US/GR BK/

NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

January 1, 1998 – March 31, 1998

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A. TELESCOPE USAGE

The following telescopes have been scheduled for research and maintenance in the following manner during the first quarter of 1998.

	140 Foot	12 Meter	VLA	VLBA
Scheduled Observing (hrs)	1827.75	1833.00	1649.10	908.00
Scheduled Maintenance and Equipment Changes	148.25	44.50	185.00	316.00
Scheduled Tests and Calibration	152.00	279.00	316.10	454.00
Time Lost	180.25	310.75	69.26	31.00
Actual Observing	1647.50	1522.25	1579.84	877.00

B. 140 FOOT OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
B662	Balser, D. Bania, T. (Boston) Huang, M. (Boston) Shah, R. (Virginia) Rood, R. (Virginia) Jackson, J. (Boston)	Measurements of ionized carbon in the Milky Way.
B678	Braatz, J. Greenhill, L. (CfA) Herrnstein, J. Moran, J. (CfA)	A search for high velocity H_2O maser lines in nearby Seyfert 2 galaxies.
B686	Baker, A. (CNRS, France) Heavens, A. (Edinburg) Hawkins, M. (Royal Obs.) Jimenez, R. (Royal Obs.) Backus, P. (SETI) Lovell, J. (ISAS, Japan)	A search for dark galaxies responsible for quasar lensing.
L319	Lockman, F. J. Murphy, E. (Johns Hopkins)	21 cm HI mapping of the galactic plane.

No.	Observer(s)	Program
L323	Lo, K. Y. (SA/IAA, Taiwan) Chin, Y-N. (SA/IAA, Taiwan) Zhao, J-H. (SA/IAA, Taiwan) Ho, L. (CfA) Ho, P. (CfA) Braatz, J. Wilson, A. (Maryland) Wilson, T. (MPIR, Bonn) Henkel, C. (MPIR, Bonn)	A 22 GHz survey of a complete sample of active galaxies for water vapor megamasers.
L332	Langston, G. Brown, R.	Search for H_2O, HCN, and CO high redshift absorption lines.
SETI	Tarter, J. (SETI)	Project Phoenix.
W398	Wootten, H. A. Claussen, M. Wilking, B. (Missouri)	Water maser monitoring of low-luminosity young stellar objects.
Y021	Young, L. (New Mexico State) Gallagher, J. (Wisconsin) Bomans, D. (Illinois) Smecker-Hane, T. (UC, Irvine)	A search for HI in and around four dwarf spheroidal galaxies.

The following pulsar programs were conducted during this quarter.

No.	Observer(s)	Program
A118	Arzoumanian, Z. (Cornell) Nice, D. (Princeton) Taylor, J. (Princeton) McLaughlin, M. (Cornell)	Bimonthly timing of 63 pulsars at 575 and 800 MHz.
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 this quarter.

No.	Observer(s)	Program
GC020	Campbell, R., *et al.*	Pulsar parallax and proper motion determination.
V043	Preuss, E. (MPIR, Bonn) Kellermann, K. Alef, W. (MPIR, Bonn) Gabuzda, D. (Lebedev)	SVLBI of the nearby class II radio galaxy 3C111.
V061	Romney, J. *et al.*	The core of 3C84.
VS003 VS005 VS007 VS008	Hirabayashi, H. (ISAS, Japan)	VSOP survey of bright AGN and bright maser sources.

C. 12 METER TELESCOPE OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A137	Aalto, S. (Chalmers, Onsala) Radford, S.	Study of molecular line ratios in the Arp 299 galaxy merger.
A138	Aalto, S. (Chalmers, Onsala) Radford, S. Johansson, L. (Chalmers, Onsala)	Study of gas temperatures in luminous mergers with compact CO-distributions.
B682	Balser, D. McMullin, J.	Constraining stellar evolution mixing theories.
B683	Brouillet, N. (Bordeaux) Braine, J. (Bordeaux) Baudry, A. (Bordeaux)	A search for new intergalactic molecular clouds.
B684	Braine, J. (Bordeaux) Brouillet, N. (Bordeaux) Masnou, J-L. (Bordeaux)	Another search for CO in high velocity clouds.
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.

No.	Observer(s)	Program
C318	Crosthwaite, L. (UCLA) Turner, J. (UCLA) Martin, R. (Arizona) Ho, P. (CfA)	Large scale CO mapping of M83.
C321	Carey, S. (Hanscom/AFGL)	Observations of G0.27+0.02 in the 303-202 and 322-221 transitions of H_2CO.
G367	Gensheimer, P. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Mauersberger, R. (Arizona)	$C^{34}S$ observations of ρ Ophiuchi B.
G368	Gao, Y. (Illinois) Gruendl, R. (Illinois) Lo, K. Y. (SA/IAA, Taiwan) Hwang, C-Y. (SA/IAA, Taiwan)	Study of the widely separated ultraluminous infrared galaxies.
G369	Gruendl, R. (Illinois) Gao, Y. (Illinois) Lo, K. Y. (SA/IAA, Taiwan) Hwang, C-Y. (SA/IAA, Taiwan)	Full synthesis imaging of CO (1–0) emission in Arp 244.
H326	Hunter, T. (CfA) Sridharan, T. (CfA) Cesaroni, R. (Arcetri) Palla, F. (Arcetri) Zhang, Q. Brand, J. (Bologna) Molinari, S. (Rome Obs.)	Search for outflows from high mass protostellar candidates.
H330	Hogg, D. Roberts, M.	An analysis of the cool component of the interstellar matter in the SO galaxy NGC 2775.
K358	Kuan, Y. (SA/IAA, Taiwan) Snyder, L. (Illinois) Charnley, S. (NASA/Ames) Ohishi, M. (Nobeyama)	Gas grain chemistry: search for interstellar complex organic molecules.
L328	Liszt, H. Lucas, R. (IRAM)	Study of Cas A radiocontinuum + CO emission.
L330	Lada, E. (Florida) Howe, J. (Massachusetts) Phelps, R. (Oberlin College)	Study of the evolution of molecular cores and star formation in the Rosette molecular cloud.
M413	Mauersberger, R. (Arizona) Sobolev, A. (Yekatarinburg) Cragg, D. (Monash U.) Johns, K. (Monash U.) Godfrey, P. (Monash U.)	Study of CH_3OD masers in star forming regions.

No.	Observer(s)	Program
M415	Mangum, J. Bontemps, S. (Stockholm Obs.) André, P. (CEA, France)	A survey of outflows in protostars.
S426	Sandor, B. (JPL) Clancy, R. T. (SSI, Boulder)	Earth atmosphere studies.
S429	Strelnitski, V. (M. Mitchell Obs.) Benson, P. (Wellesley College) Gordon, M. Holder, B. (Wesleyan U.) Jorgenson, R. (Pugent Sound U.)	Simultaneous monitoring of MWC 349 in millimeter hydrogen recombination lines and in optical domain.
T372	Turner, B.	A search for NH_3O^+.
T373	Taylor, C. (Ruhr U.) Kobulnicky, H. (UC, Santa Cruz) Skillman, E. (Minnesota)	Study of CO in dwarf irregular galaxies.
W394	Womack, M. (St. Cloud State)	Study of carbon chemistry in short-period comets Encke and P/SW 1.
W402	Watt, S. (Maryland) Mundy, L. (Maryland)	Study of molecular and dust evolution during the formation of high mass stars.
W407	Wu, Y. (Peking Obs.) Zhang, Q. Chen, H. (Arizona)	Mapping outflows from massive young stars in CO J = 2-1.
W408	Womack, M. (St. Cloud State)	Study of carbon-bearing molecules in Comet Tempel-Tuttle.
.Z153	Ziurys, L. (Arizona) Apponi, A. (Arizona) Pesch, T. (Arizona)	A search for interstellar/circumstellar NaCH.
Z154	Ziurys, L. (Arizona) Apponi, A. (Arizona) Pesch, T. (Arizona)	Tests for ion-molecule chemistry in IRC+10216: HCO^+ and $HCNH^+$.
Z155	Zhu, M. (Toronto) Bushouse, H. (STScI) Seaquist, E. (Toronto) Papadopoulos (Toronto)	Study of excitation of molecular gas in interacting galaxies.

D. VERY LARGE ARRAY OBSERVING PROGRAMS

The First Quarter, 1998 was spent in the following configurations: D configuration from January 1 to February 3; and A configuration from February 3 to March 31.

No.	Observer(s)	Program
AA211	Aparicio, A. (Laguna) Dalcanton, J. (Mt. Wilson) Gallart, C. (Mt. Wilson) Martinez-Delgado, D. (Laguna) Skillman, E. (Minnesota)	Search for HI associated with Antlia dwarf galaxy. 20 cm line
AA214	Akeson, R. (UC, Berkeley) Blitz, L. (UC, Berkeley)	HI spin temperature in high velocity clouds. 20 cm line
AA216	Anantharamaiah, K. (Raman Institute) Mohan, R. N. (IIA, Bangalore) Goss, W. M. Zhao, J. (CfA)	Recombination lines from starburst galaxies. 20 cm line
AA218	Anglada, G. (IAA, Andalucia) Rodriguez, L. (Mexico/UNAM) Torrelles, J. (IAA, Andalucia)	Short timescale variations in thermal radio jets: nature of outflows in young stellar objects. 3.5 cm
AA221	Athreya, R. (NCRA, India) Bhatnagar, S. (NCRA, India)	Low frequency radio spectra of high redshift radio galaxies. 90, 400 cm
AA223	Anantharamaiah, K. (Raman Institute) Carilli, C. Wrobel, J. Ulvestad, J. Goss, W. M.	Stimulated recombination lines from Mk 231. 3.6 cm line
AA224	Argon, A. (CfA) Reid, M. (CfA) Menten, K. (MPIR, Bonn)	Completion of high quality galactic OH database. 20 cm line
AA225	Aaquist, O. (Kayeno) Kwok, S. (Calgary)	Expansion of compact planetary nebulae. 2 cm
AB808	Blundell, K. (Oxford) Rawlings, S. (Oxford)	Complete sample of $z > 2$ radio sources at high frequency and resolution. 1.3, 2, 3.5 cm
AB840	Beck, R. (MPIR, Bonn) Shoutenkov, V. (Lebedev) Shukurov, A. (Newcastle) Sokoloff, D. (Moscow/SSAI)	Magnetic fields in barred galaxies. 3.6 cm
AB844	Bastian, T. Gary, D. (NJIT) Vourlidas, A. (NRL) Kassim, N. (NRL)	VLA/SOHO observations of coronal mass ejections. 20, 90, 400 cm

No.	Observer(s)	Program
AB846	Balser, D. De Pree, C. (Agnes Scott College) Goss, W. M.	^{4}He imaging of galactic HII regions. 3.6 cm line
AB853	Bower, G. (MPIR, Bonn)	Identification of MeV blazar GRO J1753+57. 0.7, 1.3, 3.6, 6, 20 cm
AB856	Biretta, J. (STScI) Owen, F. Zhou, F. (NMIMT)	VLA monitoring of M87 jet at 15 GHz. 2 cm
AB860	Bietenholz, M. (York U.) Frail, D. Weiler, K. (NRL)	Low frequency observations of 3C58 and Vela X. 90, 400 cm
AB862	Becker, R. (UC, Davis) White, R. (STScI) Laurent-Muehleisen, S. (LLNL)	Twenty-four radio selected BAL quasars. 3.6, 6, 20 cm
AB863	Becker, R. (UC, Davis) Schechter, P. (MIT) White, R. (STScI) Helfand, D. (Columbia)	Two new gravitationally lensed quasars. 3.6 cm
AB865	Bennett, P. (Colorado/JILA)	VV Cephei.
AB867	Boboltz, D. (Haystack) Marvel, K. (Caltech)	SiO from NML Cyg. 0.7 cm
AC308	Condon, J. Cotton, W. Perley, R.	All sky survey. 20 cm
AC493	Cotter, G. (RGO) Baker, J. (Cambridge) Grainge, K. (Cambridge) Jones, M. (Cambridge) Rawlings, S. (Oxford) Saunders, R. (Cambridge)	Measuring the structure of high redshift CMB decrements. 3.6 cm
AC495	Churchwell, E. (Wisconsin) Hofner, P. (NAIC) Shepherd, D. (Caltech) Faison, M. (Wisconsin)	Search for massive protostars and ionizing star(s) of UC HII regions. 2, 3.6 cm
AD405	Dickey, J. (Minnesota)	HI absorption of linear polarization of galactic non-thermal background. 20 cm line

