in compact HII regions. 3.6 cm
AK451	Kulkarni, S. (Caltech) Frail, D.	Possible SNR near newly discovered soft gamma repeater. 20 cm
AL400	Ledlow, M. (New Mexico State) Owen, F. Keel, W. (Alabama)	A powerful radio galaxy in a spiral host. 3.6, 20 cm
AL401	Lacy, M. (Oxford) Ridgway, S. (Oxford) Rawlings, S. (Oxford) King, L. (Oxford)	Rotation measures of z~1 radio sources. 3.6 cm
AL429	Lockley, J. (Southampton) Eyres, S. (Keele) Wood, J. (Keele)	Nature of the radio emission in the peculiar binary V Sge. 3.6, 6, 20 cm
AM547	Mirabel, I. F. (CNRS, France) Rodriguez, L. (Mexico/UNAM)	Large scale radio lobes in GRS 1915+105. 2 cm
AM554	Mundell, C. (Maryland) Done, C. (Durham) Pedlar, A. (Manchester) Shone, D. (Manchester) Thean, A. (Manchester) Brinks, E. (Guanajuato U.)	Neutral hydrogen observations of Seyfert galaxy NGC 5506. 20 cm line

No.	Observers	Programs
AM573	Miller, S. (Maryland) Veilleuz, S. (Maryland) Wilson, A. (Maryland)	Radio halos of edge on spiral galaxies. 6, 20 cm
AM577	Marcha, M. (Lisbon) Browne, I. (Manchester) Dennett-Thorpe, J. (Lisbon) Anton, S. (Manchester)	Spectral energy distribution of low luminosity AGN. 0.7, 1.3, 2, 3.6, 6 cm
AM579	Miralles, M. (CFA) Kurtz, S. (Mexico/UNAM) Pratap, P. (Haystack)	Ammonia in an outflow in the S255 IR complex. 1.3 cm line
AM581	Moore, C. (Groningen/Kapteyn) Carilli, C. Menten, K. (MPIR, Bonn)	Search for molecular absorption at z=2.636 toward lens 0414+053. 1.3 cm
AO133	Ohashi, N. (CFA) Ho, P. (CFA) Zhao, J. (CFA) Wilner, D. (CFA)	Velocity structure of the starless core L1521F. 1.3 cm line
AO134	Osorio, M. (Mexico/UNAM) Lizano, S. (Mexico/UNAM) Kurtz, S. (Mexico/UNAM) Carral, P. (Guanajuato U.) Hofner, P. (NAIC)	Observations of galactic hot core regions. 0.7, 1.3 cm
AP332	de Pater, I. (UC, Berkeley)	Jupiter Patrol: aftermath of comet-Jupiter crash. 20, 90 cm
AP353	Pisano, D. (Wisconsin) Wilcots, E. (Wisconsin)	Survey to detect extended HI around isolated galaxies. 20 cm line
AP355	Pauls, T. (NRL) Serabyn, E. (Caltech) Morris, M. (UCLA)	Observations of the galactic center arc filaments. 0.7, 1.3 cm
AR371	Roser, H-J. (MPIA, Heidelberg) Perley, R. Meisenheimer, K. (Royal Obs)	Further VLA Observations of the jet in 3C273. 0.7, 1.3, 2, 3.6 cm
AR377	Rudnick, L. (Minnesota) Koralesky, B. (Minnesota) Dickel, J. (Illinois)	Asymmetric expansion of the Kepler SNR shells. 6, 20 cm
AR378	Rudnick, L. (Minnesota) Koralesky, B. (Minnesota) Kassim, N. (NRL) Perley, R.	Dynamical evolution and current particle acceleration in Cas A. 3.6, 6, 20, 90 cm

No.	Observers	Programs
AR381	Mirabel, I. F. (CNRS, France) Rodriguez, L. (Mexico/UNAM)	Simultaneous radio and x-ray observations of the remarkable sinusoidal oscillations in GRS 1915+105. 2, 3.5, 6 cm
AR385	Rodriguez, L. (Mexico/UNAM) Torrelles, J. (IAA, Andalucia) Anglada, G. (IAA, Andalucia)	Exciting source of the HH 7-11 flow: SVS 13 or VLA 3? 1.3 cm line
AR386	Rudnick, L. (Minnesota) Treichel, K. (Minnesota) Mack, K. (Bologna) Klein, U. (Bonn U.) Katz-Stone, D. (USNA)	Electron populations and ages in radio galaxies. 6, 20, 90 cm
AR390	Rood, R. (Virginia) Balser, D. Bania, T. (Boston) Wilson, T. (MPIR, Bonn)	Continuum observations of HII regions with measured ^{3}He. 3.6 cm
AS568	Sramek, R. Weiler, K. (NRL) Van Dyk, S. (UCLA) Panagia, N. (STScI)	Properties of radio supernovae. 1.3, 2, 3.5, 6, 20, 90 cm
AS611	Sparke, L. (Wisconsin) van Moorsel, G. Cox, A. (Iowa) Schwarz, U. (Groningen/Kapteyn) Erwin, P. (Wisconsin)	HI mapping of candidate polar ring galaxy NGC 2655. 20 cm line
AS616	Shepherd, D. (Caltech) Kurtz, S. (Mexico/UNAM)	Identifying the massive YSO driving the G192 molecular outflow and determining the circumstellar disk properties. 0.7, 1.3, 3.6 cm
AS619	Sridharan, T. (CFA)	Fractal molecular cloud cores: transition to coherence. 1.3 cm line
AS620	Sanson, A. (Lancashire) Reynolds, C. (Lancashire) Hibbard, J. Cawthorne, T. (Lancashire)	Mapping ancient mergers: HI in systems with x-ray observations. 20 cm line
AS621	Smith, B. (IPAC) Struck, C. (Iowa State)	Atomic hydrogen in bridge/ring interacting galaxy pairs. 20 cm line
AS622	Simpson, C. (Florida Int) Gottesman, S. (Florida) Vilchez, J. (Laguna)	Comparative study of BCD and LSBD low mass dwarf galaxies. 20 cm line

No.	Observers	Programs
AS623	Schiminovich, D. (Columbia) van Gorkom, J. (Columbia) van der Hulst, J. (Groningen/Kapteyn)	Survey of HI in elliptical galaxies. 20 cm line
AS636	Steffes, P. (Georgia Tech) Butler, B. Jenkins, J. (NASA/Ames)	Simultaneous microwave/NIR imaging of Venus. 1.3, 2 cm
AT207	Taylor, G. Giovannini, G. (Bologna) Feretti, L. (Bologna) Venturi, T. (Bologna) Cotton, W. Lara, L. (IAA, Andalucia)	Large scale structure of low power radio galaxy 1144+352. 6, 20 cm
AT208	Takano, S. (Cologne) Hofner, P. (NAIC) Nakai, N. (NAO, Japan) Kawaguchi, K. (NAO, Japan) Winnewisser, G. (Cologne)	Observations of NH_3 in NGC 253. 1.3 cm line
AT209	Troland, T. (Kentucky) Crutcher, R. (Illinois) Roberts, D. (Illinois) Goss, W. M.	OH Zeeman observations toward Orion A. 20 cm line
AT210	Thorsett, S. (Princeton) Taylor, J. (Princeton) Nice, D. (Princeton) Briskin, W. (Princeton)	Timing fast pulsars at the VLA. 6, 20, 90 cm
AT216	Torrelles, J. (IAA, Andalucia) Lopez, A. (Mexico/UNAM)	Peculiar PN Sa 2-237. 3.6 cm
AU073	Uchida, K. (Ohio State) Morris, M. (UCLA)	The GCL/AFGL 5376 Region-A 100 pc long shock. 20 cm
AU074	Uchida, K. (Ohio State) Morris, M. (UCLA) Serabyn, E. (Caltech)	The illumination of the "snake" GC filament. 3.6, 6 cm
AU075	Urbanik, M. (Jagellonian) Soida, M. (Jagellonian) Chyzy, K. (Jagellonian)	Magnetic fields under the influence of density waves. 6 cm
AU076	Urbanik, M. (Jagellonian) Chyzy, K. (Jagellonian) Soida, M. (Jagellonian) Beck, R. (MPIR, Bonn)	Polarization in the perturbed face on spiral NGC 4254. 3.6 cm

No.	Observers	Programs
AW362	White, S. (Maryland)	The stellar activity cycle on active stars. 3.6, 6, 20 cm
AW466	White, S. (Maryland) Lee, J. (Maryland) Kundu, M. (Maryland) Thomas, R. (NASA/GSFC) Brosius, J. (NASA/GSFC)	Measuring the coronal abundance of iron relative to hydrogen. 3.6, 6, 20 cm
AW467	Wilcots, E. (Wisconsin) Pisano, D. (Wisconsin)	Gas dynamics in the NGC 672/IC 1727 system. 20 cm line
AW470	Wilcots, E. (Wisconsin)	Role of interactions in shaping asymmetric galaxies. 20 cm line
AW471	Wootten, H. A. Claussen, M. Marvel, K. (Caltech) Wilking, B. (Missouri)	Deep search for ionized gas near IRAS 05413-0104. 3.6 cm
AW472	Wilner, D. (CFA) Zhang, Q. (CFA) Ho, P. (CFA)	Continuum survey of Taurus disks. 0.7 cm
AW474	Wouterloot, J. (Bonn U.) Brand, J. (Bologna) Mack, K. (Bologna)	HII region Sharpless 151. 20 cm
AW475	Wyrowski, F. (Koln) Walmsley, C. M. (Arcetri) Natta, A. (Arcetri) Tielens, A. (NASA/Ames) Goss, W. M.	Ionized carbon towards the reflection nebula NGC 2023. 3.6 cm line
AW476	Willson, R. (Tufts) Lang, K. (Tufts) Bogod, V. (Pulkovo Obs) Ryabov, B. (RAO, Latvia) Thompson, B. (NASA/GSFC)	Solar noise storms, current sheets and coronal loops. 6, 20, 90 cm
AW478	Waldron, W. (ARC) Drake, S. (NASA/GSFC) Corcoran, M. (NASA/GSFC) Kitamoto, S. (Osaka)	Study of nonthermal radio and x-ray emission from the O star, 9 Sgr. 2, 3.6, 6, 20 cm
AY089	Young, L. (New Mexico State)	Search for HI in and around two dwarf spheroidal galaxies. 20 cm line
AY090	Yun, M. Carilli, C. van Gorkom, J. (Columbia)	HI imaging of damped Lyman absorption at z=0.103. 20 cm line

No.	Observers	Programs
AY091	Yusef-Zadeh, F. (Northwestern) Cotton, W.	Nature of the large scale linear structure G3.0-1.0. 6, 20 cm
AZ097	van Zee, L.	Gas distributions and kinematics of isolated irregular galaxies. 20 cm line
AZ099	Zwaan, M. (Groningen/Kapteyn) Dalcanton, J. (DTM/Carnegie) Briggs, F. (Groningen/Kapteyn)	Deep HI observations of very low surface brightness galaxies. 20 cm line
AZ101	Zhang, Q. (CFA) Wilner, D. (CFA) Ho, P. (CFA)	Kinematics of protoplanetary disks - ammonia and CS. 0.7, 1.3 cm
AZ103	Zhang, Q. (CFA) Sridharan, T. (CFA) Hunter, T. (CFA)	Ammonia in protostellar cores. 1.3 cm line
BW034	Wilkinson, P. (Manchester) Marlow, D. (Manchester) Browne, I. (Manchester) Jackson, N. (Manchester) Readhead, A. (Caltech) Fassnacht, C. (Caltech) de Bruyn, A. G. (NFRA) Myers, S. (Pennsylvania)	Water masers associated with protostar IRAS 16293-2422. 1.3 cm with single VLA antenna

