US/GR BK/

NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

January 1 – March 31, 1999

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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 1999.

	140 Foot	12 Meter	VLA	VLBA
Scheduled Observing (hrs)	1734.00	1859.25	1568.90	1034.00
Scheduled Maintenance and Equipment Changes	154.00	113.50	209.20	237.00
Scheduled Tests and Calibration	189.50	181.25	327.20	254.00
Time Lost	163.00	96.75	54.90	131.00
Actual Observing	1571.00	1762.50	1514.00	903.00

B. 140 FOOT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Programs
B695	Braatz, J. Wilson, A. (UMD) Henkel, C. MPIfR)	Water maser monitoring and accretion disk dynamics in AGN.
B696	Bania, T. (Boston) Rood, R. (Virginia) Balser, D. Lockman, F. J.	A search for ^{3}He+ in the diffuse interstellar medium.
L337	Lockman, F. J. Lieu, R. (Alabama) Mittaz, J. (MSSL)	Observations of galactic HI towards uv luminous clusters.
L339	Lockman, F. J. Murphy, E. (Johns Hopkins)	Extension of the 140 Foot Galactic Plane HI Survey.
M411	Murphy, E. (Johns Hopkins) Senbach, K. (Johns Hopkins) Benjamin, B. (Minnesota)	A deep map of high velocity cloud Complex M.
M425	Magnani, L. (Georgia) Engebreth, B. (Georgia)	A CH survey of the galactic plane.
M428	Minter, A. Balser, D. Wiersgala, N.	Is the turbulence in HII regions inherited or generated?

No.	Observer(s)	Programs
R270	Rood, R. (Virginia) Bania, T. (Boston) Balser, D.	^{3}He abundances in galactic HII regions.
T377	Turner, B.	A search for the cumulene molecule $H_2C=C=C=C=C$ isomers.
W398	Wootten,. H. A. Claussen, M. Wilking, B. (Missouri)	Water maser monitoring of low-luminosity young stellar objects.
Y023	Yang, J. (PMO, China) Jiang, Z. (PMO, China) Wang, M. (PMO, China) Zhang, Q. (CfA) Chen Y. (PMO, China)	Probing dense molecular gas around the extremely cold protostellar objects.

The following pulsar programs programs were conducted during this quarter.

No.	Observer(s)	Programs
A118	Arzoumanian, Z. (Cornell) Taylor, J. (Princeton) Nice, D. (Princeton)	Bimonthly timing of 63 pulsars at 500 and 800 MHz.
A132	Arzoumanian, Z. (Cornell) Nice, D. (Princeton)	575 MHz monitoring of the evolution of the PSR B1957+20 eclipsing binary system.
B687	Backer, D. (UC, Berkeley) Somner, A. (UC, Berkeley) Sallmen, S. (UC, Berkeley) Foster, R. (NRL)	Pulsar timing array.
N018	Nice, D. (Princeton) Thorsett, S. (Princeton)	Monitoring the irregularities in the rotation and orbital motion of a binary pulsar B1744-24A.

The following very long baseline programs programs were conducted during this quarter.

No.	Observer(s)	Programs
GP021	Peck, A., *et al.*	HI absorption toward 1946+708.
VS03 VS26 VS30 VS85	Hirabayshi, H. (ISAS, Japan)	VSOP survey.

C. 12 METER OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
A141	Apponi, A. (CfA)	Study of H_2C_8.
B691	Butner, H. (Arizona) Lada, C. (CfA) Alves, J. (CfA) Lada, E. (Florida) Charnley, S. (NASA/Ames)	Tracing the density profile of starless cores: CS versus dust extinction.
B692	Butner, H. (Arizona) Charnley, S. (NASA/Ames)	Understanding deuterium fractionation chemical pathways: Class 0 sources.
B694	Buckle, J. (Manchester) Fuller, G. (Manchester)	Study of methanol as a probe of protostellar environment clearing.
C322	Choi, M. (Maryland) Panis, J-F. (ASIAA, Taiwan) Evans, N. (Texas)	Study of protostellar collapse candidates using the HCO^+ and the HCN 1–0 lines.
C323	Clancy, R. T. (SSI, Boulder) Sandor, B. (High Altitude Obs)	Mars and Venus temperature and water studies.
C324	Crosthwaite, L. (UCLA) Turner, J. (UCLA)	Large scale CO mapping of NGC 2841.
D197	Dickens, J. (JPL) Irvine, W. (Massachusetts) Liu, S. (Massachusetts) Ohishi, M. (NAO, Japan) Ikeda, M. (NAO, Japan) Hjalmarson, Å. (Chalmers, Onsala) Nummelin, A. (Chalmers, Onsala) Bergman, P. (Chalmers, Onsala)	Search for furan and cyclopropenone in molecular cloud cores.
D198	Dickens, J. (JPL) Nummelin, A. (Chalmers, Onsala) Hjalmarson, Å. (Chalmers, Onsala) Bergman, P. (Chalmers, Onsala) Ohishi, M. (NAO, Japan) Ikeda, M. (NAO, Japan) Irvine, W. (Massachusetts) Liu, S. (Massachusetts) Saito, S. (Inst. for Molecular Science)	Search for vinyl alcohol (CH_2CHOH) in molecular clouds.
D199	Doeleman, S. (Haystack) Phillips, R. (Haystack) 1 mm λ VLBI Group	Test of 1 mm λ-VLBI capabilities on a SW US array.