No.	Observer(s)	Program
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
AD409	Dulk, G. (Paris Obs.) Leblanc, Y. (Paris Obs.) Bastian, T. Sault, R. (CSIRO)	Search for 74 MHz cyclotron masers of extra solar planets. 90, 400 cm
AD411	Duric, N. (New Mexico) Perley, R. Kassim, N. (NRL)	74 MHz observations of the galactic supernova remnant W49B. 90, 400 cm
AD412	Dennett-Thorpe, J. (Lisbon) de Bruyn, A. G. (NFRA) Marcha, M. (Lisbon)	Study of > 10 GHz peakers. 0.7, 2, 3.6, 6 cm
AE117	Edge, A. (Cambridge) Allen, S. (Cambridge) Crawford, C. (Cambridge) Fabian, A. (Cambridge) Taylor, G.	Resolving radio sources in cooling flows. 3.6, 20 cm
AE118	Erickson, W. (Tasmania) Gergely, T. (NSF) Bastian, T. Vourlidas, A. (NRL)	Solar active regions. 90, 400 cm
AE119	Erickson, W. (Tasmania) Webber, W. (New Mexico State) Duric, N. (New Mexico) Perley, R.	74 MHz observations of edge-on galaxies. 90, 400 cm
AF316	Fabian, A. (Cambridge) DiMatteo, T. (Cambridge) Alamaini, O. (Cambridge) Carilli, C.	X-ray emitting galaxies with hard spectra—hot ion tori? 0.7, 3.6 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
AF333	Fiebig, D. (Heidelberg Obs.)	Water masers and a possible disk in Orion A west. 1.3 cm line

No.	Observer(s)	Program
AF335	Fanti, C. (Bologna) Fanti, R. (Bologna) Gregorini, L. (Bologna) Vigotti, M. (Bologna) Dallacasa, D. (Bologna) Stanghellini, C. (Bologna)	The sub-arcsecond structure of new large sample of CSS/GPS. 3.6, 6 cm
AF336	Fruchter, A. (STScI) Thorsett, S. (Princeton) Goss, W. M. McGary, R. (Furman University)	Pulsar velocities. 20 cm
AF337	Frail, D. Kulkarni, S. (Caltech) Vakil, D. (Caltech)	Late time radio emission from well localized gamma ray bursts. 3.6, 6, 20 cm
AF338	Falcke, H. (MPIR, Bonn) Wilson, A. (Maryland) Axon, D. (STScI)	Radio outflows in Seyfert galaxies. 3.6 cm
AF339	Falcke, H. (MPIR, Bonn) Zensus, J. A. Ho, L. (CfA)	Compact radio cores in nearby galaxies. 2 cm
AF340	Fassnacht, C. (Caltech) Pearson, T. (Caltech) Readhead, A. (Caltech) Browne, I. (Manchester) Wilkinson, P. (Manchester) Myers, S. (Pennsylvania)	VLA monitoring of gravitational lens 1608+656. 3.6 cm
AF341	Frail, D. Kulkarni, S. (Caltech)	Continued radio monitoring of the May 8, 1997, gamma ray burst. 6, 20 cm
AF344	Florkowski, D. (USNO)	Stellar wind collision in the Wolf-Rayet binary HD192641. 2, 3.6, 6 cm
AG523	Gopalswamy, N. (Catholic U.) Hanaoka, Y. (NAO, Japan) Shibasaki, K. (NAO, Japan) Lemen, J. (Lockheed) Howard, R. (NRL) Gurman, J. (NASA/GSFC)	The onset phase of CMEs. 2, 3.6, 6, 20, 90 cm
AG525	Goldschmidt, P. (Imperial College) Dunlop, S. (Edinburgh) Kukula, M. (Edinburgh) Miller, L. (Oxford)	Fraction of radio-loud quasars in optically selected surveys. 6 cm
AG527	Gallimore, J. (MPIfEP, Garching) Pedlar, A. (Manchester) Thean, A. (Manchester)	Search for flat spectrum sources in Seyfert nuclei. 0.7, 1.3 cm

No.	Observer(s)	Program
AG529	Gregory, P. (British Columbia) Poller, B. (CfA)	Possible new galactic jet source. 3.6, 6 cm
AG530	Gudel, M. (SFIT, ETH)	Solar analog 47 Cas B. 2, 3.6, 6 cm
AG535	Greenhill, L. (CfA) Menten, K. (MPIR, Bonn)	Si0 masers in regions of massive star formation. 0.7, 1.3 cm line
AG536	Gopalswamy, N. (Catholic U.) Schmahl, E. (NASA/GSFC) Kaiser, M. (NASA/GSFC) Robinson, R. (Catholic U.) Gurman, J. (NASA/GSFC) Thompson, B. (NASA/GSFC) Michels, D. (NRL) Plunkett, S. (NRL) Hudson, H. (ISAS, Japan) Nitta, N. (ISAS, Japan)	Radio emission associated with coronal mass ejections. 90, 400 cm
AH603	Harper, G. (Colorado/JILA) Brown, A. (Colorado/JILA) Bennett, P. (Colorado/JILA) Hummel, C. (USRA) 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
AH627	Heiles, C. (UC, Berkeley) Young, L. (New Mexico State) Normandeu, M. (UC, Berkeley)	HI emission and Zeeman splitting in one of the spider's legs. 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
AH633	Hirabayashi, H. (ISAS, Japan) Inoue, M. (NAO, Japan) Kimura, M. (NAO, Japan) Satoh, S. (NAO, Japan) Fomalont, E. Gurvits, L. (NFRA)	Continuum spectral properties of the VSOP survey sources. 2, 6, 20 cm
AH636	Hunter, T. (CfA) Testi, L. (Caltech) Sridharan, T. (CfA) Saito, M. (CfA)	Proper motion of H_20 maser/outflow system in AFGL 5142. 1.3 cm line
AH642	Habbal, S. (CfA) Gonzalez, R. (NAIC) Woo, R. (JPL)	Coronal transient events and the solar wind. 6, 20, 90, 400 cm

No.	Observer(s)	Program
AH645	Hoare, M. (Leeds U.)	Ionized winds of luminous young stellar objects. 0.7, 2, 3.6, 6 cm
AI071	Ivison, R. (Edinburgh) Mikolajewska, J. (Copernicus/Torun) Kenny, H. (Canadian Military) Eyres, S. (Keele) Evans, A. (Keele) Bode, M. (Liverpool JMU)	Symbiotic stars. 0.7, 1.3, 3.6, 6 cm
AJ265	Jackson, N. (Manchester)	Complex FIRST source J0825+3147. 20 cm
AK446	Kawabe, R. (NAO, Japan) Ohta, K. (Kyoto) Yamada, T. (IPCR, Japan) 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
AK452	Koopmans, L. (Groningen/Kapteyn) de Bruyn, A. G. (NFRA) Jackson, N. (Manchester) Wilkinson, P. (Manchester) Fassnacht, C. (Caltech) Myers, S. (Pennsylvania)	Time delay monitoring of the CLASS gravitational lens B1600+434. 3.6 cm
AK453	Kassim, N. (NRL) Lazio, T. J. W. (NRL) Anantharamaiah, K. (Raman Institute) Goss, W. M. Falcke, H. (MPIR, Bonn)	74 MHz imaging of the galactic center. 90, 400 cm
AK454	Kassim, N. (NRL) Lazio, T. J. W. (NRL) Perley, R. Erickson, W. (Maryland) Hankins, T. (NMIMT) Moffett, D. (Tasmania) McLaughlin, M. (Cornell) Cordes, J. (Cornell)	74 MHz VLA deep fields. 90, 400 cm
AK456	Kulkarni, S. (Caltech) Bloom, J. (Caltech) Djorgovski, S. (Caltech) Vakil, D. (Caltech) Frail, D.	Radio afterglows of gamma ray bursters. 2, 3.6, 6, 20 cm

No.	Observer(s)	Program
AK458	Kern, J. (Vermont) Hankins, T. (NMIMT) Rankin, J. (Vermont)	Multi-frequency polarimetry of the Vela pulsar. 3.6, 6, 20 cm
AK459	Kulkarni, S. (Caltech) Frail, D.	RXJ 0720.4-3125: a magnetar? 3.6, 20 cm
AK461	Kassim, N. (NRL) Perley, R. Erickson, W. (Maryland) Lazio, T. J. W. (NRL) Feretti, L. (Bologna)	74 MHz observations of bright sources. 90, 400 cm
AK462	Kronberg, P. (Toronto) Ensslin, T. (MPIR, Bonn) Biermann, P. (MPIR, Bonn) Feretti, L. (Bologna) Giovannini, G. (Bologna) Perley, R. Hanisch, R. (STScI)	The coma cluster at 74 MHz. 90, 400 cm
AK464	Kenny, H. (Canadian Military) Davis, R. (Manchester) Dougherty, S. (DRAO) Eyres, S. (Keele) Richards, A. (Liverpool JMU) Taylor, A. R. (Calgary) Watson, S. (Manchester)	Stellar orbital motion in symbiotic novae. 1.3, 6 cm
AL425	Lisenfeld, U. (Granada Univ.) Dahlem, M. (ESTEC)	Continuum and polarization of interacting galaxies NGC 5426/27. 6 cm
AL427	Lim, J. (SA/IAA, Taiwan) Ho, P. (CfA) Choi, M. (SA/IAA, Taiwan)	The molecular outflow from the young massive star in Onsala 1. 0.7, 1.3 cm line
AL428	Lane, W. (Groningen/Kapteyn) Briggs, F. (Groningen/Kapteyn) Smette, A. (Groningen/Kapteyn)	HI observations of a z = 0.09 damped Ly absorber. 20 cm line
AL432	Lazio, T. J. W.(NRL) Mutel, R. (Iowa) Kassim, N. (NRL) Molnar, L. (Iowa)	Interstellar scattering observations of 1849+005. 6, 20, 90, 400 cm
AL436	Lim, J. (SA/IAA, Taiwan) Carilli, C. White, S. (Maryland)	Structure and evolution of Betelgeuse's atmosphere. 0.7, 1.3 cm
AM556	McGaugh, S. (DTM/Carnegie) Pildis, R. (CfA) deBlok, E. (Groningen/Kapteyn)	Kinematics of extremely gas rich low surface brightness dwarf galaxies. 20 cm line

No.	Observer(s)	Program
AM568	Mirabel, I. F. (CNRS, France) Rodriguez, L. (Mexico/UNAM)	HI absorption to IRAS 19132+1035: is it associated with GRS 1915+105? 3.6 cm line
AM574	Minter, A. Lockman, F. J.	Turbulence spectrum of HI emission. 20 cm line
AM578	Murphy, E. (Johns Hopkins) Sembach, K. (Johns Hopkins) Friedman, S. (Johns Hopkins)	HI distribution in galactic high velocity clouds. 20 cm line
AM579	Miralles, M. (CfA) Kurtz, S. (Mexico/UNAM) Pratap, P. (Haystack)	Ammonia in an outflow in the S255 IR complex. 1.3 cm line
AM582	Miranda, L. (IAA, Andalucia) Torrelles, J. (IAA, Andalucia)	Changes in the variable, extremely young planetary IC 4997. 0.7, 3.6 cm
AM583	Menon, T. (British Columbia)	A gravitational lens candidate from the Ooty sample. 3.6, 6 cm
AM589	McLaughlin, M. (Cornell) Arzoumanian, Z. (Cornell) Cordes, J. (Cornell) Hankins, T. (NMIMT) Lazio, T. J. W. (NRL) Moffett, D. (Tasmania)	Search for radio pulsations from Geminga. 90 cm
AM590	McLaughlin, M. (Cornell) Arzoumanian, Z. (Cornell) Cordes, J. (Cornell) Lazio, T. J. W. (NRL)	Search for radio counterparts to unidentified EGRET sources. 20, 90 cm
AM593	Myers, S. (Pennsylvania) Jackson, N. (Manchester) Fassnacht, C. (Caltech) Koopmans, L. (Groningen/Kapteyn) Marlow, D. (Manchester) Rusin, D. (Pennsylvania)	Continuation of the CLASS VLA search for gravitational lenses. 3.6 cm
AM595	Mioduszewski, A. Blundell, K. (Oxford) Rupen, M. Hjellming, R.	VLA observations of SS 433 to complement simultaneous VLBA + MERLIN. 6, 20 cm
AM598	Meier, D. (UCLA) Van Dyk, S. (UCLA) Turner, J. (UCLA)	RSNe in M83 and NGC 4826? 2, 6, 20 cm
AN076	Nath, B. (Raman Institute) Anantharamaiah, K. (Raman Institute) Srianand, R. (IUCAA)	Recombination lines from damped Lyman systems. 20 cm line