E. THE VERY LONG BASELINE ARRAY OBSERVING PROGRAMS

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

No.	Observers	Programs
BA027	Alef, W. (MPIR, Bonn) Preuss, E. (MPIR, Bonn) Kellermann, K.	Polarimetric monitoring of the outburst in 3C111. 0.7 cm
BA028	Aaron, S. (MPIR, Bonn) Roberts, D. (Brandeis) Wardle, J. (Brandeis) Cohen, M. (Caltech)	Spiral jets in 0814+425 and 1749+701. 2, 6, 18 cm with VLA single antenna
BB075	Biretta, J. (STScI) Junor, W. (New Mexico)	Search for superluminal motion in the nucleus of M87. 18 cm with VLA single antenna

No.	Observers	Programs
BB076	Bower, G. (UC, Berkeley) Backer, D. (UC, Berkeley) Wright, M. (UC, Berkeley)	Monitoring of the gamma ray blazar NRAO 530. 0.7, 1.3 cm
BC065	Clark, T. (NASA/GSFC) Ma, C. (NASA/GSFC) Ryan, J. (NASA/GSFC) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) Gordon, D. (NASA/GSFC) Eubanks, T. M. (USNO) Fey, A. (USNO) Gaume, R. (USNO) Fomalont, E. Walker, R. C.	VLBA geodesy/astrometry observations for 1997. 3.6 cm
BC066	Claussen, M. Diamond, P. Braatz, J. Wilson, A. (Maryland) Henkel, C. (MPIR, Bonn)	Water masers in elliptical galaxy NGC 1052. 1.3 cm with phased VLA
BC067	Coles, W. (UC, San Diego) Ye, S. (UC, San Diego) Massey, W. (UC, San Diego)	Measurement of solar wind speed near the sun using IPS. 2, 3.6, 6 cm
BC070	Charlot, P. (Paris Obs) Sol, H. (Paris Obs) Vicente, L. (Paris Obs)	Multi-frequency monitoring of BL Lac object OJ287. 1.3, 3.6, 6 cm
BC071	Conway, J. (Chalmers, Onsala) Rantakyro, F. (Bologna) Polatidis, A. (Chalmers, Onsala) Wehrle, A. (JPL)	Combined VSOP-VLBA-CMVA imaging of 3C273. 0.7 cm
BC074	Cawthorne, T. (Lancashire) Hutchison, J. (Lancashire)	Polarization of quasar 4C71.07. 2, 3.6 cm
BD037	Denn, G. (Iowa) Mutel, R. (Iowa)	Polarized VLB jet of BL Lac. 1.3, 2, 6 cm
BD042	Dewey, R. (Princeton) Beasley, A.	VLBA observations of millisecond pulsars for frame tie. 18 cm with phased VLA
BD044	Dhawan, V.	GRS 1915+105. 2, 4, 13 cm
BD046	Diamond, P. Kemball, A. Boboltz, D. (Haystack)	Monitoring SiO masers through a cycle of Mira TX Cam. 0.7 cm with VLA single antenna

No.	Observers	Programs
BD047	Doeleman, S. (Haystack) Lonsdale, C. (Haystack) Greenhill, L. (CFA) Kemball, A. Diamond, P.	SiO masers in VX Sgr. 0.7 cm with VLA single antenna
BD048	Doeleman, S. (Haystack) Barvainis, R. (Haystack) Lonsdale, C. (Haystack) Greenhill, L. (CFA) Phillips, R. (Haystack)	SiO masers in the Orion nebula. 0.7 cm with VLA single antenna
BE016	Edwards, P. (ISAS, Japan) Lovell, J. (ISAS, Japan) Fujisawa, K. (ISAS, Japan) Jauncey, D. (CSIRO) Reynolds, J. (CSIRO) Tzioumis, A. (CSIRO) King, E. (CSIRO) Preston, R. (JPL) Murphy, D. (JPL) Meier, D. (JPL) Jones, D. (JPL) Tingay, S. (JPL) McCulloch, P. (Tasmania) Costa, M. (Tasmania) Tornikoski, M. (Helsinki) Valtaoja, E. (Helsinki) Nicolson, G. (HartRAO)	Very high brightness source 1921-293. 0.7, 2 cm
BF028	Fey, A. (USNO) Gaume, R. (USNO) Eubanks, T. M. (USNO) Ma, C. (NASA/GSFC)	Southern hemisphere astrometry for the celestial reference frame. 3.6 cm
BF034	Furuya, R. (Nobeyama Obs) Kawabe, R. (NAO, Japan) Saito, M. (NAO, Japan) Wootten, H. A. Claussen, M. Marvel, K. (Caltech) Umemoto, T. (NAO, Japan) Kitamura, Y. (ISAS, Japan)	Proper motion of H_20 masers in the Class O protostar S106FIR. 1.3 cm
BF036	Fassnacht, C. (Caltech) Pearson, T. (Caltech) Readhead, A. (Caltech)	Gravitational lens CLASS 2045+265. 6 cm

No.	Observers	Programs
BF037	Faison, M. (Wisconsin) Marscher, A. (Boston)	Small scale structure in galactic molecular gas. 6 cm with phased VLA
BG071	Goodman, A. (CFA) Greenhill, L. (CFA)	Pre-main sequence star forming regions. 3.6 cm with phased VLA
BG073	Gomez, J. (IAA, Andalucia) Marscher, A. (Boston) Alberdi, A. (ESA, Spain)	3C 120 rapid variations. 0.7, 1.3 cm
BG076	Greenhill, L. (CFA) Herrnstein, J. Moran, J. (CFA) Braatz, J. (CFA) Diamond, P.	Weak water masers in NGC 3735 and M51. 1.3, 3.6 cm
BH042	Herrnstein, J. Moran, J. (CFA) Greenhill, L. (CFA)	Are quasars being ejected from the nucleus of NGC 4258? 18 cm with phased VLA
BH043	Hagiwara, Y. (Nobeyama Obs) Kawabe, R. (NAO, Japan) Diamond, P. Kameno, S. (NAO, Japan) Nakai, N. (NAO, Japan) Miyoshi, M. (NAO, Japan)	The megamaser galaxy NGC 5793. 6 cm
BH046	Homan, D. (Brandeis) Wardle, J. (Brandeis) Roberts, D. (Brandeis) Norris, R. (CSIRO) Rayner, D. (CSIRO) Sault, R. (CSIRO)	Circular polarization in 3C 84 and 3C 279. 1.3, 2, 3.6, 6 cm
BI007	Imai, H. (NAO, Japan) Sasao, T. (NAO, Japan) Kameya, O. (Mizusawa Obs) Miyoshi, M. (NAO, Japan) Deguchi, S. (NAO, Japan) Asaki, Y. (Nobeyama Obs)	Proper motions of water masers in W3 IRS 5. 1.3 cm
BK050	Kemball, A. Porcas, R. (MPIR, Bonn) Patnaik, A. (MPIR, Bonn)	VLBI polarimetry of gravitational lens B0218+35.7. 0.7 cm with VLA single antenna
BK051	Kemball, A. Dhawan, V.	Second epoch of snapshot polarization survey. 0.7 cm with VLA single antenna

No.	Observers	Programs
BK053	Krichbaum, T. (MPIR, Bonn) Lobanov, A. (MPIR, Bonn) Britzen, S. (NFRA) Witzel, A. (MPIR, Bonn) Zensus, J. A.	Broad band variability and jet bending in PKS 0528+134. 0.7, 1.3, 3.6 cm
BL038	Lestrade, J-F. (Paris Obs) Phillips, R. (Haystack) Jones, D. (JPL) Preston, R. (JPL)	Search for extrasolar planets by VLBI astrometry. 3.6 cm with phased VLA
BL041	van Langevelde, H. (NFRA) Beasley, A.	Formaldehyde absorption in Centaurus A. 2, 6 cm
BL048	van Langevelde, H. (NFRA) Schilizzi, R. (NFRA) Diamond, P.	Parallax of nearby Miras. 18 cm
BL049	Lestrade, J-F. (Paris Obs) Phillips, R. (Haystack) Jones, D. (JPL) Preston, R. (JPL)	A possible Jupiter-mass planet orbiting Sigma 2 CrB. 3.6 cm with phased VLA
BM049	Mioduszewski, A. Gabuzda, D. (Lebedev) Aller, H. (Michigan)	Monitoring of six highly variable BL Lacertae objects. 1.3, 3.6 cm
BM081	Moran, J. (CFA) Herrnstein, J. Greenhill, L. (CFA) Trotter, A. (CFA) Miyoshi, M. (NAO, Japan) Inoue, M. (NAO, Japan) Nakai, N. (NAO, Japan) Diamond, P. Henkel, C. (MPIR, Bonn)	Dynamics and distance of water masers in NGC 4258. 1.3 cm with phased VLA
BM086	Moscadelli, L. (MPIR, Bonn) Cesaroni, R. (Arcetri) Rioja, M. (NFRA)	Water masers in IRAS 20126+4104. 1.3 cm
BM087	Marcaide, J. (Valencia) Guirado, J. (Valencia) Perez-Torres, M. (Valencia) Ros, E. (Valencia)	Absolute kinematics of radio source components in the complete S5 survey. 2, 3.6 cm
BP037	Porcas, R. (MPIR, Bonn) Patnaik, A. (MPIR, Bonn) Kemball, A.	5 GHz polarimetry of the gravitational lens B0218+357. 6 cm

No.	Observers	Programs
BP041	Peck, A. (NMIMT) Taylor, G. Goss, W. M.	CSO candidates at 8 and 15 GHz. 2 cm with VLA single antenna
BR046	Rioja, M. (NFRA) Porcas, R. (MPIR, Bonn)	VLBA polarimetry on the quasar pair 1038+528 A and B. 1.3, 3.6 cm
BR050	Ratner, M. (CFA) Bartel, N. (York U.) Lebach, D. (CFA) Lestrade, J-F. (Paris Obs) Shapiro, I. (CFA)	Astrometry of the guide star for the Gravity Probe-B mission. 3.6 cm with phased VLA
BS044	Satoh, S. (NAO, Japan) Inoue, M. (NAO, Japan) Nakai, N. (NAO, Japan) Shibata, K. (NAO, Japan) Migenes, V. (NAO, Japan) Kameno, S. (NAO, Japan) Fujisawa, K. (ISAS, Japan)	Monitoring of the continuum and H_20 maser emission in NGC 3079. 1.3, 2, 3.6 cm with phased VLA
BT025	Trigilio, C. (Bologna) Umana, G. (Bologna) Leto, G. (Bologna) Beasley, A. Rodono, M. (Catania) Buemi, C. (Catania) Catalano, S. (Catania) Pagano, I. (Catania) Walter, F. (Bonn U.)	Radio and x-ray studies of coronal structures on AR Lac. 2, 3.6 cm with phased VLA
BT028	Tingay, S. (JPL) Preston, R. (JPL) Jones, D. (JPL) Murphy, D. (JPL) Meier, D. (JPL) Jauncey, D. (CSIRO) Reynolds, J. (CSIRO) Tzioumis, A. (CSIRO) McCulloch, P. (Tasmania) Lovell, J. (ISAS, Japan) Costa, M. (Tasmania)	Monitoring of Centaurus A at 8.4 and 22 GHz. 1.3, 3.6 cm
BV024	Vermeulen, R. (NFRA) van Langevelde, H. (NFRA) Kellermann, K. Zensus, J. A. Cohen, M. (Caltech)	Shroud around the twin jets of NGC 1052. 0.7, 1.3 cm with VLA single antenna

No.	Observers	Programs
BV026	Vermeulen, R. (NFRA) Taylor, G.	Neutral gas in the archetype compact symmetric object 2352+495. 18 cm
BW031	Wehrle, A. (JPL) Unwin, S. (JPL) Zook, A. (Pomona College) Xu, W. (JPL)	3C279: coordinated multi-wavelength observations and evolution. 0.7, 1.3, 2, 6 cm
BW037	Wootten, H. A. Marvel, K. (Caltech) Claussen, M. Wilking, B. (Missouri)	Water masers associated with protostar IRAS 16293-2422. 1.3 cm
BY006	Yates, J. (Hertfordshire) Ivison, R. (Hawaii) Diamond, P.	Water masers in the symbiotic Mira R Aqr. 1.3 cm
CMVA	Phillips, R. (Haystack)	Coordinated Millimeter VLBI Array. 0.2, 0.3 cm
GR016	Ros, E. (Valencia) Marcaide, J. (Valencia) Guirado, J. (Valencia) Perez-Torres, M. (Valencia) Lara, L. (IAA, Andalucia) Alberdi, A. (ESA, Spain)	Proper motions in quad gravitational lenses. 3.6 cm with VLA
GR017	Rupen, M. Bartel, N. (York U.) Bietenholz, M. (York U.) Beasley, A. Conway, J. (Chalmers, Onsala) Rius, A. (Barcelona) Altunin, V. (JPL) Jones, D. (JPL) Graham, D. (MPIR, Bonn) Venturi, T. (Bologna) Umana, G. (Bologna)	VLBI imaging of supernova 1993J in M81. 3.6, 6, 18, 90 cm with VLA
V004	Pauliny-Toth, I. (MPIR, Bonn)	Space VLBI observations of the quasar 3C454.3. 6 cm with phased VLA
V034	Murphy, D. (JPL)	Continuous monitoring of 1928+739. 6 cm
V035	Reid, M. (CFA)	Nuclear jet in M87. 18 cm
V041	Krichbaum, T. (MPIR)	Self similarity in the Jets of the S5-quasars 0836+71 and 1928+73. 6, 18 cm
V046	Rioja, M. (Bologna)	Space VLBI astrometry on the quasar pair 1038+528A. 18 cm

No.	Observers	Programs
V053	Witzel, A. (MPIR)	Intraday variable sources. 6 cm
V059	Davis, R. (Manchester)	VSOP Observations of the Jet in 3C273. 18 cm
V067	Carrara, E. (Sao Paulo)	Parsec-scale jet in superluminal quasar 3C273. 6 cm
V081	Junor, W. (New Mexico)	Parsec scale and sub-parsec scale jet of Virgo A. 6 cm with phased VLA
V090	Kus, A. (Copernicus/Torun)	Helical jet in CSS quasars: 3C 309.1. 18 cm
V092	Roberts, D. (Illinois)	Polarization space VLBI of four bright quasars: 3C 454.3. 18 cm with phased VLA
V110	Nicolson, G. (HartRAO)	Rapid variations in BL Lac objects: 1144-379. 6 cm
V138	Okayasu, R. (ISAS, Japan)	Do BL lac objects have rapidly decelerated jets: BL Lac. 6 cm
VSOP	Tests/VSOG	HALCA in-orbit checkout: 1954+513 and 2021+614. 6 cm; 6, 18 cm with phased VLA.

F. SCIENCE HIGHLIGHTS

Socorro

A global VLBI study of the luminous infrared galaxy Arp 220, a merging system with twin nuclei, has revealed approximately a dozen luminous radio supernovae and four major regions of OH maser emission in the galaxy's nuclear region. Detection of the supernovae, shown by 18 cm continuum observations, supports a starburst model for the galaxy's infrared luminosity. The OH masers, seen in the 1667 and 1665 MHz lines, consist of both compact and diffuse emission regions. The compact maser regions may trace shock fronts related to AGN activity in the dense nuclear environment.

Investigators: Colin Lonsdale (Haystack); H.E. Smith (UCSD); P. J. Diamond (NRAO); and Carol Lonsdale (Caltech).

Green Bank

The pulsar B1821-24 is an isolated, 3.05 ms pulsar located in the globular cluster M28. It has a large apparent rotational energy loss rate and shows non-thermal pulsed x-ray emission. Dual-frequency polarimetry of this pulsar using the 140 Foot Telescope shows three components in the radio pulse at relative position angles 0, 108, and 175 degrees. The emission can be interpreted as arising from a pulse and an interpulse from opposite magnetic poles, with an extra component from a "conal outrigger" of one pole. Two of the components are strongly polarized, and this allows a model to be fit which constrains the relative orientation of the spin, dipole, and observer axes and to infer the two-dimensional emission beam profile. A determination of the relationship between the radio and x-ray pulses awaits absolute timing data in the x-ray. Conventional methods of interpreting both the shape of the pulsar's radio pulse and its polarization angle may not be applicable to this millisecond pulsar, owing to the small size of the light cylinder in relation to the stellar radius.

Investigators: D. Backer and S. Sallmen (UC, Berkeley)

Tucson

Mars Global Surveyor (MGS), which entered Mars orbit on September 12, 1997, is an orbiter mission which will conduct, among other things, the first global mapping of the surface mineralogy and elevations, magnetic field measurements, and high/medium resolution imaging. During the next three months, Todd Clancy of the Space Science Institute and Brad Sandor of JPL will conduct observations of the martian CO absorption using the 12 Meter Telescope which are being used to provide atmospheric sounding measurements of the martian atmosphere in support of the aerobraking maneuvers of the MGS orbiter. During these aerobraking maneuvers, MGS will dip into the upper atmosphere of Mars in order to circularize it's orbit for mapping operations. Due to a problem with a damaged solar panel, MGS aerobraking is now being conducted at a 60 percent reduced intensity (i.e., at 117 km altitude versus 110 km, to accommodate the damaged solar panel). This change has lengthened the aerobraking schedule to a much longer period (now, planned into late 1998).

12 Meter observations of the martian atmospheric CO absorption provide measurements of the dust heating of the lower martian atmosphere (0-50 km). These measurements will provide early warning to associated changes in the atmospheric densities to be encountered by the MGS orbiter. During the past several months, 12 Meter measurements of the CO 2-1 absorption from the martian atmosphere have produced the most accurate measurements of the pressure changes at an altitude of ~70km. These measurements show a very good correlation with the density changes MGS has so far seen (up to +100 percent) at the aerobraking altitudes and above (110 km up to 170 km, when they backed-off). Therefore, the 12 Meter measurements are now employed as a primary indicator of Mars atmospheric behavior for MGS aerobraking decisions.

Due to power consumption constraints, during the January-through-March-1998 conjunction period the onboard instruments which measure the martian atmosphere will be turned off. This means that other than the real-time spacecraft acceleration (engineering) measurements, the only measurements of the martian atmospheric behavior will be those obtained at the 12 Meter. Since this period occurs during a season when large global dust storms are known to start up, the 12 Meter measurements will be of critical importance to the MGS mission during this period.

Investigators: R. T. Clancy (Space Science Institute) and B. Sandor (JPL).

A significant fraction of low-redshift ($z \leq 0.1$) powerful radio galaxies were detected by IRAS. The shape of the far-infrared/submillimeter spectral energy distribution of these galaxies is characteristic of the thermal emission from dust. This fact has led to searches for the cold ISM in these objects. A continuing CO 1-0 survey of IRAS-detected radio galaxies has been conducted at the 12 Meter Telescope since 1995, leading to a detection rate of about 30 percent. Discovery of this cold ISM component coupled with their infrared and radio properties suggests that these objects may be experiencing a galaxy merger, and may indicate that gas-rich galaxy mergers are involved in the genesis of powerful extragalactic radio sources.

Investigators: A. Evans (Caltech); D. Sanders (IfA); and J. Mazzarella (IPAC).

G. PUBLICATIONS

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

H. CHARLOTTESVILLE ELECTRONICS

Amplifier Development, Design, and Production

Efforts in the fourth quarter concentrated on developing the last of the prototypes for the MAP amplifiers and delivering the first of the flight hardware to Princeton.

The shop advanced considerably in its capability for writing software for the CNC milling machine and using the machine to manufacture amplifier bodies. Considerable refinement in technique has resulted in rapid fabrication of large quantities of bodies with excellent accuracy and surface finish characteristics. This expertise will be of great value in both amplifier and mixer fabrication in the future.

The first batch of ten Q-band flight amplifiers was completed and passed vibration tests successfully prior to final inspection and shipment. The first flight radiometer was assembled by Princeton engineers and operates extremely well: the phase match of two channels over the entire receiver bandwidth is ± 5 degrees, which is four times better than the specification.

The prototype V-band amplifier (useful only above the atmosphere) was completed and required considerable debugging effort to suppress oscillations, which is not surprising for a new design. The first batch of V-band amplifiers, intended for a laboratory prototype radiometer, was completed and is in the testing process.

A new six-stage W-band amplifier prototype was completed, which offers more gain than the previous five-stage design, yet is unconditionally stable. The first batch of five flight amplifiers was completed, shaken, tested, and shipped to Princeton. Two pre-prototypes were returned and sent to Socorro to be used in W-band receiver #2. The MAP W-band amplifiers constitute half the total delivery and about two-thirds of the total assembly and test effort.

A new K_a-band design was completed and the first prototype was tested with good results. Construction was begun on the first batch of flight amplifiers. A new K-band design was completed and the first amplifier of this design is under construction.

We anticipate completing delivery of all MAP amplifiers by June 1998. NASA managers recognized the achievement of the NRAO team in a special meeting in which achievement awards were presented to numerous staff. It should be emphasized that a large number of personnel have contributed to the success of this effort. This includes the dedicated efforts of the MAP team: Marian Pospieszalski, Ed Wollack, Nancyjane Bailey, Skip Thacker, Bill Lakatosh, Bill Wireman, Tod Boyd, and Ron Harris, with the support of Matt Dillon, Pat Madigan, Vince Summers, Cathy Burgess, Greg Morris, Kirk Crady, Dan Boyd, Francoise Johnson, Tony Marshall, Mark Wharam, and Neil Horner.

Superconducting (SIS) Millimeter-Wave Mixer Development

Wafers of 230 GHz balanced SIS mixers and sideband separating SIS mixers await testing. Work has been held up by very long lead times in the Central Development Laboratory (CDL) machine shop, and also by the failure of a critical cryogenic microwave switch.

Failure of the single-pole six-position IF switch, apparently due to the magnets weakening with repeated thermal cycling between room temperature and 4 K, underscores the need for low-static switches for DC-12 GHz for MMA receiver development. Work with Novak Corporation over the last two years led to a broadband static suppressor. Now Dynatech Microwave Technology has agreed to develop a product based on this design at no cost to NRAO. The first DC-12 GHz switches are expected about mid-1998.

Design work has begun on integrating SIS mixers with IF amplifiers, as required for the MMA. The mixer is represented as a noisy five-port network in the microwave circuit simulator MMICAD. It is connected to the IF amplifier stage through a matching circuit whose elements can be optimized using MMICAD.

UCLA has begun work on a photomixer local oscillator, intended for use on the MMA. The output of two 1550 nm lasers, one of fixed frequency and the other tunable, will be combined in a photomixer to produce a beat frequency in the 100-1000 GHz range. Based on their earlier work on velocity-matched distributed photodetectors (VMDP's) at 860 nm, UCLA was given a contract to develop a prototype photomixer at 1550 NM. The alternative approaches to photomixers appear to have substantial disadvantages: The Elliott Brown type of photoconductive photomixer is inherently very inefficient because, to obtain very high frequency response, the carrier lifetime is made extremely short—much shorter than the transit time. This means that only a small fraction of the photogenerated charge carriers are collected at the electrodes before recombining. A third approach—the traveling-wave photodiode developed at UCSB—is limited by the low coupling efficiency of the photons to the photodiode by the length of the photo-Schottky diode, which is in turn limited by the difference in phase velocity between the optical waveguide and the RF transmission line. The UCLA VMDP largely overcomes these shortcomings, and should be capable of high conversion efficiency over broad frequency bands. As a first step, UCLA has demonstrated a velocity-matched distributed photodetector at 1550 NM. Work is also proceeding on possible RF coupling circuits that will allow the millimeter-wave output from the photomixer to be coupled efficiently to an output waveguide.