No.	Observer(s)	Program
AN078	Neuhauser, R. (MPIfEP, Garching) Sterzik, M. (MPIfEP, Garching) Menten, K. (MPIR, Bonn)	X-ray emitting PMS stars. 3.6 cm
AP331	Pooley, G. (Cambridge) Hardcastle, M. (Bristol, UK) Riley, J. (Cambridge) Alexander, P. (Cambridge)	Constraining the luminosity function of jets in FRII radio galaxies. 3.6 cm
AP334	Perley, R. Carilli, C. Dreher, J. (SETI)	VLA observations of Cygnus A at 43 GHz. 0.7 cm
AP353	Pisano, D. (Wisconsin) Wilcots, E. (Wisconsin)	Survey to detect extended HI around isolated galaxies. 20 cm line
AP357	Paredes, J. (Barcelona) Marti, J. (CNRS, France)	New radio emitting x-ray binary from the NVSS survey. 1.3, 2, 3.6, 6, 20 cm
AP360	Pentericci, L. (Leiden) Carilli, C. Rottgering, H. (Leiden) Miley, G. (Leiden) DeBreuck, C. (LLNL) van Breugel, W. (LLNL)	High redshift radio galaxies. 3.6, 6 cm
AP368	Pihlstrom, Y. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala) Black, J. (Chalmers, Onsala) Polatidis, A. (Chalmers, Onsala)	Search for excited OH in compact symmetric objects. 3.6, 6 cm line
AR378	Rudnick, L. (Minnesota) Koralesky, B. (Minnesota) Kassim, N. (NRL) Perley, R.	Dynamical evolution and current particle acceleration in Cas A. 6, 20, 90, 400 cm
AR382	Richer, J. (Cambridge) Chandler, C. (Cambridge)	SiO imaging of the jet from the driving source of HH211. 0.7 cm line
AR387	Reipurth, B. (Grenoble) Chini, R. (MPIR, Bonn) Rodriguez, L. (Mexico/UNAM)	A string of Class O sources in OMC 2/3. 3.6 cm
AR388	Rosenberg, J. (Massachusetts) Schneider, S. (Massachusetts)	High resolution studies of galaxies discovered. 20 cm line
AR392	Rodriguez, L. (Mexico/UNAM) Cernicharo, L. (CSIC, Spain) LeFloch, B. (Grenoble)	Exciting source of the optical jet in the Trifid nebula (M20). 3.6 cm

No.	Observer(s)	Program
AR393	Reid, R. (Toronto) Kronberg, P. (Toronto) Perley, R. Dyer, C. (Toronto)	Investigation of weak gravitational lensing in southern radio jets. 3.6, 6 cm
AS568	Sramek, R. Weiler, K. (NRL) Van Dyk, S. (UCLA) Panagia, N. (STScI)	Properties of radio supernovae. 1.3, 2, 3.6, 6, 20 cm
AS616	Shepherd, D. (Caltech) Kurtz, S. (Mexico/UNAM)	Molecules and continuum in the G192 massive molecular outflow. 0.7, 1.3, 3.6 cm line
AS625	Schulman, E. Brinks, E. (Guanajuato U.)	Nature and origin of high velocity clouds in disk galaxies. 20 cm line
AS639	Somers, A. (AAO) Backer, D. (UC, Berkeley) Zepka, A. (AAO) Cordes, J. (Cornell)	A new millisecond pulsar. 20 cm
AT210	Thorsett, S. (Princeton) Taylor, J. (Princeton) Nice, D. (Princeton) Briskin, W. (Princeton)	Timing fast pulsars at the VLA. 6, 20, 90 cm
AW362	White, S. (Maryland)	The stellar activity cycle on active stars. 3.6, 6, 20 cm
AW472	Wilner, D. (CfA) Zhang, Q. Ho, P. (CfA)	Continuum survey of Taurus disks. 0.7 cm
AW479	Wiseman, J. Zinnecker, H. (API, Potsdam) McCaughrean, M. (MPIR, Bonn) Wootten, H. A.	Ammonia core of the HH 212 protostellar jet. 1.3 cm
AW481	White, S. (Maryland) Ray, T. (DIAS, Ireland) Muxlow, T. (Manchester) Davis, R. (Manchester) Davis, C. (DIAS, Ireland) Mundt, R. (MPIA, Heidelberg)	Joint VLA/MERLIN observations of the T Tauri system. 3.6, 6, 20 cm
AW483	Weiler, K. (NRL) Bietenholz, M. (York U.) Frail, D. Spencer, J. (NRL)	SN 1604 (Kepler). 90, 400 cm
AW484	Willson, R. (Tufts) Lang, K. (Tufts) Redfield, S. (Tufts)	VLA-SOHO observations of coronal mass ejections and other transients. 90, 400 cm

No.	Observer(s)	Program
AW487	Wilner, D. (CfA) Ho, P. (CfA)	PMS star TX Hya. 0.7 cm
AX004	Xanthopoulos, E. (Manchester) Browne, I. (Manchester) Wilkinson, P. (Manchester) Patnaik, A. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) King, L. (Manchester)	Monitoring the CLASS gravitational lenses B1030+074 and B1933+503. 3.6 cm
AY085	Yun, M. Hibbard, J.	Tidal HI in IR luminous mergers. 20 cm
AY088	Yun, J. (Lisbon) Moreira, M. (Lisbon) Torrelles, J. (IAA, Andalucia)	Nature of radio continuum sources seen toward Bok globules. 3.6 cm
AY089	Young, L. (New Mexico State)	Search for HI in and around two dwarf spheroidal galaxies. 20 cm line
AY093	Yun, M. Carilli, C.	Redshifted CO emission in z = 4.4 QSO host galaxy. 0.7 cm line
AY095	Yusef-Zadeh, F. (Northwestern) Cotton, W.	G359.87+0.18: a young SNR candidate. 2, 3.6, 6, 20 cm line
AZ097	van Zee, L.	Gas distributions and kinematics of isolated irregular galaxies. 20 cm line
AZ101	Zhang, Q Ho, P. (CfA) Wilner, D. (CfA)	Kinematics of proto planetary disks. 7,1.3 cm
BL049	Lestrade, J-F. (Paris Obs.) Phillips, R. (Haystack) Jones, D. (JPL) Preston, R. (JPL)	A possible Jupiter-mass planet orbiting σ2 CrB. 3.6 cm with phased array VLBI

E. VERY LONG BASELINE ARRAY OBSERVING PROGRAMS

No.	Observer(s)	Program
BA026	Aaron, S. (MPIR, Bonn) Wardle, J. (Brandeis) Roberts, D. (Brandeis) Paragi, Z. (FOMISGO) Fejes, I.(FOMISGO) Murphy, D. (JPL)	Imaging of misaligned jets at 327 MHz. 90 cm

No.	Observer(s)	Program
BA029	Alberdi, A. (IAA, Andalucia) Gomez, J-L. (IAA, Andalucia) Marcaide, J. (Valencia) Perez-Torres, M. (Valencia) Marscher, A. (Boston)	Superluminal source 4C39.25. 0.7, 1.3, 2 cm
BA030	Attridge, J. (Brandeis) Roberts, D. (Brandeis) Wardle, J. (Brandeis)	Blazar 1055+018. 2, 3.6, 6, 18 cm with VLA single antenna
BA031	Anantharamaiah, K. (Raman Institute) Mohan, R. N. (IIA, Bangalore) Goss, W. M. Subrahmanyan, R. (Raman Institute)	Structure of PKS 1830-311 at 327 MHz. 90 cm with VLA single antenna
BB070	Blundell, K. (Oxford) Beasley, A. Lacy, M. (Oxford)	Are the jets in radio quiet quasars relativistic? 3.6 cm with phased VLA
BB078	Bradshaw, C. (George Mason) Fomalont, E. Geldzahler, B. (George Mason)	Sco X-1. 6, 18 cm with VLA single antenna
BB091	Braatz, J. Wilson, A. (Maryland)	The flaring H_20 megamaser in IC 2560. 1.3 cm with phased VLA
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
BC077	Charlot, P. (Paris Obs.) DeGrange, B. (Ecole Polytechnic) Gabuzda, D. (Lebedev) Pare, E. (Ecole Polytechnic) Sol, H. (Paris Obs.)	Simultaneous VLBI polarization and TEV gamma ray observations. 1.3, 2, 3.6, 6 cm
BC078	Chatterjee, S. (Cornell) Cordes, J. (Cornell) Arzoumanian, Z. (Cornell) Goss, W. M. Beasley, A. Benson, J. Lazio, T. J. W. (NRL) Xilouris, K. (NAIC)	Neutron star kinematics: gated VLBA pulsar astrometry. 18 cm
BC080	Campbell, D. (Cornell) Black, G. (Cornell) Butler, B. Ostro, S. (JPL)	VLBA radar observations of asteroid 1988 EG. 3.6 cm

No.	Observer(s)	Program
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
BD052	Diamond, P.	Target of opportunity: new flare in H_20 supermaser region of Orion nebula. 1.3 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. (CfA) 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
BF039	Falcke, H. (MPIR, Bonn) Bower, G. (MPIR, Bonn) Zensus, J. A. Aller, M. (Michigan) Aller, H. (Michigan) Terasranta, H. (Helsinki)	VLBA observations of extremely variable spiral galaxy III Zw 2. 0.7 cm
BG070	Gallimore, J. (MPIfEP, Garching) Mundell, C. (Maryland) Pedlar, A. (Manchester) Baum, S. (STScI) O'Dea, C. (STScI)	Imaging the ionized Torus in NGC 4151. 3.6 cm with phased VLA
BG073	Gomez, J-L. (IAA, Andalucia) Marscher, A. (Boston) Alberdi, A. (IAA, Andalucia)	3C 120 rapid variations. 0.7, 1.3 cm
BH040	Hough, D. (Trinity U.) Cross, L. (Texas) Readhead, A. (Caltech)	Second epoch imaging of four lobe dominated quasars. 3.6 cm
BH045	Homan, D. (Brandeis) Wardle, J. (Brandeis) Roberts, D. (Brandeis) Aller, H. (Michigan) Aller, M. (Michigan)	Survey for circular polarization in AGN at 8 and 15 GHz. 2, 3.6 cm

No.	Observer(s)	Program
BI007	Imai, H. (NAO, Japan) Sasao, T. (NAO, Japan) Kameya, O. (Mizusawa Obs.) Miyoshi, M. (NAO, Japan) Deguchi, S. (NAO, Japan) Asaki, Y. (NAO, Japan)	Proper motions of water masers in W3 IRS 5. 1.3 cm
BJ027	Johnston, K. (USNO) Fey, A. (USNO) Gaume, R. (USNO) Eubanks, T. M. (USNO) Kingham, K. (USNO) Clark, T. (NASA/GSFC) Ma, C. (NASA/GSFC) Ryan, J. (NASA/GSFC) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) Shaffer, D. (Radioferometrics) Gordon, D. (NASA/GSFC) Fomalont, E. Walker, R. C.	VLBA geodesy/astrometry observations for 1998. Scheduled as RDV07 3.6 cm
BK052	Kellermann, K. Zensus, J. A. Vermeulen, R. (NFRA) Cohen, M. (Caltech)	Kinematics of quasars and AGN. 2 cm
BL038	Lestrade, J-F. (Paris Obs.) Phillips, R. (Haystack) Jones, D. (JPL) Preston, R. (JPL)	Search for extra solar planets by VLBI astrometry. 3.6 cm with phased VLA
BL059	Ludke, E. (UFSM, Brazil) Cotton, W. Sanghera, H. (NFRA) Dallacasa, D. (Bologna)	Faraday rotation and depolarization in CSS jets. 3.6, 6 cm
BL061	Laurent-Muehleisen, S. (LLNL) Taylor, G. Becker, R. (UC, Davis) Brotherton, M. (LLNL) Gregg, M. (LLNL)	Radio bright broad absorption line quasars. 18 cm with phased VLA
BL062	Lobanov, A. (MPIR, Bonn) Gurvits, L. (NFRA) Rioja, M. (NFRA)	Frequency dependence of the VLBI core position in 3C 345. 2, 3.6, 6 cm
BL064	Lazio, T. J. W. (NRL) Mutel, R. (Iowa) Kassim, N. (NRL) Molnar, L. (Iowa)	Interstellar scattering observations of 1849+005. 2, 3.6, 6, 18 cm with VLA single antenna