Considerable effort this quarter went into evaluating QuickWave, a 3-D electromagnetic simulator which we believe might overcome major shortcomings of HFSS. Earlier we evaluated MicroStripes, a TLM (transmission lines method) simulator. QuickWave, a FDTD (finite-difference time-domain) simulator, was found to be very much faster than HFSS, and able to handle classes of structures not allowed by HFSS. We have obtained QuickWave for a six-month trial period. W. Gwarek, author of the software, presented a three-day tutorial in the theory and use of QuickWave, which was attended by NRAO engineers and University of Virginia (UVA) graduate students.

Work on fabrication of laminated PTFE/quartz/PTFE vacuum windows has progressed with the development of a vacuum procedure for attaching the PTFE to the quartz with a glue line less than 0.001inches thick.

During this quarter we have assembled and tested only one SIS mixer.

Electromagnetic Support

VLA - Dimensions for eight feeds to cover the 1 to 50 GHz range were determined. Illumination efficiency and spillover temperature calculations were done for these feeds for a VLA-equivalent Cassegrain antenna.

Input return loss and differential phase shift of an electroformed K-band (18 to 26.5 GHz) phase shifter were measured. Simulated results agree quite well with the measurements, and the phase shifter meets specifications.

GBT - Reflection measurements were made on the upper feed arm structure which is currently on the ground. The level of reflections back into the feed is at least 15 dB lower than that measured on symmetric antennas. A spillover shield, intended to divert the reflections off the structure away from the feed, was installed and measurements were repeated. The shield further reduces certain reflections by 5 to 10 dB.

Work on the Short Backfire antenna is in progress. This will be used as prime focus feed for the lower frequency bands.

GBT Spectrometer

During the last quarter, final laboratory testing of the GBT spectrometer was completed. Work on the Tucson 8-beam spectrometer continued.

All of the pulsar modes for the GBT spectrometer were written and tested to the extent possible in the lab. Work on the software for the GBT spectrometer has continued, but this effort is still far behind schedule. Much of the software already written consists of test programs to assist in system verification, leaving the task of writing operational software still to be done. Most microprocessor firmware required for the GBT spectrometer has now been written, but some of it has yet to be tested sufficiently.

Racks for the Tucson spectrometer have been received and some chassis work has been started. PC cards for the unit are ready to be tested. Assistance from NRAO/Tucson has accelerated the 8-beam spectrometer project considerably.

Frequency Coordination

During the quarter teleconference meetings with Motorola staff have been held at approximately monthly intervals to plan testing of the emission from IRIDIUM satellites within the 1610.6-1613.8 MHz radio astronomy band. Meetings on this subject have been taking place for over a year, and the technical details have been addressed. Measurement of interference in the radio astronomy band requires the insertion of special software into one or more satellites to provide emissions that simulate various traffic loads. A problem in scheduling the tests is that at NRAO we would like to obtain four to six weeks notice so that time for the tests can be included within the observing schedules for the VLA and the 140 Foot Telescope, both of which will be used. Over forty of the satellites are now in orbit, but so far Motorola has been unable to agree upon a date, apparently because at this stage of the IRIDIUM project they have difficulty planning the satellite activities so far in advance. Another meeting will be held in January, and it is hoped to be able to schedule tests in the first quarter of 1998.

I. GREEN BANK ELECTRONICS

GBT Fiber IF System

We have had progress and setbacks on this system. The setbacks have all been failures of certain components of the system we are designing. One laser transmitter from the company UTP failed and we have had problems getting the company to repair it quickly. Another laser transmitter, from Ortel, was shipped with the wrong type fiber optic cable. This caused an excess loss due to the mismatch of the fiber, believed to be the launching of the light down the fast axis rather than the slow axis as required by the modulator.

The progress has been in a few areas. Although the UTP laser transmitter had failed—it was transmitting significantly less power than it was specified to—the designed system was still able to work. This confirms robustness in the design. We have designed and received the printed circuit cards to close the AGC loop. The design of the mechanical box is near completion and will be given to the shop for fabrication.

GBT Receiver Systems

Holography System - We have determined that the reference receiver box is adequately temperature stable after slight modifications to the thermal electrics. The test and reference antenna will next be tested for phase stability.

C-Band Receiver - As noted in the last report, the C-band receiver was installed at the 140 Foot Telescope for the first time in September. It performed very well. Since then, the system developed a small vacuum leak in its cryogenics system. This leak was repaired and the system was re-installed. A filter was also put on the compressed helium lines to filter out impurities which are in the lines. Since this receiver was installed on the 140 Foot before it was completely tested, we plan on finishing these tests by the end of the first quarter of 1998.

S-Band Receiver - The electronics design and prototype for this receiver was completed last year. We are now awaiting the Orthomode transition, dewar, and feed horn from the machine shop. We anticipate this receiver being built by the first half of 1998.

L-Band Receiver - The final testing of this receiver was completed in late December. The system will next be setup for long-term (one year) cryogenic testing.

K-Band Receiver - This receiver has been working marvelous over the past nine months. Prior to this time, the receiver kept warming up every couple months. Since we have put a filter in the compressed helium lines we have had very good cryogenic reliability.

Communications System - The Electronics Division has received documentation defining the communications requirements for the GBT. This document addresses the telephone, intercom, video, two-way radio, and local-area network requirements. We have since contacted various companies which deal with these systems, working to get bids. Electronics has since given requests to the Operations group to better define certain requirements. We expect to have a system defined and bids received by the end of the first quarter of 1998.

LO Reference Distribution System

The LO reference distribution system had been complete and tested with the exception of random spikes in the monitored return data. After extensive tests the problem was identified. The remaining modules will be modified and tested by the end of the first quarter of 1998.

GBT Servo System

Tests of the feed arm servo have demonstrated that the system presently does not meet the velocity specification for some trajectories. NRAO staff is working in conjunction with the contractor to solve the problem. A formal list of action items and issues has been generated and forwarded to management to discuss with them.

A testing program continues to exercise all components of the feed arm servo on a weekly basis. Junction box interiors are inspected monthly for traces of moisture, following replacement of ineffective seals.

GBT Subreflector Surface Setting

In November the initial photogrammetric measurement of the surface of the subreflector was completed. RMS measurement errors for most of the 158 measured points were 0.0003" to 0.0004". The computed surface error was 0.0138" RMS, which is in remarkably close agreement with the Contractor's estimate of 0.014", based on theodolite measurements. Corrections for each of the adjustment points were computed and the adjustments were then made.

In December follow-up photogrammetric measurement of the surface of the subreflector was completed. RMS measurement errors for 215 measured points ranged from 0.0006" to 0.001", in three orthogonal directions. The computed surface error was approximately 0.007" RMS, about a factor of two improvement over the initial setting. An additional setting attempt will probably take place in the spring.

Photogrammetric measurements of 16 additional poses were also completed. The data from these measurements will be analyzed to improve the accuracy of the subreflector positioner.

GBT Mockup

Over the past quarter the Mockup was used extensively by different groups. The Monitor and Control group used it to test and integrate software with the hardware. Integration engineers tested the GBT Electronics system from end to end. During these tests we found some components which were not as temperature stable as required. Various measures have been taken to make the hardware more stable and to guarantee that the temperature stability for the total system is sufficient.

GBT Atmospheric Monitoring System (Water Vapor Radiometer)

The GBT Atmospheric Monitoring System (Tipper) was completed and put on-line in early December. Data from this system is currently on the WWW. The system requirements for this system are as follows:

- Center Frequency- 86 GHz.
- Bandwidth-5 GHz Maximum.
- Sensitivity-15 mK in 10 seconds.
- Time between measurements-10 Minutes.

A double-sideband heterodyne receiver configuration was chosen; a balanced mixer, Gunn oscillator, and an IF amplifier purchased from Spacek labs gave the system an input noise temperature of less than 800 Kelvins without the use of a low-noise pre-amp. The theoretical sensitivity of this receiver, not considering gain fluctuations, is 15 mK in two seconds. The mechanical layout of the receiver front-end components will allow for the addition of a pre-amp, if one is found to be necessary. A room-temperature amplifier from the CDL will reduce the receiver noise temperature to 350 K.

The radiometer uses two black bodies (295 K and 335 K) for gain calibration during each scan. The scanning mirror rotates continuously at 1 Hz while data collection is synchronized to an encoder index pulse. Integration time is controlled in software by specifying the number of scans to be summed in the data processing.

Site Operations

Timing Center - With the USNO control center being moved to the new Jansky addition, Electronics was asked to determine the viability of moving the Timing Center (Maser and Timing Rack) from the Interferometer Control Building basement to the new Jansky addition. After researching the different issues it was decided that moving the center to the GBT Equipment room was the prime location choice. This move will involve some intermediate configurations to insure that each telescope will be down an absolute minimum amount of time (hours). We expect this move to occur sometime in the second quarter of this year.

OVLBI - Numerous issues have been addressed and solved over the past quarter. Overall, the system has performed very reliably.

An electronics technician was hired and is successfully working on the project. Major issues that need to be solved over the next quarter are an intermittent TWT control module, ACU brakes setting at random times, Peltier temperature controller problems, and an inductosyn readout redesign.

Interference Protection Group - This group meets twice a month to discuss interference issues encountered at the site over the previous period. The GBT, as well as various other equipment, is being RFI tested. Most of the equipment we test fail to meet the CCIR line limits. The tested equipment and a report is then sent back to the group responsible for it with recommendations on how to fix it. The responsibility to shield/filter the tested equipment and bring it into the CCIR limits lies with the designer/owner.

Maintenance, repair, and installation support was supplied to the 140 Foot, the USNO 20-Meter, and the OVLBI earth-station telescopes. This includes electronic maintenance, electronic design projects to assist users for special projects, and cryogenic support for virtually every receiver in Green Bank. Normal day-to-day support of UNIX workstations, weather station, time systems, and local area networks is maintained.

J. TUCSON ELECTRONICS

1-mm Array 220-250 GHz Receiver

This receiver is now in routine use. Several early operational problems have been identified and solved. We have identified two faults in this system which may be the source of the problems with baseline stability which sometimes affects wide-bandwidth

measurements. This receiver is the ideal candidate for the development of automatic tuning of receivers, and the software to realize this has been developed and implemented. Although all of our receivers are tuned remotely over the computer network at the telescope site (or even tuned over the Internet from our downtown offices), the precise tuning still relies on the telescope operator closing the loop. The receiver characteristics are such that a simple lookup table of tuning parameters is not adequate to ensure optimum performance. With eight receivers to tune, this clearly puts considerable demand on the operator and can lead to inefficiency in the setup time needed for a new observer, even though the individual receiver channels are less complex to tune than our regular single-beam systems. We are currently using the experience gained with automating the 1-mm Array system to modify the tuning procedure for all receivers on the 12 Meter Telescope.

The 8-Channel, 4-Beam, 3-mm System

A commercially available frequency tripler for the LO has been tested and works well at 4 K. This validates the concept of using coaxial lines to input the LO to the dewar at one-third of the LO frequency. The dewar has been built and awaits testing. The design of the basic receiver insert has been completed and fabrication has begun. A crossed-grid polarization diplexer designed to operate at 4 K has been constructed and tested. A prototype 2-channel system will be tested early next year.

Planned Wideband Continuum Receiver

The availability of HEMT amplifiers covering the frequency range from 70 - 90 GHz raises the possibility of building a continuum receiver with a sensitivity of around 50 mJy per root sec; the extraordinarily high sensitivity comes from the very wide bandwidths. The major problem to be overcome is the "1/f" noise which has been reported from early experiments. Although not necessarily worse in this system than in other HEMT amplifiers, the extremely large (bandwidth times integration time) product means that much lower levels of "1/f" gain modulation can dominate the residual noise in the detected output from the receiver. Progress with this project is dependent on available manpower, and has been given lower priority than the multi-beam systems mentioned above.

New Phase Lock Control

One of the most efficient observing modes, generally applicable to relatively narrow bandwidth observations, is frequency switching. Unlike other switching schemes, in this observing mode the object of interest is in the telescope beam and in the spectrometer passband for 100 percent of the time. At present, we are limited in our ability to frequency switch, in both switching rate and in total frequency throw, by the analog phase lock system. We have designed, tested, and installed a digital phase lock system into our 2/3 mm receiver that combines both frequency and phase control and provides faster and reliable switching over a broader frequency range. We can now routinely switch by as much as ± 35 MHz, making frequency switching useable for a wide variety of research projects. We are currently producing digital phase lock systems for all of our receivers.

Another capability which will become practical thanks to the enhanced digital phase lock is "sideband smear" operation. This is a powerful technique of reducing confusion in spectral line observations from features appearing in the unwanted sideband. The principles have been established during some ad hoc test observations performed at the 12 Meter Telescope, and have been described in conference proceedings. The practical implementation of a usable system at the 12 Meter has been hampered by the performance of the phase lock system; fast switching times over a relatively large bandwidth are required. The digital phase lock should solve these problems.

Receiver Component Servo Systems

Given the importance of the accuracy and reliability of the servo drivers for the components of the 12 Meter receivers, we have investigated these aspects on our 1-mm Array system. By implementing a periodic test and maintenance procedure for all of the mechanical systems in these servo drivers, we have dramatically improved the accuracy, reliability, and repeatability of these systems. This will have direct impact on our ability to quickly and automatically tune all of the 12 Meter receivers.

Cryogenics

All receivers on the 12 Meter Telescope rely heavily on reliable operation of cryogenic systems. A new cryogenic compressor system has been developed for our closed-cycle 4 K refrigerator. The individual compressor units for the Gifford-McMahon refrigerator and the Joule Thomson expansion valve have been combined into a single unit, resulting in a smaller installation with lower power consumption. All four of these units have been fabricated, tested, and installed on the telescope.

Quadrant Detector and Thermal Sensors

One of the main contributions to pointing changes on the 12 Meter Telescope is lateral movement of the subreflector, with respect to the main telescope surface. This is caused by unbalanced thermal effects on the subreflector support structure. We have installed a system on the 12 Meter to sense these changes; we have a laser quadrant detector to measure the lateral motion of the subreflector mount, with respect to the telescope central hub structure, and we have thermistors continuously monitoring the temperature of the feed legs and other parts of the telescope structure. We are currently trying to build up statistics to enable us to understand the detailed relationship between the thermal distribution of the telescope and telescope pointing offsets. At a later date we hope to incorporate the thermal data into our telescope pointing model to give real-time pointing corrections.

New Digital Spectrometer

Work has begun on a new digital spectrometer for the 12 Meter Telescope which will be copied from the GBT design. The new spectrometer will have twice the instantaneous bandwidth currently available for our multi-beam systems, and will use a single wideband sampler for each IF channel, so avoiding the persistent platforming problems experienced with our existing hybrid correlator spectrometer. This new correlator will support the existing 1.3 mm and 3 mm, and any future, multi-beam systems on the telescope. In anticipation of this development, the Tucson programming staff have been participating in the development of real-time software for the GBT spectrometer.

Software

Continuum On-The-Fly Analysis has been added to the AIPS package which allow the analysis of continuum on-the-fly (OTF) data. By employing the Emerson, Klein, Haslam deconvolution algorithm, these analysis tasks add greatly to our complement of OTF analysis software. This development has also expanded the scientific capabilities of the 12 Meter by adding continuum OTF to its complement of observing modes.

MMA

Many Tucson staff are delighted to be more involved in Millimeter Array (MMA) activities, but this has an inevitable impact on 12 Meter activities. The MMA receiver system development, laser local oscillator and cryogenics, and antenna design are all based in Tucson. The current site testing activities and logistics support are managed out of Tucson. It is important to put effort into these activities, but until MMA resources become available, the staff involved are shared between MMA development and 12 Meter support. This has been a major factor in delays with the new 8-feed, 3-mm receiver, for example. All Tucson staff look forward to increasing MMA development, and will do everything possible to avoid too large an impact on 12 Meter operations.

K. SOCORRO ELECTRONICS

VLA K-Band Front-end

Development work continued on a full waveguide band front-end in the frequency range of 18 GHz to 26.5 GHz. The CDL completed an improved prototype polarizer consisting of a waveguide phase shift section and an OMT section. An electroformed phase shift section has replaced the machined section and provides better performance. The first front-end was installed on Antenna 9 in September and the second front-end was installed on Antenna 5 in December. The components for the third and fourth front-ends have been received. The VLA machine shop has fabricated the dewar components. These front-end units will be assembled and tested after receiving the cooled amplifiers from the CDL during the second quarter of 1998. They will be installed on two antennas during

the third quarter of 1998. The three sub-band total power monitors for estimating atmospheric phase variations will be installed on these third and fourth front-ends.

Preliminary system tests of the first front-ends indicate that with a zenith atmospheric temperature of 20 K the total system temperature will be about 50 K. This is about three times more sensitive than the present narrow band K-Band front-ends.

VLA, VLBI, and Pulsar Improvements

The LO/IF group completed major improvements in the VLBI and pulsar back-ends. They installed an analog-sum buffer equalizing amplifier for each of the four analog-sum IFs along with a VLBI baseband switch. The switch connects any of 16 baseband inputs to the four inputs of the 600 MHz VLBA upconverter. Four inputs come from the analog-sums and 12 inputs come from the four IFs of one antenna on each arm. The switch was constructed by modifying surplus Wandel & Goltermann matrix switches. It allows the observer to select antenna outputs for each VLBI IF via the observe file. Both single dish and phased array observations correlated successfully with this new system. The group also installed a new pulsar patch panel. This connects the four IF outputs from the analog-sum buffer to the 14-channel video converter pulsar system, the wideband detectors and digital scopes. The signal paths within the panel provide amplification and continuously variable gain control. The panel was used successfully in L-band observations of pulsars. This project is complete.

VLA Correlator

Connectors were added to all of the newer style samplers to allow measurement of quadrature network performance above 50 MHz. Measurements and adjustment of all samplers were completed over the range from 1 to 100 MHz. A breadboard of the piggyback delay board for the Pie Town-to-VLA optical fiber connection was tested. A prototype printed circuit board now is being fabricated.

VLA Correlator Controller

Lack of time for online programming has delayed this project. The hardware for this phase of the project is mostly complete. The spare VLA correlator controller backplane is being modified for testing at the AOC and eventual testing and installation at the VLA. Completion of this project has been turned over to the online computer group and a programmer has been assigned to this project.

Amplitude Equalizers for the VLA

The average passband for the VLA antennas has a large slope across the 50 MHz passband. This affects the observing center frequency during continuum observations at 50 MHz bandwidth. A simple R-L-C equalizer circuit to correct the bandpass slope has been tested using a spectrum analyzer in the laboratory. We plan to further investigate and implement the equalizer modification during the next quarter.

Increasing the VLA Continuum Bandwidth

Work on increasing the VLA continuum bandwidth on all four IFs continues. We plan to increase the bandwidth, at first, to 70 MHz/IF using existing electronics in the back-end. The IF filters needed in the F7 and F8 front-end modules are being fabricated in the VLA machine shop and tuned by the Front-end Group. The cost of the modifications to increase the bandwidth to 70 MHz should be less than about $1k per antenna. We plan to have the system installed in all four IFs on three antennas and ready for tests during the next quarter.

VLA to Pie Town Fiber Link

NSF Major Research Instrumentation (MRI) funding in September allows us to start a detailed design effort to link the VLBA antenna at Pie Town (PT) to the VLA via existing in-ground optical fiber. Project engineer Ron Beresford, visiting from ATNF, led the development of a detailed design, that minimizes additional electronics without sacrificing performance of the Pie Town antenna, to use PT antenna as the 27th VLA antenna. The design includes the proposed VLA bandwidth increase to 70 MHz. Implementation of the design prototypes will begin next quarter. Including the PT antenna will double the resolution of the array at all common frequency bands.

GPS Receivers

The VLBA Odetics 325 GPS receivers will not function after August 1999 and are not fixable. We are searching for low cost compatible replacements. A Truetime Model XL-AK- 600 was received and is working well at VLBA Pie Town. A second Truetime was ordered and will be installed next quarter.

VLBA Masers

Maser #1 was delivered by the maser group to the Brewster, Washington, station to replace failing maser #4, which had been at Brewster since February 1991. At the AOC, re-adjusting the multiplier tuning stages of #4 restored the LO power level. The group implemented three retrofits and replaced a noisy DC/DC converter. The nearly depleted metal-hydride hydrogen source will be re-charged (a non-trivial task) in January. Also, the PLL bandwidth will be optimized to minimize VCXO phase noise, the top plate temperature will be evaluated and several specifications will be tested.

VLBA 3-mm Receivers

The second 80-90 GHz receiver dewar was mostly assembled in Charlottesville with support by some of the unique capabilities of the CDL in custom waveguide fabrication and electroforming techniques. The Socorro Front-end Group completed assembly of Receiver 2. A pair of prototype MAP low noise amplifiers which were returned from Princeton University will be installed in early January. Receiver 2 will be installed at Los Alamos next quarter. Most components are on-hand for Receivers 3 and 4. Construction will continue during 1998 as manpower and component availability allows.

VLBA Correlator

One *old* ASIC has failed in the fourth quarter. The Fractional Sample Time Correction (FSTC) fix for 1K and 2K FFTs and the fix for 64 point FFTs have been installed. The replacement cables for the PBI to FFT interface have been fabricated and installed. This completes the re-cabling of the backplane.

A troubleshooting guide to the correlator, emphasizing system test, has been written. A companion document has been distributed to the correlator operators to aid them in interpreting system test results. Several of the Technical Report manuals for portions of the VLBA Correlator are underway and should be completed next quarter.

VLBA Data Acquisition and Playback

Development work continues on the project to double the data output of the VLBA Formatter. This would make it possible to double the current recorded bandwidth at the VLBA sites by recording on two tape drives at the same time. Modifications to the Formatter firmware code to support the 512 MBps mode are installed at Pie Town. The support software is used at all the sites. There are no backward compatibility problems with current one tape observations. The next step will be to install the additional three boards at Pie Town, and try actual two-tape operations. This will be done in January or February, when the hardware is available.

Testing still progresses to evaluate the triple-cap head stacks. Three have now been received and we expect to receive one more from Spin Physics, and two have been received from Metrum, for a total of six. One of the head stacks has now been in use at the VLBA correlator for about two months and has been performing well. We expect that the triple-cap head stacks will have a longer lifetime and thus reduce operations costs.

A large effort is underway to find the best method to quickly contour a new head stack when it is received from the manufacturer. Head stacks do not function with thin tape immediately when they are received, and tape must be shuttled over them before they can be used. For future purchases, we intend to provide information to the manufacturers that will enable them to properly contour head stacks before delivery to NRAO.

Work progresses on ten humidity reduction systems. We expect that these systems will increase head stack lifetime by decreasing the relative humidity in the area of the head stack. We intend to install these systems in the late winter and early spring of 1998.

VLBA Stations

North Liberty, Iowa, station technician, Jack Meadows, installed a video camera and array operator, Dave Medcalf, programmed it to take a picture of the antenna every 15 minutes. The most recent picture is accessible through the VLBA SITES link on the VLBA home page. If this system proves useful for monitoring antenna position and snow/ice conditions, several other stations will be outfitted next year.

One technician from each station attended the second VLBA Technician Workshop in Socorro in October. It lasted five days and included instructional visits to shops at the VLA and the AOC. This mutually beneficial workshop will be repeated each year, or at least every other year.