No.	Observer(s)	Program
BM079	Mioduszewski, A. Rupen, M. Hjellming, R.	VLBI observations of x-ray binary SS 433. 6, 18 cm with VLA single antenna
BM080	Moellenbrock, G. (ISAS, Japan) Roberts, D. (Brandeis) Wardle, J. (Brandeis)	Polarization structure monitoring of gamma ray blazars. 0.7, 1.3, 2, 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
BM085	Miyoshi, M. (NAO, Japan) Imai, H. (NAO, Japan) Deguchi, S. (NAO, Japan)	SiO masers in M supergiant IRC-10414. 0.7 cm with VLA single antenna
BM088	Mantovani, F. (Bologna) Junor, W. (New Mexico) Saikia, D. (NCRA, India) Salter, C. (NAIC)	Rotation measures of compact steep spectrum sources. 6 cm with VLA single antenna
BM095	Marscher, A. (Boston) Cawthorne, T. (Lancashire) Gear, W. (Cambridge) Stevens, J. (Cambridge) Marchenko, S. (St. Petersburg) Yurchenko, A. (St. Petersburg) Gabuzda, D. (Lebedev) Lister, M. (Boston) Forster, J. (UC, Berkeley)	Monitoring bright AGNs. 0.7 cm
BN006	Nakai, N. (NAO, Japan) Inoue, M. (NAO, Japan) Miyoshi, M. (NAO, Japan) Hagiwara, Y. (Nobeyama Obs.) Diamond, P.	Water vapor megamaser in the Seyfert IC 2560. 1.3 cm with phased VLA
BP036	Polatidis, A. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala) Murphy, D. (JPL)	Coordinated monitoring of 1928+738 from VSOP and millimeter-VLBI. 0.7 cm
BP038	Pihlstrom, Y. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala)	HI absorption/OH maser observations of 4C12.50. 3.6, 6, 18 cm

No.	Observer(s)	Program
BP041	Peck, A. (NMIMT) Taylor, G. Goss, W. M.	CSO candidates at 8 and 15 GHz. 2 cm with VLA single antenna
BP042	Paragi, Z. (FOMISGO) Fejes, I. (FOMISGO) Vermeulen, R. (NFRA) Schilizzi, R. (NFRA) Spencer, R. (Manchester) Stirling, A. (Manchester)	SS433. 1.3, 2, 3.6, 6 cm with VLA single
BP044	Palen, S. (Iowa) Fix, J. (Iowa) Claussen, M.	Main line OH emission in R Aql and WX Psc. 18 cm with VLA single antenna
BR052	Reid, M. (CfA) Eubanks, T. M. (USNO)	Trigonometric parallax to Sgr A*. 0.7, 3.6 cm
BR053	Ratner, M. (CfA) Bartel, N. (York U.) Lebach, D. (CfA) Lestrade, J-F. (Paris Obs.) Shapiro, I. (CfA)	Astrometry of HR 8703 in 1998 for the Gravity Probe-B mission. 3.6 cm
BT032	Taylor, G. Vermeulen, R. (NFRA)	Absolute motions in the bi-directional jets of 1946+708. 2, 3.6 cm
BU009	Ulvestad, J. Roy, A. Beasley, A.	Compact radio sources in NGC 253. 18 cm with phased VLA
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, 2 cm with VLA single
BV025	Vermeulen, R. (NFRA) Britzen, S. (NFRA) Taylor, G. Wilkinson, P. (Manchester) Pearson, T. (Caltech) Readhead, A. (Caltech)	Caltech Jodrell snapshot survey of superluminal motion - third epoch. 6 cm
BZ019	Zhao, J. (CfA) Lo, K. Y. (SA/IAA, Taiwan) Shen, Z. (Shanghai Obs.) Ho, P. (CfA)	Superluminal expansion in M104. 0.7, 3.6 cm with phased VLA

No.	Observer(s)	Program
GC020	Campbell, R. (NFRA) de Bruyn, A. G. (NFRA) Vermeulen, R. (NFRA) Verbunt, F. (Utrecht) Lestrade, J-F. (Paris Obs.) Schilizzi, R. (NFRA) vanden Heuvel, E. (Amsterdam) Galama, T. (Amsterdam)	Pulsar parallax and proper motion determination. 18 cm
GG034	Garrett, M. (NFRA) Garrington, S. (Manchester) Polatidis, A. (Chalmers, Onsala)	Global VLBI survey of faint, compact radio sources. 6 cm
GL022	Lal, D. (IIA, Bangalore) Shastri, P. (IIA, Bangalore) Gabuzda, D. (Lebedev)	Global observations of a matched sample of Seyfert galaxies. 6 cm
GM030	Marcaide, J. (Valencia) Ros, E. (Valencia) Guirado, J. (Valencia) Perez-Torres, M. (Valencia) Alberdi, A. (IAA, Andalucia) Diamond, P. (Manchester) Shapiro, I. (CfA) Preston, R. (JPL) Jones, D. (JPL) Schilizzi, R. (NFRA) Mantovani, F. (Bologna) Trigilio, C. (Bologna) Van Dyk, S. (UCLA) Weiler, K. (NRL) Whitney, A. (Haystack)	Monitoring the expansion of SN 1993J.
V010	Marscher, A. (Boston)	Comparison of observed and simulated relativistic jets: 1807+698. 6 cm
V016	Cotton, W.	VSOP polarimetric observations of NGC 315. 18 cm
V018	Giovannini, G. (Bologna)	Four low power radio galaxies: 3C465, NGC 315. 6 cm with phased VLA
V030	Preston, R. (JPL)	Pearson-Readhead survey from space. 6 cm
V053	Witzel, A. (MPIR, Bonn)	Polarization variability of intraday variable sources: 2007+777. 6 cm with phased VLA

No.	Observer(s)	Program
V061	Romney, J. Alef, W. (MPIR, Bonn) Backer, D. (UC, Berkeley) Benson, J. Dhawan, V. Kellermann, K. Readhead, A. (Caltech) Vermeulen, R. (Caltech) Walker, R. C.	Core of 3C84. 18 cm
V064	Zensus, J. A.	Physics of the jet in quasar 3C345 at light-year resolution. 6 polar, 18 cm polar with phased VLA
V110	Nicolson, G. (HartRAO)	High resolution imaging of rapid variations in the BL Lac objects: 1144-379. 6 cm
V112	Reynolds, J. (CSIRO)	High resolution imaging of nearby lobe-dominated radio galaxies. 6 cm
V115	Tingay, S. (JPL)	Gamma ray loud and quiet AGN with VSOP and SHEVE at 5 GHz: 0438-436, 0537-441. 6 cm
V140	Fujisawa, K. (ISAS, Japan)	Study of AGN jet acceleration by monitoring of Cen A. 6 cm
V147	Hirabayashi, H. (ISAS, Japan)	Determining the emission mechanism of the OVV quasar 3C279. 6, 18 cm
VT833	Edwards, P. (ISAS, Japan)	HALCA in-orbit check-out. 6 cm
CMVA		Combined Millimeter VLBI Array. 0.3 cm

F. SCIENCE HIGHLIGHTS

Socorro

Microquasar Imaged At High Resolution – The Galactic microquasar GRS 1915+105 was imaged with a resolution of approximately 5 AU. Data from the VLA, UKIRT, and RXTE showed that, during an active period, thermal x-rays from the inner accretion disk disappear and the power-law spectrum is hardened from ejection of relativistic electrons. VLBA images during the activity indicated a synchrotron jet whose flux was pulsed with a period of about 30 minutes. VLBA astrometry shows a proper motion of 5.8 + -1.5 mas per year, ascribed to secular parallax. This roughly agrees with other distance measurements of 12 kpc.

Investigators: V. Dhawan, I. F. Mirabel (Saclay), and L. F. Rodriguez (Mexico/UNAM).

Compact Galaxy Groups Physically Related, VLA Data Shows – A controversy over whether Hickson Compact Groups are physically related or simply appear as groups because of projection may have been resolved. Some 15 of these groups have been imaged in HI with the VLA, and in the majority of cases, the HI images show that the groups are, in fact, related. The studies show that the HI is missing in the majority of disk galaxies in these groups, instead appearing as bits of streamers or shreds being ripped out of the remaining disks.

Investigators: M. Yun, R. Williams (Delaware), and L. Verdes-Montenegro (IAA, Andalucia).

VLBA Reveals Sub-kpc Disk in Active Galaxy – Markarian 231 is an ultra-luminous infrared galaxy with a possible weak secondary nucleus revealed by deep optical images and tidal features indicating a merger. Images of CO emission revealed a molecular disk in the nuclear region. New VLBA observations show HI absorption against a diffuse radio continuum. Both the HI absorption and the continuum emission may come from the inner portion of a disk centered on the active galactic nucleus, a disk whose outer portion is seen in the CO images. The physical conditions for the thermal and non-thermal gas in this sub-kpc disk are similar to those proposed for compact nuclear starburst galaxies.

Investigators: C. Carilli, J. Wrobel, and J. Ulvestad.

Tucson

12 Meter Participation in the Mars Global Surveyor Mission – 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, R. T. 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 vs. 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 ~70 km. 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 have been turned off. This means that other than the real-time spacecraft acceleration (engineering) measurements, the only measurements of the martian atmospheric behavior during this period have been 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 have been of critical importance to the MGS mission during this period.

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

The Outflow Evolution of Young Stellar Objects – Recent advances in our understanding of the physical processes which take place during protostellar evolution have lead to the suggestion of an evolutionary sequence. In this proposed evolutionary sequence, molecular outflow characteristics are expected to evolve with age. In order to better understand this evolutionary sequence, a complete survey of the outflow characteristics of the protostars in Rho Ophiuchus and Taurus is currently being made. With sensitive CO 2-1 imagery of the outflow characteristics in these regions, the outflow statistics, physical and dynamical properties, and the relationship of outflow energetics to dust emission properties is being investigated. A total of 14 Class 1 and Class 0 sources have been identified in this region through ISOCAM measurements of the dust continuum emission. Many of these objects have identified outflows. There is a correlation between CO momentum flux (Fco) and circumstellar mass (Menv), as derived from the bolometric luminosity, in these sources. As has been shown by previous studies, this correlation indicates an evolutionary sequence. The youngest objects (Class 0) inhabit the high-Fco, high-Menv portion of this correlation, indicating a decrease in outflow energetics with age. By comparing the Fco/Menv correlation derived for Rho Ophiuchus with that derived from measurements of the Taurus protostars, the affects of clustered (Rho Ophiuchus) vs. isolated (Taurus) low-mass star formation will be investigated.

Investigators: P. Andre (CEA/DSM/DAPNIA), S. Bontemps (Stockholm Observatory), and J. Mangum.

Large Scale CO Imaging of M83 – The 12 Meter Telescope OTF images of the CO 1-0 and 2-1 emission from the SAB(s)c galaxy M83 have been used to study the distribution of dense gas in this gas-rich barred spiral galaxy. The presence of a strong bar and extensive star formation throughout the disk may well be the byproduct of a recent interaction. The CO 1-0 image was made before it was realized how extensive the molecular gas is in this galaxy. Emission is seen at the edges of the map. Recently, OTF strip images have been obtained along the edges of this image which can be added to the existing data set so that the true extent of the dense gas can be better ascertained. In the CO 2-1 image, the bar structure is readily apparent. By comparison with IRAS HIRES images at 60 and 100 micron and Digital Sky Survey optical images, the following facts have been derived: (1) The extent of the CO 1-0 emission is equal to or greater than the optical extent; (2) The bar structure is clearly indicated in both CO images; (3) There is substantial inter-arm CO 1-0 emission; (4) From the expected correlation of IRAS 60 micron emission with CO 2-1 emission (seen in a parallel study of NGC 6946), the CO 2-1 emission is probably more extensive than seen in the image. M83 is one of the program galaxies in a larger survey of CO in spiral galaxies which includes NGC 1097, NGC 4736, and NGC 6946.

Investigators: L. Crosthwaite and J. Turner (UCLA)

Green Bank

A major difficulty in understanding molecular clouds is that their main constituent is molecular hydrogen, which is usually impossible to observe. The amount of H_2 can be inferred from measurement of the centimeter-wave transitions of the CH molecule which, though quite weak, are more representative of the amount of H_2 than the more easily-observed transitions of CO. Recent observations of two high-latitude molecular clouds in CH using the 140 Foot Telescope show, in fact, that the ratio of CO to H_2 varies by an order of magnitude from point to point across a cloud, and that the mean value varies by a factor of three between the two clouds. It appears that, at least in high-latitude molecular clouds, CO is a poor surrogate for H_2. The observations also show a broad CH component in one of the clouds which may arise in the disturbed outer layers of the cloud and may contain a significant fraction of the cloud's mass.