The St. Croix station technicians, with support from the Engineering Services Division, re-positioned and re-tightened the locking mechanism of an azimuth wheel.

Interference Protection

The acquisition and plotting of W8 pad spectrum analyzer data for the full 1250 MHz to 1750 MHZ section of L-band continued with only minor interruptions throughout the quarter. During September, the frequency coverage of the W8 monitor was reduced to the monitoring of just the 1610 MHz to 1630 MHz portion of L-band in anticipation of the upcoming IRIDIUM satellite tests. That monitoring program yielded useful information on the current bandwidth and channelization parameters of the IRIDIUM test transmissions. Work continued on streamlining the data logging program in order to allow greater set-up flexibility and efficiency. The most current week of the full L-band grayscale plots is available for viewing in the lobby of the AOC.

Work continued on the development of the new VLA RF Environmental Monitoring System (RF-EMS). Rotator control software was written to allow direct control of the RF-EMS azimuth/elevation rotator from the system control PC. The IEEE-488 control software which commands the military surplus, channelizing receiver was successfully tested. Debug of a new, multi-band, low noise front-end is in progress. The new front-end will allow pre-amplification at the directional antenna from HF through X-band. An embedded CPU controller allows simple switching from band to band or to a calibrated noise source using single ASCII text commands from the system control PC. On-tower, integrated tests of the new system will begin in January.

Frequency coordination efforts continued at a fast pace, with spectrum scheduling activities occurring between the Interference Protection group and military spectrum users from six different military bases. In addition, studies and write-ups were generated for nearly a half dozen newly proposed, and potentially damaging, transmitter facilities.

IRIDIUM Satellite Tests

The 1994 MOU between NRAO and Motorola Satellite Communications, Inc., requires cooperative work on a test program to determine the IRIDIUM satellite system signal levels at the observatory sites. Motorola intends not to exceed a spectral power flux density (SPFD) of -223 dB ($W/m^2/Hz$) at the VLA at all times. VLA test objectives are to measure (A) the impact of IRIDIUM emissions on VLA observations of 1612 MHz OH, and (B) the spectral power flux density (SPFD) of IRIDIUM emissions in the 1610.6-1613.8 MHz radio astronomy band.

Our test plan for objective (A) calls for measurements with two subarrays. One subarray of three antennas will use special 1612 MHz bandpass filters to minimize gain compression from the satellite's main emissions at 1621.35-1626.50 MHz. The second subarray will use 24 antennas in normal mode to determine the effects of gain compression caused by the satellite's main emission.

Tests for objective (B) use the antenna at W8 with a modified L-band front-end, a direct coax connection from the front-end to the test back-ends in the control building. Test back-ends include a four channel digital spectrometer and the pulsar high time resolution processor (HTRP). Spectral differences taken synchronously with the IRIDIUM transmission on/off cycle remove GLONASS satellite emissions.

A cooled bandpass filter for the 1612 MHz RA band inside the W8 antenna L-band dewar is in-line for IRIDIUM testing. Cooled switches bypass it for normal operation. Otherwise, the normal unfiltered cooled amplifier configuration will gain-compress sufficiently to impair measurements of satellite spurious emission when the satellite is near and in the VLA main beam.

The three antenna subarray test system, including the synchronous detection algorithms for the digital spectrometer and HTRP, was tested on the VLA and appears to be working properly.

Motorola has drafted a test plan which will be finalized next quarter. The tests with NRAO will occur after special software in the test satellite is debugged and when the NRAO tests can fit into Motorola's test schedule, probably sometime next quarter.

VLA Site Annual Progress Report

VLA antenna painting is over half done with the three antennas painted in 1997; the work will take an estimated four more years to complete. The oldest paint job on Antenna 10 is now three years old and holding satisfactorily, though later paint jobs done with Siloxane are superior. In addition, the VLBA antenna at North Liberty, Iowa, was painted and the antenna at Hancock, New Hampshire, was about half painted. An on-going paint contract for painting at VLBA at St. Croix has proven successful so far.

Problems with premature bearing failure on the VLBA AZ wheels are thought to be caused by excessive thrust and under-rated bearings. We are building two spare drive wheels with half-flex couplings to protect gear boxes from excessive thrust and larger bearings better suited for the load. Drive wheels will be replaced on an as-needed basis. For idler wheels that slip radially, a locking collar has been designed that can be field installed. The wheel bearing problems were discovered during regularly scheduled VLBA maintenance visits.

A fourth VLA AZ bearing was changed out, this one on Antenna 1, the oldest of the VLA antennas. Though the outer race of the Antenna 1 bearing was ruined, the inner race, spacers, and rollers were in good shape. In fact, a sizeable number of spacers on the previous three replaced bearings were broken but no spacers on the Antenna 1 bearing were damaged. A notable difference in the Antenna 1 bearing is a larger chord diameter than the AZ bearings replaced to date. We are studying the differences in the two bearing designs to see if anything can be learned to reduce future bearing wear. Fortunately, a spare refurbished bearing with the larger chord diameter was available.

Measurements are planned for all VLA AZ bearings to see if there are others like the one from Antenna 1. The AZ bearing "pocket mill" was used for the first time to level the bearing support surface to within the 0.012" / 90 deg. tolerance. Use of the instrument saved $30,000 over contracting with a vendor. New strain gauges made this year's procedure safer. A Finite Element Analysis (FEA) of the antenna support structure used during the bearing change shows that some stiffening of the structure is necessary before it is used again.

The VLBA vertex room HVAC modification is complete at all ten VLBA sites. The change provides digital microprocessor control of heating and cooling for energy savings and precise temperature control. Next step for the vertex room is to improve temperature control in the upper level or feed cone area. VLBA station building HVAC systems at Fort Davis, Kitt Peak, and Pie Town were modified to use a system similar to the vertex room, that is, to provide digital control of heating and humidification. Since the temperature control of the maser and D racks at those three sites is so dramatically improved as a result, the modification is planned for all VLBA sites over the next two years.

The VLA main track is gauged, leveled, and aligned from wye center to State Highway 52, and gauged and leveled from DN2 - DN9 and from wye center to DW5. Four complete spur intersections were replaced, one main line crossing was installed at CE8, and one main line crossing/turn-around was installed at DN9. Two concrete rail anchors were poured at DN3 and DN5 as a test procedure in preventing extension rails at intersections from "curling up" from the weight of the transporter. Concrete for the pours was mixed in the surplus cement mixer which is now working and available for use. This year, 850 ties were replaced and 3500 cubic yard of ballast were used. A survey shows that 30 percent of the ties on the array are past their service life so that greater emphasis will have to be given to tie replacement in future years.

Six leaky concrete waveguide manholes were replaced with metal conduit, and four antenna pad waveguide centers were excavated so that the casements could be sealed against leaks. Soil and rock added to 22 manholes along the east arm will improve drainage and reduce leaks. Fifty-one of the 123 manholes have now been replaced. No further corrosion damage to the waveguide was discovered, leading to the conclusion that corrosion found at CN8 and CN9 in 1996 was an exception, possibly introduced by a concrete encasement installed on the waveguide in this area during original construction which may have, in turn, compromised the performance of the cathodic protection system.

Tests by Bill Erickson and Namir Kassim show that 75 MHz dipoles on the VLA will reduce gain in other bands. Hardware is being installed on all 28 antennas to test the 75 MHz dipoles array-wide in January, but because of the gain problems, the dipoles can be left in place for a short time only. Two NMIMT students are planning to propose and build a prototype deployable dipole.

Modifications to the wheel truck hydraulics on Transporter #2 have corrected an intermittent problem that caused a truck to lower unexpectedly. The modified transporter was used during the Antenna 1 AZ bearing change without incident. Lightweight aluminum rail inserts have been tested successfully for turning the loaded transporter. In September 1997, the Transporter Crew logged their 1500th antenna move.

Severe problems with the AZ track grout at Mauna Kea led to extensive grout repairs at that site this summer. The remaining original grout should last another two years when a similar amount of work will be necessary to complete the repair. So far, splice plate repairs to the AZ tracks at all VLBA sites are helping, though grout repairs are currently necessary at Brewster, Washington, and Los Alamos.

Feed covers were installed for all VLA L-band feeds to prevent errors in polarization measurements as a result of rain catching in the dielectric lens.

Waste oil collection stations were installed at the antenna assembly building and the auto shop to reduce spillage. Concern for the environment also led to drafting a hazardous materials communication plan and initiation of a VLA site recycling program.

New K-band feed cone segments are now in use on VLA Antenna 5 and Antenna 9; more are planned. The segments are designed to permit the addition of more cone segments, eventually resulting in a complete feed cone all the way around the feed ring.

Panel adjustments on the Hancock antenna improved its efficiency. Though these adjustments were done "open loop," eventually, all VLBA antenna panels will be adjusted using holographic measurements.

A 18' x 40' x 16' paint booth was erected in a new building behind the AAB so that instrument and equipment painting can be accomplished on-site and in compliance with OSHA regulations. The paint booth is part of an aggressive effort to improve the VLA facility. Other improvement projects include major repairs to the exterior of the Visitor Center, a complete Materials Storage Yard cleanup and reorganization, installing new gutters and walkway lights for the Visiting Scientist Quarters, replacement of one of the buses, a dump truck, and a manlift, painting the interior of the Control Building, and improving signs for visitors.

A new Finite Element Analysis of the VLA antenna agrees reasonably well with the original analysis and closely with recent holographic work, especially at Q-band. The new FEA predicted minimal effect of adding 600 pounds to the apex area, and actual tests confirmed the FEA results. VLA upgrade work is expected to draw heavily on the FEA study.

The VLA was awarded Honorable Mention in the 50th Anniversary Engineering Achievement Competition, sponsored by the New Mexico Society of Professional Engineers. Jack Lancaster, PE, Program Manager during construction of the VLA and now retired, nominated the NRAO for the competition. The award is on display at the Visitors Center

L. COMPUTING AND AIPS

Hardware

During the fall of 1997, we purchased the equipment necessary to fully connect the outlying buildings at the VLA site (technical services building, warehouse, maintenance building, antenna barn, and visitors' center) to the NRAO computer network. Previously, employees in these buildings have had to rely solely on dial-up access; this is no longer acceptable for their work. All of the inside wiring is now complete; we anticipate that the fiber between VLA buildings will be buried in early 1998 and that the network should be fully functional by March. In addition to this work, we also ordered a Cisco router to replace the one at the AOC which provides access to the VLBA sites when the normal network connections are down; Cisco no longer offers any kind of support for the old model.

The IBM RS/6000 which has been the NRAO-Charlottesville main file server and general-purpose UNIX system for six years was replaced in December by two Sun SPARCstation Ultras. One is acting as a dedicated file server; the other has taken over the general computing activities. The IBM is now in the same situation as other NRAO RS/6000 systems: it is still available for limited in-house use, but is not fully supported and will not be repaired if it breaks.

Twelve additional Sun workstation upgrades were purchased late in the year. This brought the NRAO-wide total for 1997 to approximately 70. We need to continue this level of replacement in 1998 and beyond, in order to retire the remaining ~120 Suns that have a very limited support lifetime, and thus keep NRAO's computing facilities viable for the long term.

The latest release of the Sun Solaris operating system, 2.6, is being tested at three NRAO sites. This release introduces support for files greater than 2 gigabytes in size, which is an attractive prospect for some VLBA/VLBI experiments. An installation of AIPS has now been compiled with this support at the AOC and is being tested.

In October, a Tektronix Phaser 560 color laser printer was purchased for testing at NRAO Charlottesville. While the quality of the output is perhaps not as high as could conceivably be achieved, it is clear that it cannot be improved upon without spending three or four times as much money. In light of this fact, and the fact that the 560 performed as well as, or better than, other models in its price range, we purchased identical printers for the other three main NRAO sites (Green Bank, Socorro, and Tucson) in December. This will provide significantly better color hard copy facilities than were previously available.