Investigators: L.Magnani and N.G. Adams (Univ. Georgia), J. S. Onello (SUNY Cortland), D. Hartmann and P. Thaddeus (Harvard-Smithsonian)

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

The principal construction activity continues to be for the MAP project. The following table shows the status of each of the five bands, including both prototypes and flight units:

Band	Completed	Remaining	T_{rcvr} (band center)
K	2	12	10
Ka	9	10	16
Q	19	5	22
V	14	10	33
W	23	24	60

More Ka-band amplifiers will be produced than originally intended because of a problem with the first units produced: some may have less than the optimum amount of glue under the substrates, so that even though they have passed vibration tests, they conceivably could fail with repeated thermal cycling. It may thus be necessary to manufacture additional units to make up the total required quantity of ten. The amplifiers already completed may be useful in other projects.

Superconducting (SIS) Millimeter-Wave Mixer Development

There has been a serious problem caused by flaking of gold plating inside the scalar feed horns used in the new 8-channel, 3 mm receiver under development in Tucson. The flakes fall into the SIS mixers and appear to cause erratic receiver performance. The CDL is attacking this on two fronts: we are now inserting expanded PTFE plugs in the input waveguides of all mixers to prevent foreign matter entering the mixer, as well as undertaking a thorough revision of our electroforming process. It appears that, even with solder or conductive epoxy filling, some voids are still occurring in the fins of our corrugated horns. Also, cleavage planes in the plating at sharp inside corners tend to cause separation under the stress of repeated thermal cycling. In collaboration with the CDL electromagnetics project, we are therefore experimenting with rounded groove bottoms to eliminate cleavage planes. Also, we are setting up a chamber to allow the solder-filling of the scalar feed mandrels under vacuum, followed by pressurization before the solder solidifies. This should eliminate voids. Because electroforming and plating quality is crucial to successful development of prototype components for the MMA, we are also enlisting the services of a commercial electroforming and plating consultant.

Production of Type-D 90-116 GHz SIS mixers continued throughout this quarter. Eight of these and some spares are required for the new 8-channel, 3 mm receiver under development in Tucson.

Work continues on design and fabrication of low loss vacuum windows with high vacuum integrity. An experimental 100 GHz laminated PTFE/quartz/PTFE vacuum window was assembled using a vacuum procedure for attaching the PTFE to the quartz with a glue line less than 0.001" thick. Measurements with the window in front of a 15 K HFET receiver indicate a noise contribution from the window of ~3 K, about twice that expected from theory. Loss in the glue may account for the discrepancy.

Members of the CDL Millimeter Group were authors of the following papers presented at the 1998 International Space Terahertz Technology Symposium in Pasadena and the SPIE conference on radio astronomy instrumentation in Kona:

- A. R. Kerr, S-K. Pan, and H. G. LeDuc, "An integrated sideband separating SIS mixer for 200-280 GHz," *Proceedings of the Ninth International Symposium on Space Terahertz Technology*, 17-19 March 1998.
- A. R. Kerr, S-K. Pan, A. W. Lichtenberger, and H. H. Huang, "A tunerless SIS mixer for 200–280 GHz with low output capacitance and inductance," *Proceedings of the Ninth International Symposium on Space Terahertz Technology*, 17-19 March 1998.
- J. C. Webber, A. R. Kerr, S-K. Pan, and M. W. Pospieszalski, "Receivers for the Millimeter Array," *Proc. SPIE*, 3357, 20-28 March 1998.
- J. M. Payne, L. D'Addario, D. T. Emerson, A. R. Kerr, and W. Shillue, "A photonic local oscillator for the Millimeter Array," *Proc. SPIE*, 3357, 20-28 March 1998.

During this quarter the CDL has assembled and tested eleven SIS mixers for four frequency bands, all using Nb circuits fabricated at UVA.

Electromagnetic Support

VLA– Aperture efficiency and spillover temperature calculations were done for the prime focus frequencies of 240 MHz, 330 MHz, 610 MHz and 900 MHz.

GBT–Work on the Short Backfire antenna is in progress. An optimum configuration with two reflectors in front of the dipole element was developed and far-field patterns have been measured. The prototype feed measures about -9 dB taper at 15 degrees at 385 MHz at the low end of the band. At 450 MHz it has a taper of -12 dB and at 520 MHz a taper of -13.4 dB. Input return loss is better than -13 dB in the 385-520 MHz band.

General–A new finite-difference time-domain based program (Quickwave) was used to analyze a K-Band (18 to 26.5 GHz) corrugated square waveguide phase shifter. The predictions agree well with measurements. The purpose was to evaluate the accuracy of the software. A Ka-Band (26 to 40 GHz) phase shifter is being designed and will be evaluated using the above software.

GBT Spectrometer

During the last quarter, the GBT spectrometer was delivered to Green Bank. System testing at the site so far has shown no problems. Work on the Tucson 8-beam spectrometer has progressed to the point where the rack wiring is almost completed. Power has been applied to the rack but with no cards installed.

All cards to be used in the Tucson spectrometer, with the exception of the control cards, have been built and tested. The design of all control cards was completed, and the cards sent out for wirewrapping. All of the internal modules for the high-speed samplers were finished and initial testing was done. Construction of the sampler units has begun.

The study of a straw man design for the MMA correlator has continued. The possibility of using digital filtering in the MMA correlator has recently been studied.

Frequency Coordination

Dick Thompson attended meetings of ITU-R (International Telecommunication Union, Radiocommunication Sector) Working Party for radio astronomy in Geneva 2-10 June 1997 and 23-27 February 1998. He also attended a meeting of IUCAF (Interunion Commission for Frequency Allocation for Radio astronomy and Space Science) in Grenoble, 20-21 February, which immediately preceded the most recent ITU-R Working Party meeting. An important topic at these meetings has been a method to determine the size of coordination zones around observatories for protection from uplinks of MSS (Mobile Satellite System). Development of a computer program for this analysis is continuing through a correspondence group of which Thompson is a member. Allocations to radio astronomy at frequencies above 71 GHz will be on the agenda of the next WRC (World Radiocommunication Conference), and possible actions to benefit radio astronomy have to be planned. There are also a number of studies that have been called for before the next WRC concerning the impact of proposed new allocations on nearby radio astronomy bands.

Also during this quarter, test observations were made to measure the emission from Iridium satellites within the 1610.6 – 1613.8 MHz radio astronomy band. The downlink frequency band of the satellites is 1621.35 – 1626.5 MHz, but sidebands in the 1612 MHz OH band are expected to be produced through intermodulation in the output stages of the satellite amplifiers. Measurements were made using antennas of the VLA during 22-24 February and 3-7 March. Measurements were also made at Tucson during the same passes observed at the VLA. A small antenna of the University of Arizona, which has some fast-tracking capability, was used. At Green Bank, measurements were made using the 140 Foot Telescope during 25 February to 2 March. The VLA antennas and the 140 Foot cannot track fast enough to follow the satellites, so beam transits were observed, the duration of each being in the range of somewhat less than one second to about two seconds, depending on the elevation. Generally, there were two passes per day of the satellite. Emissions within the 1610.6–1613.8 MHz band were observed at all three sites, and at the time of writing the results are still in the process of reduction.

I. GREEN BANK ELECTRONICS

GBT IF System

The retrofitting of the 100 MHz Converter/Filter modules in the Analog Rack is still ongoing, with about 14 of the 16 modules completed.

In-house fabricated parts for repackaged Optical Driver Module are completed. The first unit should be completed in a few weeks. All bandpass filters for the continuum filterbank have been tested and accepted.

Fiber Optic E-stops

Began investigating the feasibility of using fiber cable for the remote GBT emergency stop located in the Joint Operations Center (remote control room).

GBT Fiber IF System

The AGC loop with the Ortel laser was tested. The loop locked without difficulty, and the photodiode current was stabilized to 4 x 10-6, or about an equivalent of 8 x 10-6 RF gain stability. The digital link for returning the error signal was tested for temperature and RFI. The measurements indicate that the RFI is controlled to acceptable levels by filtering. A compromise between filter roll-off and delay will have to be met, however. This will be determined empirically when the laser diode is returned. The V/F will need to be stabilized to 0.03 C over a typical integration time. The F/V is more temperature stable and the final temperature coefficient will not be known until the RFI filter is specified.

GBT Receiver Systems

Prime Focus – Over the past quarter, a new engineer and technician have taken over the Prime Focus receiver. During this time they have been learning the system, and finishing all of the detailed work so that the dewar could be closed up and cooled. The dewar electronics for the first four bands is finally complete, with the exception of the final 800 MHz amplifiers from CDL. During the second quarter, the system will undergo extensive electrical, vacuum, and cryogenic testing.

The OMT, feedhorn, and transitions, for band 5, have been completed this past quarter. We will resume testing of the OMT shortly. The cryogenic amplifiers for this band are due from CDL in early May.

C-Band – A new stainless steel dewar can with a side-mounted flange for a Varian Vac Ion pump is being fabricated by the machine shop. The radiation shield is also being remade in copper (w/Au plating). The hope is that both of these will reduce thermal loading of the refrigerator and eliminate temperature cycling. A Vac Ion pump was salvaged from one of the old maser receivers; it was tested and found to work, and will be installed along with the other new components at the next opportunity, probably in late April. The necessary wiring changes and modification of the diagnostic software to accommodate the Vac Ion pump are complete.

S-Band – The machine shop finished the OMT this quarter, and initial electrical testing was completed. Trapped-mode resonances were eliminated by using RF absorber material on the OMT back-short. Initial probe tuning with a single capacitive element reduced the OMT's return loss from -10 dB to -20 dB.

Q-Band Receiver – A schedule for the Q-Band receiver development was completed this month. If we receive money this year to work on this receiver we could complete it before the end of the year for the GBT.

K-Band Receiver – This receiver has been running cold, continuously, for 11.5 months. No problems to report. This is a record for this receiver, and very good for any cryogenic receiver.

GBT Servo System

A program to exercise weekly all components of the feed arm servo continues; this requires one to two hours per week. Limit switches are exercised monthly, and the insides of junction boxes are observed for traces of moisture monthly. NRAO and CRSI personnel observe and conduct the tests together.

In order to make the measurement of motor currents practical in the feed arm servo, a current monitor system has been designed and is now installed and tested. The box is an add-on to the PCD servo cabinet in the feed room, and displays currents for all 12 motors on LCD read-out meters.

Work has continued in refining a list of spare components for the GBT servo system. Several quotes have been obtained from vendors, and some requisitions have been prepared.

Drawing from the PCD action item list, various memos, and the feed arm servo log book, a summary of known problems and issues has been compiled. The summary, along with supporting documentation and a cover letter, has been sent to PCD and distributed internally.

The Precision Controls Division of CRSI (PCD) sent personnel to the GBT to complete their testing of the feed arm servo system (FAS). Many outstanding issues were resolved, and many problems were fixed. An action-item list, maintained by PCD, details the work still to be completed on the FAS.

GBT Mockup

The GBT Mockup was moved from the Jansky Lab basement to the GBT Equipment room in January. The move took approximately three weeks and went very smooth. Engineers, astronomers, technicians, and programmers started using it routinely around the first of February.

GBT Atmospheric Monitoring System (Water Vapor Radiometer)

The 86 GHz tipping radiometer has been in operation throughout the first quarter of this year. Preliminary statistics for the indicate that the opacity at 86 GHz is less than 0.1 approximately 30 percent of the time. This value corresponds to an opacity of 0.03 at 23.7 GHz, 0.6 at 49 GHz, and 0.3 at 115 GHz.

Site Operations

Project Phoenix (SETI) – During the January run we had cryogenic problems with the SETI receiver. We replaced the refrigerator and the system is back up and running.

In late March we made some receiver noise temperature measurements on the S-Band receiver, the results are still being evaluated.

OVLBI – Overall, the station is in good shape. TWT Control problems appear to be all solved, and phase noise in the two-way path residuals is lower than ever. The satellite had problems and went out of operation a couple times this past quarter. Green Bank was instrumental in providing first orbital correction data to JPL to re-establish orbit predictions after rocket firings shifted the orbit slightly.

Interference Protection Group – Electronics is an integral part of the Interference Protection Group. Over the past quarter we have tested and re-tested many subsystems, identifying sources of RFI in each subsystem.

As usual, 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, the weather station, time systems, and local area networks.

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 1mm 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 is currently being tested.

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, 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. We anticipate installation of this new spectrometer during the 1998 summer shutdown period.

Software

Continuum On-The-Fly Analysis - Eric Greisen has added tasks 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 involved in MMA activities, with 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

Construction and development work continued on a full waveguide band front end in the frequency range of 18 GHz to 26.5 GHz. The first front-end was installed on Antenna 9 in September and the second front end was installed on Antenna 5 in December. Tests of the first two front-ends indicate that with a zenith atmospheric temperature of 20K the total system temperature is 55 to 60 Kelvin. This is about three times more sensitive than the present narrowband K-Band front ends. The components for the third and fourth front ends have been received. The VLA machine shop has fabricated the dewar components. These front-ends will be assembled and tested after receiving the cooled amplifiers from CDL during the second quarter of 1998. They will be installed on two antennas during the third and fourth quarters of 1998. The three sub-band water vapor total power monitors for estimating atmospheric phase variations will be installed in one polarization on these third and fourth front ends.

VLA Correlator

A prototype of the piggyback delay board for the Pie Town to VLA connection has been tested. This board provides a delay range of 0 to 820 usec (more than the required range of approximately 690 usec). We have enough printed circuit boards and components to build the ten prototypes needed for initial system testing, except for one item that is expected in April. The old analog sum has been hooked back up for possible use in future autophasing of all four IFs. Power supplies have been received to use on the new analog sums, in order to reduce noise on the sums. They should be installed during the second quarter.

VLA Amplitude Equalizers

The average passband for the VLA antennas has a slope across the 50 MHz passband. This affects the observing center frequency during continuum observations at 50 MHz bandwidth. A simple passive equalizer circuit to correct the bandpass slope has been tested in the laboratory. However, the gain slope is dissimilar among the antennas, so the origins of the inconsistency must be investigated and understood to allow proper equalization. This project will continue into next quarter.

Increasing the VLA Continuum Bandwidth

Work continues on increasing the VLA continuum bandwidth on all four IFs. We plan to increase the bandwidth, at first, to 70 MHz per IF using existing electronics in the back-end. The prototype IF filters needed in the F7 and F8 front-end modules have been fabricated in the VLA machine shop and tuned to the proper passbands by the Front End Group. The cost of the modifications to increase the bandwidth to 70 MHz should be about $1k/antenna. The system is installed in all four IFs on three antennas. Testing will continue into the next quarter.

VLA to Pie Town Fiber Link

NSF Major Research Instrumentation (MRI) funding in September 1997 triggered our starting a detailed design effort to link the VLBA antenna at Pie Town (PT), New Mexico, to the VLA via existing in-ground optical fiber. Including the PT antenna as the 27th VLA antenna will double the resolution of the array at all frequency bands common to the two arrays. 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. The design includes the proposed VLA bandwidth increase to 70 MHz. Implementation of the design prototypes has started and will continue into the second and third quarter. Integral to the project has been the establishment at the AOC of a fiber optics laboratory with a complete suite of fiber optic (FO) test equipment, including an optical spectrum analyzer (OSA), optical time domain reflectometer (OTDR) and a fusion splicer.

GPS Receivers

The Truetime model XL-AK-600 GPS receivers will replace the Odetics 325 receivers which will not function after August 1999. Truetime receivers have been installed at the VLA and at Pie Town. They are working well. Budget permitting, as many as ten more will be purchased this year.

VLBA Masers

A hand-wound inductor will replace a commercial inductor which has aged excessively in the intermediate frequency module of several masers. Next quarter, a modified module will be installed in maser #1 at Brewster. At the AOC, a new version local oscillator module with 10 dB more gain replaced the original module in maser #4. Tests indicate that its Hydrogen supply will last about six years. The characteristics of the Palladium heater, which controls Hydrogen flow, are being determined to provide a better estimate of hydrogen supply lifetime.

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. Two prototype MAP low noise amplifiers, which were returned from Princeton University, were installed in #2 in early January. Performance is not as good as #1, with higher noise and large gain ripples. Receiver 2 will be installed at Los Alamos in April. Experience with dewars 2 and 3 indicated that disassembly for component testing and troubleshooting was extremely time consuming. A new dewar design has been started and will be completed next quarter. Most components are on hand for receivers 3 and 4. Construction will continue during 1998 as allowed by manpower and component availability.

VLBA Data Acquisition and Playback

The Formatter expansion has now been completed at Pie Town. This expansion doubles the present recording bandwidth to 512 MBps and requires recording on two tapes at the same time. We plan to continue outfitting VLBA sites with this upgrade throughout the year.

Testing progresses to evaluate the triple-cap headstacks. NRAO has now received four from Spin Physics and one from Metrum. Three are now in use at the VLBA Correlator, and are performing well. An effort is underway to develop a common specification for these headstacks that could be used for purchasing by NRAO and other members of the VLBI community. We expect that triple-cap headstacks will have a longer lifetime, and thus lower headstack replacement costs.

All parts have now been received for ten humidity reduction systems. We intend to install the systems by this summer. They will increase headstack lifetime by reducing the relative humidity in the tape contact area of the headstack.

VLBA Correlator

A state counter, to count the four sample states out of the Deformatter, has been tested and is available for use. The FFT system technical report is nearly complete and ready for possible release to a technical writer for finishing touches. The Playback Interface (PBI) System technical report is not far behind. Work continues on other system technical reports.

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 throughout most of the first quarter, with occasional interruptions due to IRIDIUM testing. The VLA IPG homepage has been upgraded to include a link to these plots. On 22 and 24 February and 3 – 7 March, the W8 spectrum analyzer and data logging PC was used to collect quick-look data during the IRIDIUM satellite test passes. Special data collection software developed for these tests performed without a hitch. This data will be available for general review once the test report has been released.

A new summary of current and planned satellite systems which may impact radio astronomy was generated and posted on the Socorro IPG web site at: [http://www.nrao.edu/vla/interference/survey.shtml]. On 5 March, the W8 spectrum analyzer was re-set to cover the low end of L-band, below the normal VLA band edges. Almost two hours of data were collected for the 950 MHz to 1240 MHz band. The grayscale plotting routine was modified to be able to handle one minute peak hold data. The resulting low L-band plot is available for inspection on the Socorro IPG web site at: [http://www.nrao.edu/vla/interference/gsplots/]. Additional low L-band surveys will be scheduled in the near future.

The new VLA RF Environmental Monitoring System (RF-EMS) is now operational. The military surplus scanning receiver has the capability of continuous frequency coverage from 50 MHz to 12 GHz. The system is currently outfitted with a log periodic, directional antenna which should provide useful gain up through most of L-band. The RF-EMS system includes an Az/El rotator with MEO & LEO satellite tracking capability. MEO satellites (GLONASS) already have been tracked successfully. Tests of the system's LEO satellite tracking capability, as well as a new VLA site RFI survey, will begin during the second quarter.

During this first quarter new 200 MHz, S-band, bandpass filters were received, tested, and installed at the Los Alamos (LA) and North Liberty (NL) VLBA sites. After installation at LA, special tests were performed at the site to determine the extent of RFI reduction using the new filters. The results indicate a significant reduction in in-band RFI, with very little RFI now seen within the bandpass of the filters, except when the antenna is pointed directly at the RFI sources on Tesuque peak.

Frequency coordination efforts continued between the Socorro IPG and military spectrum users from seven different military bases. In addition, RFI reduction technical information was collected and distributed to the engineering subcontractors of a newly proposed and potentially damaging TV transmitter facility being constructed in southern Arizona.

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 at all times not to exceed a spectral power flux density (SPFD) of -223 dB(W/m^2/Hz) at the VLA and -208 dB(W/m^2/Hz) at all NRAO observatory sites. 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 and a direct coax connection from the front-end to the test back-ends in the control building. Test back-ends include a four-channel autocorrelating digital spectrometer, the pulsar high time resolution processor (HTRP) and the W8 spectrum analyzer monitor (see Interference Protection above). 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.

On 22 and 24 February and from 3 – 7 March, the VLA acquired data from the IRIDIUM test satellite emitting under three different operating scenarios. The data from VLA, the 140 Foot Telescope in Green Bank, and a small tracking antenna at Tucson, will be released in a report sometime in April.

L. COMPUTING AND AIPS

Hardware

In early 1998, the primary Cisco router at the AOC, which is no longer supported by the manufacturer, was replaced with a new model which will allow us to consolidate all our wide-area connections. Burial of fiber at the VLA site for networking between buildings is almost complete.

The three Tektronix Phaser 560 color laser printers purchased in late 1997 are now operational in Green Bank, Socorro, and Tucson. The two DLT tape drives have also been used successfully for loading and backing up large data sets in AIPS. Unfortunately, one of the two drives malfunctioned in February and had to be returned to the vendor for repairs. Concerns about the robustness of the DLT hardware and its media mean that we should also evaluate other high-speed tape technologies, such as Exabyte Mammoth, as the budget permits.

Personnel

In early March of 1998, the Assistant Director for Computing, Richard Simon, left Computing to assist the Millimeter Array project management team, and a new approach to Observatory-wide computing was announced. An Observatory Computing Council has been created to formulate and recommend strategy and policy for NRAO computing. Ruth Milner has been appointed Assistant to the Director and will serve as the executive officer of the Council, based in Socorro. The Council members are A. Beasley, T. Cornwell, G. Hunt, J. Mangum, P. Murphy, and G. van Moorsel, with A. Bridle as chair. The membership represents the major software projects and operating sites, and the scientific staff.

P. Murphy has been appointed Computing Division Head in Charlottesville. The now-vacant position of Manager of Computing Systems in Socorro will be filled as quickly as possible.

Planning

The report of the 1997 Visiting Committee recommended that the NRAO develop a long-term computing plan. Development of this plan began in late 1997; the objectives of the plan are to characterize the drivers for computing capabilities, to aid in setting computing directions and budgets, and to identify common trends and requirements across the different sites which may let us increase efficiency further by sharing resources and by co-ordinating acquisitions.

Planning discussions for RE expenditures in computing in 1998 were held in March despite budget uncertainties. The major focus planned for 1998 is the continuing upgrade and replacement of obsolete equipment, including items essential for Y2K remediation.

Software

AIPS – Recent developments in AIPS include solutions to the FITS Y2K problem, enhancements to display capabilities, parallelization of a selected subset of tasks, and support for data files in excess of the classical 2 Gbyte limit under Solaris. The next release of AIPS will include CD-ROM as a distribution medium, with support for Linux and Sun systems, and the capability of running off the CD or from local disk. An agreement outlining the steps for a transition between AIPS and AIPS++ was reached in early 1998.

Linux Testing and Evaluation – Efforts to build AIPS using the GNU Fortran compiler, g77, have borne fruit. Earlier problems in getting this compiler to work for AIPS have been solved, and DDT benchmark tests run on various Intel platforms using the new executables showed a factor of two improvement in performance. This makes the inexpensive Intel platform running Linux a very attractive desktop-class system for moderate-size scientific projects. However, some issues regarding the support of large-scale Linux installations have yet to be resolved.

PCs – The presence of Windows NT at the NRAO is increasing: Green Bank has installed an NT file server, and the NRAO PC support staff collaborated on the creation and testing of an NRAO-wide NT domain. The new domain will facilitate central authentication, coordination of user services, and file sharing between PC users at all NRAO locations.

NCSA – An agreement was reached with the NCSA (the National Computational Science Alliance, formerly the National Center for Supercomputing Applications) in March regarding the elimination of possible conflicts between their contract and NRAO's cooperative agreement. This paves the way for NRAO to receive funding from the NCSA so that our cooperative efforts can be increased. Development work on software parallelization techniques has been ongoing during the first six months of the grant cycle; with these funds available, it will now also be possible to implement improvements in network access between the NRAO and the NCSA.

VLA Archive Project

It was discovered that for older (pre-1988) data and certain correlator modes, visibilities in the VLA archive have zero amplitudes and phases. The bug in the conversion program that caused this has been fixed. The effects of this should be transparent to the user community: when faulty data are requested we will re-run the corrected conversion program on the old nine-track tapes before sending the data out. After finishing the re-archiving process later this year, we intend to redo all affected data and reinsert them in the existing archive. We are still in the process of assessing the time required to do this.

VLA Networking

During the fall of 1997, equipment was purchased to fully connect the outlying buildings at the VLA site (technical services building, warehouse, maintenance building, antenna barn and visitor center) to our 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; burying of the optical fiber between VLA buildings is currently in progress and we expect the network to be fully functional by April.