NRAO recently purchased two DLT7000 tape drives. This type of drive has considerably higher capacity and transfer speed than the most commonly-used tape media (8 mm and DAT), and may be useful for storing and transporting large datasets. The price of this equipment currently prevents wide deployment within NRAO, at least until further testing of the usefulness and robustness of the media has been done.

Personnel

Effective November 1, Gareth Hunt assumed responsibility for managing all GBT computing efforts in Green Bank. This was in response to the recommendation made by the GBT software review committee in September. Gareth has also taken over for Bob Vance, who recently retired, as Head of the Green Bank Computing Division.

Gareth's change in responsibilities leaves vacant the position of Deputy Assistant Director for Computing in Charlottesville. For the time being, his previous duties are being performed by Ruth Milner, who has temporarily relocated from Socorro until the position can be filled.

Planning

The report of the 1997 Visiting Committee strongly recommended that NRAO develop a long-term computing plan. Work on this has now begun and a draft should be available for the 1998 Committee Meeting.

Planning discussions for RE expenditures in computing in 1998 have started, despite the budget uncertainties for 1998. Major efforts being planned for 1998 include the continuation of efforts to upgrade or replace obsolete workstations and improve the networking and data storage facilities at the observatory.

Software

AIPS - The most recent version of AIPS was released in November 1997, as planned. Since then, the features and capabilities of AIPS and the (formerly) experimental CVX version of AIPS have been merged. The merged version of AIPS is now being used and tested in-house, prior to the next planned release of AIPS in April 1998.

Linux Testing and Evaluation

This effort continues at NRAO, an investment which will both allow NRAO to provide support to our outside users running the Linux operating system as well as provide potential savings for some workstation upgrades. NRAO is now able to support a version of AIPS running under Linux on a Dec Alpha workstation. Investigation is continuing on Linux compilers for Linux, with the goal of improving AIPS performance under Linux. For the present, a stable and reliable FORTRAN compiler exists for Linux, in the form of the f2c FORTRAN converter and the GCC C compiler. Roughly ten Linux workstations have been installed and are being supported at the Charlottesville site, with smaller numbers of similar workstations at other sites. Most technical issues associated with these machines have been resolved, and a few issues deferred.

Efforts to install AIPS on the a low-cost "clone" workstation have been successful. Tests and evaluation of this workstation (which uses a DEC Alpha CPU chip) have been successful. The Alpha-based machine is extremely cost effective in terms of price/performance.

Ultimately, the Linux installation efforts at NRAO will accomplish two goals: (1) devising efficient methods for NRAO to support its small (but growing) population of Linux workstations, and (2) allow a detailed evaluation of the current readiness of Linux for a major installation at NRAO in the future.

Partnership with NCSA

Effort at the NRAO began in October in support of the NRAO partnership with the NCSA (the National Computational Science Alliance, formerly the National Center for Supercomputing Applications). NRAO is a part of the "Alliance"and will be funded at a level starting 1 October 1997. Funds are available for 1.5 to 2 positions at NRAO, increasing to two full-time positions in subsequent years. The emphasis for NRAO involvement will be in two areas: (1) developing applications which can efficiently utilize parallel architecture computer to solve large problems in radio astronomy, and (2) networking support and development to devise methods to allow NRAO users straightforward access to large computing facilities. The latter will enable access to facilities whose capabilities are well beyond those available at either NRAO or our users' home institutions. We anticipate that NCSA will become one node on the NRAO intranet, allowing guaranteed levels of network access to NCSA facilities in Illinois from NRAO.

VLA Archive Project

The copying of the VLA archive from 9-track tapes to Exabyte is steadily moving along. Just over two years of data from the mid-eighties is left to be reformatted and copied before the project is completed. We anticipate this happening in the latter half of 1998.

Use of the archive and its catalog is on the rise, and a number of problem areas with the catalog been pointed out. In some isolated cases, visibility data in the archive do not have a counterpart in the catalog; in other cases, fields in the catalog contain erroneous information. Some of these problems have been corrected and work on others is still in progress. We continue to request feedback from the user community in order to make the catalog more robust and complete. When, in the second half of next year, all data have been moved from 9-track to Exabyte, we plan to spend a number of weeks on rebuilding the catalog. We have had no complaints about the contents of the archive itself.

VLA Visitor Support

We further improved computer resources for visitors to the VLA site. We added a second workstation for use of the general observers at the site. This workstation, Puck, is located in the visitors' office on the second floor. The main visitors' station, Miranda, which had been upgraded to a SPARCstation 20 earlier, now received much more disk space. This allows us to offer visitors to the site complete AIPS functionality and a sufficient amount of disk space for data.

AOC Operating Systems

We recently have begun testing Solaris 2.6 in stand-alone mode on one of the visitors' workstations at the AOC. One of its main advantages over previous versions is its support of file sizes greater than two gigabytes, which is gaining increased importance when accessing large datasets in AIPS from, e.g., the VLBA. Once these tests are successful, we intend to start installation of Solaris 2.6 on the server, after which we will gradually move over the vast majority of Sun workstations.

AOC Security Issues

The AOC anonymous ftp server has been moved to a dedicated system (still accessed as ftp.aoc.nrao.edu) and now has considerably more space available to staff members and their collaborators. However, due to a minor security incident in November where a group of people used our anonymous ftp area to store pirated software (which was discovered and removed within 24 hours), we have had to revise our policy for access from outside NRAO. Anyone who needs to deposit files on our ftp area for an NRAO colleague, will now have to use the directory path pub/staff/*account*, where *account* is the person's first initial and up to seven letters of the last name.

The public-domain *ssh* package is now supported on all AOC Sun workstations, and the SVLBI Silicon Graphics systems. *ssh* is a suite of encryption routines which prevents passwords and other information from being transmitted over the network in the clear, thus making connections immune to "sniffing." We are encouraging our user community to take advantage of this facility when doing remote logins to NRAO computers.

AOC Hardware

The general-purpose system at the AOC, zia.aoc.nrao.edu, was upgraded in October from a seven year old Solbourne running SunOS 4.1.1 to a SPARCstation 20 running SunOS 5.5.1. The NRAO WWW home page was moved to the new system as well (still accessible as www.nrao.edu). However, any Web-based interfaces to databases, such as the VLA archive, the library database, and the VLAIS system, had to be kept on the old computer, now known as oldzia.aoc.nrao.edu. We believe that all links in our web pages have been updated to reflect this change. Any personal bookmarks pointing to these areas will have to be modified. Work is underway to move all database applications onto other platforms.

AOC Personnel

Ruth Milner left for a four-month visit to Charlottesville to take over Gareth Hunt's duties. A fair fraction of her management of the AOC and VLA computing systems is done remotely. Jon Spargo left the computer division to devote all of his time to safety

related issues. His previous responsibility of assigning and organizing public workstation bookings has been taken over by the Data Analysts.

Tom Wilson, our general programmer, left NRAO in December; we were able to fill this position internally, thus avoiding costly delays in areas such as archive support. Wes Young left the computer division for an NCSA funded position in the AIPS++ group.

Green Bank Networking

In preparation for the move of the GBT Mockup, 100 Mb Ethernet boards were installed in the Ethernet switches in the Jansky Addition. After the acceptance of the building, fiber cables were pulled between the two floors and a few of the fibers terminated in the GBT operations area. When the under-floor trays are completed, the fibers will be connected through to the GBT IF and receiver room.

Green Bank General

As at the other sites, a new Tektronix Phaser 560 color laser printer was installed. This will provide superior color hard-copy output to both Unix and PC users.

Green Bank Unix Systems

As part of the Observatory-wide upgrade program, three old Sun workstations were upgraded to Sun Ultra1 computers. The main server, arcturus, was upgraded to Solaris 2.1. In order to prepare for an eventual upgrade of all Sun workstations to Solaris 2.6, a dedicated computer was isolated for a test installation; results were very favorable. The main advantage of 2.6 is support for large files (more than 2 gigabytes); these will not be required for a while in Green Bank. So, although Green Bank will be prepared to move to 2.6 with the rest of the observatory, the pressure to upgrade is not as great.

Green Bank Personal Computers

Around the site, eight PCs were upgraded during this period. These all have Windows 95 installed. This leaves only six general users to be upgraded from Windows 3.1 so as to be compliant with the year 2000 problem. These users will be upgraded to Windows 95 on their existing PCs early in the next quarter. To improve the service to PC users, a Windows NT server was acquired. This computer will serve the same version of standard software, such as Microsoft Office and Corel Office, to all PC users on the site. It will be configured to provide individual user disk space that is routinely backed up. In addition, it will become the local NT domain controller.

Green Bank Personnel

The Green Bank computer division welcomes Arno Granados, Simon Hoyle, and Gareth Hunt to it's number. They will all be working on GBT software. With his retirement after 35 years of service, Bob Vance will be sorely missed. He has generously agreed, on a part-time basis, to continue to help support those systems on the 140 Foot Telescope that only he presently has the knowledge to do. Gareth Hunt will take over his responsibility as Head of the Green Bank Computer Division.

Year 2000 Issues

When the Year 2000 (Y2K) arrives in just over 700 days, the potential exists for many computer systems, software, and 'smart' hardware containing embedded microprocessors to malfunction, if not updated or replaced by then. The convention of using two digits for the year instead of four has created a potential problem for date-aware software and hardware. Its effects may be widespread, and disastrous for organizations which are unprepared.

At NRAO, our project to identify and resolve Y2K related issues is well underway. The formal assessment process for potential problems related to the Year 2000 issue at the NRAO is on schedule. Implementation, testing, and verification is already underway for many critical systems. Since the Observatory's functions are not dependent upon large amounts of internally written, date-sensitive software, and since the Observatory has considerable hardware expertise to deal with the minor hardware problems

associated with the Year 2000 transition, no major difficulties associated with Y2K are foreseen. All critical systems and functions at NRAO should continue to operate normally through the transition to the year 2000. All critical systems and functions at the NRAO are scheduled for testing during 1998 to identify and correct any remaining small problems associated with Y2K. Contingency plans will be formulated in the event that critical outside vendors experience Y2K related difficulties.

Project Details - Richard Simon has been appointed as Year 2000 Project Manager for NRAO. This merely formalizes the existing structure for the NRAO Y2K effort. The Y2K working group, which is coordinating efforts to identify and mitigate potential Y2K problems, has changed slightly. Current members are: R. Simon (Computer Division), A. Beasley (AOC), C. Bignell (Personnel), A. Bridle (Charlottesville), J. Desmond (Fiscal), J. Hagen (Tucson), and G. Hunt (Green Bank). The project web site is http://www.cv.nrao.edu/y2k/.

Y2K Inventory and Assessment - Earlier expectations that NRAO does not face the severe problems which many large institutions face have been borne out by the nearly completed assessment and inventory. All possible areas of risk, including use of date-aware software, communications and networking infrastructure, computing hardware, safety and environmental systems, embedded microprocessors, use of customized routines for financial tracking and reporting, and so on, were considered. The detailed hardware assessment and inventory for the entire observatory has been completed, including physically tagging and collecting information for every piece of hardware at NRAO which might have Y2K vulnerabilities, and assigning a priority to each piece of hardware. No major surprises turned up. Some of the older machines may need upgraded or replaced, but generally such machines would be scheduled for replacement before 2000 in any event. The hardware inventory turned up a few machines which will need detailed testing to verify that they will perform correctly.

Software - Identification of all critical software systems at the Observatory has been started. The Observatory does not use massive amounts of customized date-aware computer software, so we do not face the severe problems which confront many businesses and financial institutions. The key scientific packages which NRAO provides to users, AIPS and AIPS++, are both designed to be Y2K compliant and have been successfully tested. The Observatory uses a large amount of commercial and public domain software; applications which affect critical functions will be tested and repaired or replaced, if necessary. Tests to date have not discovered significant problems which might affect NRAO.