AOC Hardware

We installed a new color laser printer at the AOC to replace our old thermal wax printer. Advantages of the new printer include higher resolution, faster throughput, better color representation, and much lower cost per page, especially for hard copies. This printer is now operational for hard copies; we still are in the process of fine-tuning the printer for transparencies.

AOC Software

We are in the process of purchasing a commercial PC-based maintenance system to replace our locally developed product. An RFP for such a system was sent to three vendors in early March. The bids from the vendors are due shortly, after which we will invite the top vendor(s) to give presentations at the AOC some time in April. We expect final selection of the software to follow soon after.

In February 1998, we introduced a new way to run Windows applications on a UNIX workstation. While being displayed on the local UNIX workstations in an X-window, the Windows applications run natively on the remote hardware of a Windows NT 3.51/WinDD server with dual 200 MHz Pentium Pro CPUs and 128 MB of RAM. Using five concurrent user licenses, a number of Windows applications is available, such as MS Office 97 and Corel Suite 7.

AOC Personnel

In January, Stephan Witz joined the Computer Division, replacing Thomas Wilson who left us in December 1997. Stephan is currently primarily working on archive and archive catalog matters, but also supports a variety of software packages and maintains our Web pages. In March, it was announced that Ruth Milner was moving to a newly created position in NRAO-wide computing management. We have initiated the search for her replacement.

AIPS

An agreement outlining the steps in a transition between AIPS and AIPS++ was reached in early 1998.

15OCT97 – The 15OCT97 version of AIPS has been distributed to 76 sites, running 184 installations (including Solaris, Linux, DEC Alpha, HP and SGI versions). The majority of AIPS distributions are now by ftp. At present it is planned to release 15APR98 in mid April.

15APR98 – In August 1997, the decision was made to incorporate Eric Greisen's Charlottesville Experimental Version of AIPS (CVX) as the next version of AIPS after 15OCT97, becoming the 15APR98 version. Extensive testing of the 15APR98 version in Socorro and Charlottesville identified a modest number of bugs in the new version, some of which also were in previous versions.

Some of the improvements found in the 15APR98 version are several new interactive and non-interactive data editing tools (some of which had been ported to 15OCT97 previously), improved bandpass calibration methods, improved tools for examining the quality of calibration, and enhancements to the interactive imaging/self-calibration tasks. New algorithms to allow single-dish beam-switched continuum imaging were included, as well as enhancements to the 12 Meter Telescope spectral-line on-the-fly imaging. Solutions to the Y2K problem, remote display capability, and data files in excess of the classical 2 Gbyte limit (also available in 15OCT97) have all been implemented into the 15APR98 version.

Non-coplanar imaging has been added to the basic imaging task IMAGR. Previous imaging tasks, when making images well away from the original phase-tracking direction, corrected phases to the center of the image, but did not re-project the interferometer coordinates. The 15APR98 version of IMAGR allows a 3-D option in which the interferometer coordinates are re-projected so that all fields imaged are tangential to the celestial sphere.

AOC Hardware Performance – Recent hardware performance tests yielded some promising results. The latest version of g77 does a significantly improved job of optimization during the f2c conversion and the C compilation (our theory), resulting in significant performance improvements. On the standard "DDT" test, a Pentium Pro 200 (dual-processor) went from 3.6 AIPSMarks under f2c to 6.7 AIPSMarks with g77. On a well-equipped Pentium II 300MHz PC, the results went from 4.6 to 9.6 AIPSMarks. Sun's Ultra 5 (low-end) computer was found to give 4.3 AIPSMarks while an Ultra 30 gave 10.0. Full results of all recent AIPS benchmarking can be found via the AIPS homepage.

Documentation – The VLBI chapter in the AIPS Cookbook user manual was completely revised, to include extensive documentation on the use of AIPS for Space VLBI data analysis. New understanding, developed as work with VSOP observations proceeds, is being incorporated continuously into an electronically-accessible version.

General Developments – A Van Vleck correction has been added to FILLM. Initial tests show a substantial decrease in artifacts for very bright, extended sources.

Parallelization – We are currently introducing support for shared-memory multiprocessor machines into the AIPS computational libraries. FRING has been adapted to take advantage of more than one processor and shows significant savings in execution time when multiple processors are used. Our initial parallelization efforts are targeted at the SGI Origin series of computers, taking advantage of NRAO's Origin 200. Code written for SGI's machines can easily be adapted to run on machines that support the OpenMP standard. Many of the changes required to support parallel execution have also proved to be beneficial on single-processor systems so that all AIPS users can be expected to benefit from the parallelization initiative.

Real-time VLA Data Filling – The possibility to fill VLA data in real-time remains a popular method for AOC-based users to inspect and reduce their data rapidly. In 1997, some new bugs were fixed, increasing the general robustness of the system. Cause for concern is the limited bandwidth between the VLA and the AOC, which remains an obstacle preventing large spectral line data sets or high time resolution continuum data sets to be filled in real-time without loss of data.

The August 1997 upgrade of the operating system software on the real-time FILLM server at the VLA site uncovered a severe problem with filling VLA data in real-time. Small packets from the VLA real-time computers would intermittently hang the visibility server on Miranda and any on-going or subsequent FILLM's would not get visibility data. This problem was resolved November 1997.

Space VLBI Developments in AIPS – Most of the Space VLBI enhancements to AIPS had been completed and tested, as extensively as possible, using simulated Space VLBI data, prior to the launch of HALCA. AIPS was used effectively throughout the initial fringe-search phase. Later stages of data analysis—calibration and imaging—appear to function normally for Space VLBI observations, at least superficially, and were used with some success to produce a number of images from early VSOP observations. Careful study of the imaging stage, including development of optimal techniques for using the AIPS imaging tasks, however, is just beginning.

Over the past year we have added facilities for storing the position of orbiting antennae with AIPS data. The position and velocity vectors of the satellite may be tabulated as a function of time in an orbit (OB) table, together with several derived quantities such as the orientation of the antenna, and mean orbital elements, may be stored in the antenna (AN) table.

Several AIPS tasks, including OBEDT, UVFIX, and VPLOT, can make use of the data stored in these tables. HALCA has a relatively small dish collecting area and a high system temperature compared with ground-based antennae. Combined with the fact that sources are more highly resolved on longer baselines, this means that the signal is usually weak on ground-space baselines. In some cases, it may be necessary to add the signal from several baselines (using closure relations) to find fringes to the space antenna. This technique has always been available in FRING but also has been incorporated into the baseline oriented fringe fitting program BLING during the past year. BLING has also been made more efficient (its run-time performance has improved by more than an order of magnitude) and has been adapted to cope with the large ranges of delay and rate that must be searched in some space VLBI experiments.

Year 2000 Issues

When the Year 2000 (Y2K) arrives in just over 600 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 making excellent progress. The formal assessment process for potential problems related to the Year 2000 issue at the NRAO is largely complete. Testing for many critical systems, such as the VLA, has been completed successfully, with few surprises. The remaining critical systems and functions at the NRAO are scheduled for testing during 1998. 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. Contingency plans will be formulated in the event that critical outside vendors experience Y2K related difficulties.

Project Details – In March of 1998, the Assistant Director for Computing, Richard Simon, who was also the NRAO Year 2000 Project Manager, left Computing to assist the Millimeter Array project management team, and a new approach to Observatory-wide computing was announced. An Observatory Computing Council has been created to formulate and recommend strategy and policy for NRAO computing. Ruth Milner has been appointed Assistant to the Director and will serve as the executive officer of the Council, based in Socorro. She will also assume the responsibilities of Year 2000 Project Manager, coordinating the efforts of the various sites and divisions. The project web site is www.cv.nrao.edu/y2k/.

Y2K Inventory and Assessment – The comprehensive inventory of all NRAO date-aware hardware was completed in late 1997. Plans have been made to replace older hardware which performs critical functions that will be affected by the Y2K problem during 1998.

Software – All NRAO software which understands the FITS (Flexible Image Transport System) data format has now been updated, and will begin using the new format for date-related keywords as of 1999-01-01T00:00:00. A Y2K-related bug in some of the auxiliary functions of the current VLA OBSERVE program has been identified, and will be fixed in the near future. Although a new version of OBSERVE is under development which does not exhibit this problem, the current program is widely used by observers at their home institutions, not all of whom may be able to begin using the newer version by the end of 1999. We therefore need to ensure that the older version is also Y2K-compliant.

A Y2K leap year bug in Windows NT 4.0 was recently publicized and a patch from MicroSoft is expected soon. All NRAO PCs which run this operating system will be updated shortly thereafter.

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. In early 1998, upgrades were applied to the operating system and accounting software on the primary in-house fiscal computing systems which ensures that these components are Y2K-compatible. A detailed review of customized reports and scripts is underway, and full system tests are scheduled for May 1998. Testing is also underway for the small amount of customized software in use by Personnel.

Telescope Operations – In theory, 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, and the 140 Foot) were completed last year. A trivial update to the operating system for the Modcomp computers used by the real-time control system for the VLA will be installed during 1998. If the decision to continue operation of the 140 Foot Telescope beyond 1999 is made, the required changes in the control software will be implemented in late 1998. The VLBA itself will be tested in mid-1998, after the next release of the correlator software is completed (scheduled for ~ April 1998). The VLBA control software has already been carefully reviewed and is 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. In Tucson, Y2K testing of the 12 Meter control system has been scheduled just prior to the next maintenance shutdown in July 1998.

Communications and Networking – Only a few instances of non-compliance exist within NRAO internal communications, telephone, and computer networks. The Green Bank telephone PBX is scheduled for replacement in mid-1998. The network server in Socorro, which is so obsolete that it cannot use a Y2K compliant operating system, will be replaced during the second half of 1998. Other minor bugs, such as the Charlottesville PBX voice mail system software, will be fixed during routine updates.

M. AIPS++

In Single-dish Support, we added the following to the Dish program: frequency switching support, re-gridding, and sequencing of multiple operations. We continued the formalization of the SDFITS standard, providing a number of test examples files. At Green Bank, we continued support of the various fillers needed by the GBT development team, and we also developed an RFI database inside AIPS++ using Glish tools.

In Synthesis Support, we added the following to the Sky program: a graphical user interface, simple Sault-style mosaicing, multiple field processing, imaging in any coordinate frame supported by the AIPS++ Measures system (such as RA/DEC, Az/El, Galactic, SuperGalactic, planet-based, etc.). Synthesis calibration will be carried out using a sibling of Sky called Cal. Currently this supports self-calibration of the form that was present in the old imager program but the intention is that this will soon be augmented by more sophisticated handling of cross-calibration. The visibility visualizer (mans) developed by Jan Noordam with C++ support from Mark Wieringa, has been released into the system. The speed has been much improved by changes to the underlying ms object. Support for various urgently-needed WSRT-specific capabilities, such as determining antenna delay offsets, phase zeroes, is also provided by mans. These will be shifted to the mainstream calibration software when possible.

We have circulated a draft specification for version 2 of the AIPS++ MeasurementSet. The intention is that this should support new scientific requirements arising from VLBI and single-dish processing, and also rectify a few problems found with the existing format (e.g. the inadequacy of one pointing index to specify mosaiced data). We expect that this format will be implemented following the next beta release.

In Measures, we have improved the GUI for the measures object in Glish, adding applications of interest to end-users (e.g. rise/set times), pop-up help, and numerous clarifications. A test program for the measures object has been developed. The IGRF Earth magnetic field model is now available. UVW coordinate transformations to other coordinate systems are now supported by special UVWMachine.

In Glish support, we improved memory use, added floating help, supported private colormaps in tgpgplot, added regular expression handling, and did much of the implementation of file access. We also developed Glish-based matrix algebra classes. And as usual, we fixed a number of Glish bugs.

In AIPS++ Infrastructure, we developed a Lattice Expression Language, allowing Lattices to be combined using complicated mathematical operations that are evaluated at run-time. We developed a number of important tools for the graphical user interface of AIPS++. In addition, we have added the capability to augment objects with plug-in's that add extra functionality, such as standard reductions. We expect that this will become widely used as a means for adding local customizations both by observatories and by astronomers.

In Image Analysis and Display, we have implemented an image calculator based upon the Lattice Expression Language. Image expressions are also now available via Aipsview, so one may display a combination of a number of images without any temporary image ever being written to disk. Similarly, image expressions may also be formed from image objects in Glish. The standard plotter, pgplotter, has been incorporated in the image object. Performance of some methods of the image object has been improved by the use of the revised LatticeApply classes. Aipsview has continued to accumulate more capabilities: vector overlays, display of image expressions. No significant development using the Display Library has occurred, but some debugging has been performed and we have developed a strategy for incorporating PGPLOT capabilities into the DL. We expect significant development of DL-based applications to start once David Barnes begins work at the ATNF this April.