Financial and Personnel Systems - The key financial management software and payroll systems at NRAO are purchased from outside vendors with active or completed Y2K compliance efforts. After installation of a routine upgrade to the operating system, and a detailed review of customized reports and scripts is completed, we will do a full system test using test hardware to duplicate our live systems. These tests of our fiscal software are scheduled for May 1998 to verify full Y2K compliance. The Personnel division uses small customized databases and spreadsheets which are likely to have few if any Y2K problems; testing is being planned.

Telescope Operations - In theory, the NRAO telescopes are Y2K compliant by design because they use Julian day numbers for internal time calculations. Reviews of the control software for many NRAO telescopes (including the VLA, the VLBA, the 12 Meter Telescope, and the 140 Foot Telescope) have been completed. Small problems were corrected for the VLA; the ancient software used to control the 140 Foot Telescope will need one to two weeks of effort to be brought into compliance. The VLBA is believed to be ready for testing; the VLA has already been tested, and successfully observed sources and obtained fringes when the system time was advanced by three years. One minor problem turned up in the VLA operating system, which will be corrected during routine maintenance in the coming months.

During 1998, we will test the remaining critical telescope control systems with system dates set to post-2000. This will not pose a danger to current operations, but will be done during scheduled maintenance time. The VLBA itself will be tested in early 1998, after the next release of the correlator software is completed (scheduled for ~ February 1998). This test will be designed to test the complete system, from scheduling to data processing. The VLBA control software has already been carefully reviewed and is presently expected to be Y2K compliant. In Green Bank, the GBT control software is designed to be Y2K compliant; testing to the extent possible will be done ahead of telescope completion.

Telescope operations are generally dependent on scheduling programs to produce detailed schedules from a user's input. At NRAO, scheduling programs which allow ordinary dates for user input immediately convert such dates to Julian day numbers. They use standard algorithms which are Y2K compliant. The scheduling program for the VLA remains to be tested. The scheduling software for the VLBA has been tested and is fully Y2K compliant. It produces correct output for both humans and the VLBA control system.

Embedded Processors - There are only a handful of systems at NRAO which use embedded date-aware processors. These will be tested; correcting or developing reliable work-arounds for these systems will be straightforward, and this work will be scheduled during the first half of 1998.

Communications and Networking - Only a few minor instances of non-compliance exist within NRAO internal communications, telephone, and computer networks. These will be corrected in the coming months, when necessary. As examples: a network server in Socorro is so obsolete that it cannot use a Y2K compliant operating system; it was already scheduled for replacement. In Charlottesville, the PBX voice mail system needs a software upgrade. Some of our network routers may not support post-2000 dates, but the dates in these routers are not actually used, so no corrective action is needed.

M. AIPS++

As mentioned in the last report, the second beta release was made in mid September. Since then a number of beta testers both inside and outside NRAO have used the system and provided some feedback. However, we believe that much more feedback will have to await further changes in both functionality (particularly in the synthesis applications) and interfaces (where a graphical user interface is being developed). Our schedule calls for a further beta release in early spring followed by the first limited public release in early summer.

To improve our documentation, we now have a technical writer on board, Kate Weatherall, who is shared equally between AIPS++ and the MMA. As part of an initiative to increase knowledge of our activities, we expect to issue a monthly email newsletter shortly. This will be edited jointly by Kate and Bob Hjellming. This will be HTML-based and will provide information on latest developments as well as links into our web-based documentation tree.

Initial applications are now being written using the C++ display library developed by NCSA and ATNF.

We have ported the AIPS++ system to the NCSA Origin2000 computer using the SGI native C++ compiler.

As part of a collaboration with NCSA, we have begun development of parallelized code within AIPS++. While this work is primarily targeted for massively parallel computers, it should also benefit inexpensive systems with a small number of processors. If networking speeds are sufficient, we will allow transparent access of NCSA hardware from Charlottesville and the AOC. The first parallel applications will be available for the first limited public release.

We have released version 2.6 of the Glish system. There has not been a public release of Glish since shortly after AIPS++ adopted it for use within the project, and there have been many improvements since then. In preparing for the release, we have had to overhaul Glish's 250 page manual, ensure that the auto configuration scripts (based on GNU's "autoconf") worked properly with minimal user effort, fix all of the major outstanding bugs, and create a home page for Glish (http://www.cv.nrao.edu/glish/). It was important to have a public release so external users (primarily at MIT and ODS) could be brought more into sync with the version of Glish which AIPS++ uses. Since the NRAO is now the official maintainer of Glish, it was also important to produce a release emanating from NRAO.

N. GREEN BANK TELESCOPE

Antenna Structure

Construction of the GBT is moving ahead steadily, taking advantage of the recent good weather at the site. Twelve of the 22 modules that make up the backup structure are now in place on the elevation box. Inter-module welding on the structure is keeping pace as new modules are added. Only four modules remain to be moved out of their trial assembly position. The other six have already been moved to a position that the large derrick can reach for lifting onto the elevation structure.

The initial photogrammetric measurement of the subreflector surface has been completed. The overall surface error of the 158 measured points was 0.0138" RMS, which is in close agreement with the contracto's initial estimate of 0.014" RMS, based on theodolite measurements. Corrections for each of the adjustment points were computed and the adjustments have been completed yielding an RMS of 0.007 inch. The expected subreflector panel accuracy following one more adjustment is 0.004" RMS or less.

The truss work, which holds the feed arm vertex platform, has been fabricated and trial erected on the ground. This will be lifted into place on the horizontal feed arm in one lift. Also, the frame work that makes up the vertical cable wrap is now in place. The electricians have completed much of the wiring in the servo cabinets for the azimuth and elevation drives.

Servo

(Progress on the GBT servo is addressed in the Charlottesville Electronics section of this report.)

Spectrometer

(Progress on the GBT spectrometer is addressed in the Charlottesville Electronics section of this report.)

Electronics

Atmospheric Monitoring System - The tipping radiometer to monitor the atmospheric opacity at 3 mm has been completed and tested. Users can look forward to seeing this data on the WWW in the near future. Initial results are consistent with expectations—a satisfying fraction of the time the opacity is 0.1 or better.

Quadrant Detector III - After taking data for several days, it was realized that the system was temperature sensitive. The power supply and modulation circuit have been placed inside a temperature-controlled box and tests have resumed.

Accelerometers - Accelerometer data was recorded while the subreflector was being moved plus or minus one centimeter at rates of 0.4 Hz to 1.1 Hz. This data will be used to determine the amount of motion induced in the feed arm, to which the subreflector is mounted. This test is clearly preliminary, as only the top end of the feed arm has been assembled and used in this test.

Communications - The operations group has proposed video, telephone, and intercom systems for telescope communications using fiber between the control room and the antenna. A search for potential system vendors is underway.

Weather Station - The weather station that will eventually go to the GBT was moved from the interferometer to Laser Station 10 at the 140 Foot Telescope. The station was installed and connected to the 140 Foot control room via fiber optic cable. It was then recalibrated.

Receivers - Progress has been made on various receivers. In particular, the C band receiver was reinstalled at the 140 Foot Telescope in early November, and except for short episodes of warming on the 15K stage of the dewar, no problems have been noted. The warming was caused by contamination in the helium supply. An attempt will be made to eliminate this problem by installing a filter. The L band receiver was cooled in preparation for polarization calibration, noise temperature measurement, and vacuum leak check. The K band receiver has now been running cold for 7.5 months. VSWR and radiation pattern measurements were performed on the 450 MHz prototype.

Short Back Fire Antenna (SBFA) - A second prototype SBFA with a conical reflector has been designed in an attempt to increase pattern bandwidth.

LO Reference Distribution System - Construction of a 5 MHz distributor module has been completed.

Metrology

Production - Machine shop work on the instrument bases was completed in mid-November. The twenty-two base castings were then delivered to the vendor for anodizing. Custom stainless steel tooling balls for the mounts have been received, which completes the parts needed to assemble the instruments. A major program to assemble and calibrate 20 production instruments and spares has begun. An agreement has been reached with The University of Arizona on reworking the spherical retroreflectors which were returned to The Optical Sciences Center in mid-November.

Experimental Work - Additional RFI testing was conducted on the oscillator boxes. The 1500 MHz leakage was just above the detection threshold in the anechoic chamber. All of the instruments were moved from the GBT to the 140 Foot Telescope and tested in mid-November. By and large, these were extremely successful. The data produced 350 micron RMS residuals. Although the internal consistency of contiguous measurements was good, the repeatability of measurements taken a few minutes apart was not good. There are several possible reasons for this: an inadequate algorithm for the resolution of the phase ambiguity, the non-orthogonality of the parameter set, etc. This is still under investigation. Further test time on the 140 Foot is expected in January. About the same time in November, experiments with four instruments and three spherical retroreflectors were conducted at the 140 Foot Telescope. These experiments should provide sufficient data to test data analysis software. Then the instruments will be moved back to the GBT for the performance measurements program and refractometer baseline experiments.

Performance Measurements Program - A rare and no longer manufactured autocollimating prism (Wild GAP1), required to set the elevation bearing retroreflectors as well as other calibration measurements, has been located and a rental agreement has been reached.

Monitor and Control

The GBT Monitor and Control group welcomes Arno Granados and Simon Hoyle to it's number. After familiarization with the Monitor and Control system, Granados will work initially on completing the software controllers for the holography and DCR back-ends; Hoyle will be working on the software to control the IF systems and the front-ends.

The group is preparing for a new software release (2.7). The primary goal for this release is to have all necessary software available for at least one receiver, the essential IF equipment, and the DCR and Holography back-ends. Present estimates indicate that this release should be available by the end of March 1998.

In preparation for release 2.7 of the Monitor and Control Software, several tasks have been completed: changed from the old compiler, which is no longer supported, to the compiler provided by the Free Software Foundation (g++); changed to a superior tool for tracking changes to the source code (CVS); to support these, re-wrote all files associated with building the system (makefiles); upgraded the VxWorks operating system on the single board computers to the currently supported revision (5.3). All software for this release will undergo a checklist to enforce compliance with coding and documentation standards. These standards have not been heretofore strictly enforced.

The microwave tipper is now fully operational. The control software and data analysis software were completed. The tipper operates around the clock. Preliminary results are available on the WWW. Tests on the focus tracking and the feed arm servo were also successfully completed.

For development of the graphical user interface (GUI) for use by operators and engineers, tcl/tk was selected. A GBT memo outlining this decision will be available shortly. Specifications for enhancements to the GUI builder are being developed.

Software

As a result of recommendations made by the GBT Software Review Committee and the GBT Advisory Committee, all GBT software development will now come under the direction of Gareth Hunt.

Software progress is being tracked using a new procedure modeled closely on the one used by AIPS++.

O. PERSONNEL

New Hires		
Anantharamaiah, K.	Visiting Scientist	11/10/97
Braatz III, James	Research Associate	12/01/97
Granados, A.	Scientific Programming Analyst	11/03/97
Hoyle, S.	Vis. Scientific Programming Analyst	12/08/97
Verheijen, M.	Research Associate	12/02/97
Zhang, Q.	Research Associate	10/01/97
Terminations		
Hicks, S.	Junior Engineering Associate	11/17/97
Seaman, D.	Mechanical Engineer	11/07/97
Vance, B.	Head/Green Bank Computing Division	12/31/97
Wilson, T.	Scientific Programmer	12/11/97
Promotions		
Balser, D.	to Assistant Scientist - Green Bank Operations	10/01/97
Change in Title		
Milner, R.	to Acting Division Head/CV Computing	11/01/97
Other		
Fomalont, E.	returned from Leave of Absence	10/01/97
Thompson, A.	began Gradual Retirement, Part-time 80%	10/01/97

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