We have started an effort to parallelize AIPS++ synthesis code, including gridding, FFTs, and clean deconvolution. First preliminary results with the parallelized deconvolution show linear speed-up for up to 16 processors. The goal over the next few months will be to translate such speed-ups into working code in the sky object.

We have published two editions of the AIPS++ Newsletter: http://aips2.nrao.edu/aips++/docs/newsletters/frontpage.html. We have started the construction of a user cookbook.

We held the second meeting of the AIPS++ Scientific and Technical Advisory Group in Socorro on February 9 and 10. The STAG report and the Project response are to be found at: http://aips2.nrao.edu/aips++/docs/notes/217/217.html and http://aips2.nrao.edu/aips++/docs/notes/218/218.html

While we agreed with the STAG over many of their recommendations, the one major recommendation, of holding back a first release until there exists a true end-to-end data reduction path for telescope data, is one that we do not believe is wise. Instead, we are implementing a compromise whereby a complete path is available for data that have been initially calibrated elsewhere.

N. GREEN BANK TELESCOPE

Antenna Structure

Many of the basic elements of the tipping structure are in place atop the Green Bank Telescope alidade. These include the elevation shaft, box structure, horizontal feed arm, the elevation wheel, bull gear and drive, and most of the main reflector backup structure (BUS). The 22 counterweight boxes on the elevation wheel are completely welded, and ten have been filled with concrete. The boxes are filled in a precise order to safely counterweight the BUS as additional modules are added into the structure. Primary elements of the servo and electrical systems have been installed on the alidade and the antenna is rotated frequently to aid in the erection process. Currently, the electricians are running conduit and cable trays from the elevation feed wrap out the horizontal feed arm.

The reflector BUS trial erection was completed on the 175-foot square concrete slab at the telescope in June 1997. The BUS consists of 7,652 different members and joints, weighing approximately 2.3 million pounds. During the trial erection, all joints in the BUS were aligned with a positional accuracy of ± 0.25 inches. When finished, the jacks at the top of the 110 scaffolding towers were retracted, leaving the BUS supported by the 17 reinforced concrete piers on which it was built. The deflected shape of the BUS under gravity load was measured to verify the predicted values of the finite element analysis. Lifting of its 22 modules onto the box girder began in October 1997. Currently, 17 modules are on the box and the remaining five are on the ground in the staging area in position to be lifted and placed in the BUS.

The Contractor has recently brought in an additional tower crane (Manitowoc Model 4100) to aid in the lifting and positioning of the remaining modules. Individual modules will be sequentially placed at the base of the main derrick, the surface panel support actuators will be installed, and the module will then be lifted and placed in the BUS. Modules vary in weight between 25 tons and 74 tons, the rigging used for lifting weighs an additional 40 tons, making the heaviest lift 114 tons. As the remaining modules are placed on the structure, they will be held aloft by the derrick cranes while the interconnecting beams between the modules are reinstalled for both stability and accurate positioning of the neighboring units.

The upper 60-foot portion of the feed arm was trial erected at the site, including the deployable prime focus boom, the prime focus positioning mechanism, the subreflector, and the subreflector positioning mechanism. The feed/receiver room, which is located directly below the upper feed arm, has been located nearby with the secondary focus feed turret in its roof. The feed arm servo, which controls all of the above-mentioned equipment, has been installed and tested along with some of the NRAO monitor and control hardware. The first photogrammetric setting of the subreflector surface and calibration of the six subreflector "Stewart platform" actuators has been accomplished to within 0.007" RMS. Additional photogrammetric measurements are anticipated to allow final setting of the subreflector to a tolerance somewhat better than 0.004" RMS.

The 200-foot dual tower section of the vertical feed arm was trial erected at the Contractor's fabrication plant in Mexia, Texas. It was disassembled and shipped to Green Bank where final assembly is now underway. All steel is on site, and the first elements of the vertical feed arm have been assembled and on the ground.

The 2,004 main reflector panels are now in production at the Contractor's plant. Approximately 1,400 panels have been manufactured. Nine of 44 tiers have been accepted by NRAO, and painting has begun. Several of the larger panels have been sent to the site where they were positioned on the structure as a comprehensive fit and alignment check for the structure, actuators, panels and cabling. Subsequent return of the panels to the Contractor demonstrates that the shipping method is acceptable and will not degrade the accuracy of the precision built panels.

The unofficial working schedule for completion of the telescope is now mid-November 1999. Most of the delay of nearly one year is due to problems in the permanent supports of the back-up structure. The remainder can be accounted for by allowance for bad weather and schedule contingency. Close inspection of the 16 permanent supports has revealed that most need to be rebuilt. This is due to errors in design and/or faulty fabrication, specifically, poor quality welding of the interior stiffeners. Because these supports are critical to the structural integrity of the GBT, they must be rebuilt in spite of the consequences for the schedule.

On March 17, 1998, Comsat announced the sale of its subsidiary Comsat RSI, the contractor for the GBT. The buyer, a Dutch company known as TBG, does not want the obligation of the GBT contract, and Comsat itself will finish the telescope. To do so, Comsat has retained key members of the current GBT project management team at CRSI and placed them under the leadership of John Evans, Comsat Chief Technical Officer. John is well known to many radio astronomers from his years with Lincoln Labs and as director of Haystack Observatory prior to becoming head of Comsat Labs. The sale awaiting government approval.

GBT Spectrometer

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

GBT Servo

(Progress on the GBT Servo is addressed in the Green Bank Electronics section of this report.)

GBT Metrology

Production – Fifteen of 20 model PSH97 instruments (GBT production model) have been assembled, and 12 have been calibrated—except for the zero point offset. Calibration procedures have been written. Ten spherical retroreflector mounts have been built, and four have been assembled. Delivery of the remaining optical components is expected by September. A prototype "triplet" system has been built and will be assembled when optics become available. The elevation bearing, box, reflector BUS, and feed arm retroreflector weld plates have been built. All ZY computer boards have been purchased and tested. Assembly drawings and as-built revisions have been made. An alternate vendor has been qualified to supply the laser detectors.

Experimental Work – A small (300 micron) amplitude/phase interaction has been identified and rectified. Experimental work has shifted from the 140 Foot Telescope to the first seven GBT ground instruments. A spherical retroreflector has been mounted on the horizontal feed arm to do vibration experiments in conjunction with accelerometers on the alidade. Preliminary testing with the accelerometers exposed software problems which are being corrected. Testing of the panel setting tool exposed a problem, which has been rectified. Temperature loggers continue to log data in locations around the GBT. Attempts to include GBT weather station data exposed housekeeping problems which are being corrected. Box offsets were measured for 7/8 receiver room turret positions.

Software – Item 4 in the GBT Advisory Committee Report, relating to the antenna metrology effort, is being addressed by project management. Documentation has been written for the ZIY software. An update to the ZY documentation is underway, and will be completed by early May. The ZY and ZIY computer hardware and software have proven to be very reliable at this stage.

Monitor and Control

The Monitor and Control (M&C) group says au revoir (not goodbye, as he will be back next summer) to Stephane Jouteux, who has been with the group since last summer helping with the graphical user interface. We also welcome Nic Benders. Nic is a co-op student who will be working with John Ford on the re-configuration of the network for the GBT.

The M&C group is preparing for a new software release (2.7). The primary goal for this release is to focus on the basic core capabilities for commissioning: to have all necessary software available for at least one receiver (Ku-band), the essential IF equipment, and the DCR, holography, and spectral processor back-ends. There is a high degree of confidence that this release will be available by the end of April. Adding support for other equipment (other front-ends, etc.) will be straightforward thereafter; it will be a matter of assigning relative priority to be compatible with the engineering development and testing schedule.

The last major piece of (re-)design in the M&C software was the new system had to handle monitor points. This includes a new data description library which provides a flexible description of the monitor points provided by devices in terms of data types, units, and FITS representation. It further enables encoding and decoding in an architecture-independent manner based on XDR. This is particularly important, since the Metrology system uses PCs, which are "little endian" machines. The new monitor system will be retrofitted into all devices included in the 2.7 release. When this is done, it will enable us to replace the FITS writing functions with a single set of procedures (cfitsio from NASA Goddard).

The spectrometer was moved from Charlottesville to Green Bank in January. The control software for it has made good progress. All modes for use in both narrow band and broad band with one and two IFs have been checked out. We have developed a set of specifications to allow full flexibility to be available to the astronomer through the observers' interface. Other modes are still to be done; as yet unspecified are the modes for 9-level sampling and pulsar observing. In order to support as high a data rate as possible, a SPARC VME card (running Solaris) was purchased. This has now been successfully installed and tested. The chip "personalities" (to support the different modes) are still loaded via the VME-167 board because of baud-rate incompatibilities, but the output data is read into the SPARC and processed there.

Software General

There has been a significant improvement in the publication record. Don Wells has produced several internal reports to document his work on ray tracing, subreflector motions, active surface corrections, and pointing. Three software engineers (Joe Brandt, Mark Clark, and John Ford) presented papers at the SPIE meeting in Kona, HI in March.

We have expanded the scope of the weekly reports to include all aspects of the GBT software into the report system.

Weather data from the GBT weather stations together with the data from the OVLBI ground-station is now available on a single web page.

AIPS++

The microwave tipper is fully operational. The data is written by the M&C software into FITS files. From there, it is filled into an AIPS++ table for further analysis. Data is gathered continuously and then is available on the web.

We now have specifications for the software needed for commissioning and acceptance of the GBT. This includes the usual operations to determine system temperature, efficiency, opacity, beam, focus, pointing, etc. The software to reduce the data from the appropriate observations will be written in AIPS++.

Operators' and Engineers' Displays

We have received initial specifications for some of the operators' screens, and the design and construction is in progress. Several of the prototype screens have been completed. A review of these by all operations and engineering staff will be held in April.

O. PERSONNEL

New Hires

Benders, F.	Junior Engineering Associate	01/19/98
Hardy, E.	Scientist	01/01/98
Morris, A.	Junior Engineering Associate	01/14/98
Ray, J.	Junior Engineering Associate	01/05/98 (Rehire)
Sumner, M.	Junior Engineering Associate	01/05/98
Willems, W.	Junior Engineering Associate	01/13/98
Wray, L.	Electronics Engineer III	01/14/98 (Rehire)

Terminations

Porta, L.	Junior Engineering Associate	01/09/98
Tarleton, D.	Senior Personnel Representative	01/16/98
Zhang, Q.	Research Associate	03/31/98

Change in Title

Hunt, G.	to Division Head/Green Bank and GBT Computing	03/01/98
Milner, R.	to Assistant to the Director – Computing	03/01/98
Petencin, G.	to Electronics Engineer I	01/01/98
Witz, S.	to Scientific Programmer	01/19/98

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ACORD, J.M.; CHURCHWELL, E.; WOOD, D.O.S. The Expansion Rate and Distance of G5.89-0.39.

BASTIAN, T.S.; BENZ, A.O.; GARY, D.E. Radio Emission from Solar Flares.

BASTIAN, T.S.; GARY, D.E.; WHITE, S.M.; HURFORD, G.J. Broad-Band Microwave Imaging Spectroscopy with a Solar-Dedicated Array.

BECK, R.; BERKHUIJSEN, E.M.; HOERNES, P. A Deep lambda 20 cm Radio Continuum Survey of M31.

BOWER, G.C.; BACKER, D.C. 7 mm lambda VLBA Observations of Sagittarius A*

BRADLEY, R.F.; PORTERFIELD, D.W. New Frequency Multipliers for Millimeter and Submillimeter Wavelength Coherent Array Receiver Applications.

BROWN, R.L. Technical Specification of the Millimeter Array.

CARILLI, C.L.; HARRIS, D.E.; PENTERICCI, L.; ROTTGERING, H.J.A.; MILEY, G.K.; BREMER, M.N. An X-ray Cluster at Redshift 2.156?

CARILLI, C.L.; ROTTGERING, H.J.A.; MILEY, G.K.; PENTERICCI, L.H.; HARRIS, D.E. Radio Observations of High Redshift Radio Galaxies.

CHRISTIANTO, H.; SEAQUIST, E.R. Angular Expansion Measurement of the Young and Compact Planetary Nebula Vy 2-2.

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ESCOFFIER, R.P.; WEBBER, J.C. Wideband Correlators for Radio Astronomy.

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