No.	Observer(s)	Programs
F137	Fong, D. (Illinois) Meixner, M. (Illinois) Sutton, E. (Illinois) Welch, W. J. (UC, Berkeley)	Imaging the history of mass loss of evolved stars.
G373	Gensheimer, P. (Arizona) Ziurys, L. (Arizona)	Search for SiC_2 in Sgr B2.
H334	Helfer, T. Thornley, M. Regan, M. (DTM/Carnegie) Sheth, K. (Maryland) Vogel, S. (Maryland) Harris, A. (Maryland) Wong, T. (UC, Berkeley) Blitz, L. (UC, Berkeley) Bock, D. (UC, Berkeley)	Update: zero-spacing data for BIMA survey of nearby galaxies.
H336	Hunter, T. (CfA) Zhang, Q. (CfA) Sridharan, T. (CfA) Molinari, S. (IPAC) Cesaroni, R. (Arcetri) Palla, F. (Arcetri) Brand, J. (Bologna)	Search for outflows from high mass protostellar candidates.
I21	Ikeda, M. (Tokyo U.) Hiroto, T. (Tokyo U.) Yamamoto, S. (Tokyo U.)	Study of variation of isotope abundances in the Taurus molecular complex.
K361	Kuan, Y-J. (ASIAA, Taiwan) Snyder, L. (Illinois) Charnley, S. (NASA/Ames) Wilson, T. (MPIR, Bonn) Lovas, F. (JILA)	Study of interstellar glycine.
L338	Lee, S-W. (ASIAA, Taiwan) Ohashi, N. (ASIAA, Taiwan) Moriarty-Schieven, G. (JACH) Butner, H. (Arizona)	CS(3-2) observations of starless cores in Taurus.
M421	Magnani, L. (Georgia) La Rosa, T. (Kennesaw State) Shore, S. (Indiana)	A study of turbulence in MBM 40.
M422	Moore, T. (Liverpool JMU) Ridge, N. (Liverpool JMU) Chandler, C. (Cambridge) Collins, C. (Liverpool JMU)	Study of the luminosity correlation for high-mass molecular outflows.

No.	Observer(s)	Programs
M427	Marston, A. (Drake U.) Appleton, P. (Iowa State) Norris, R. (CSIRO) Heisler, C. (Mt. Stromlo) Dopita, M. (Mt. Stromlo)	Study of molecular gas associated with compact objects in low-powered AGNs (COLAs).
S436	Sandor, B. (High Altitude Obs) Clancy, R. T. (SSI, Boulder)	Earth atmosphere studies.
S438	Smith, B. (Colorado) Struck, C. (Iowa State)	Study of molecular gas in bridge/ring galaxy pairs.
S441	Smith, B. (Colorado) Struck, C. (Iowa State)	Study of molecular gas in bridge/ring galaxy pairs.
S442	Strelnitski, V. (Maria Mitchell Obs) Gordon, M. Moringello, S-A. (Vassar College)	Monitoring of MWC 349 in H30α and H35α recombination lines.
S443	Shah, R. (Virginia) Wootten, H. A.	Study of deuteration in galactic protostellar cores.
T379	Turner, B.	A search for NCO to test the chemistry of HNCO detected in translucent clouds.
W412	Lee, C-W. (CfA) Myers, P. (CfA) Plume, R. (CfA)	Mapping of four starless cores with infall asymmetry.
W414	Webster, Z. (UC, Santa Cruz) Welch, W. J. (UC, Berkeley) Drake, F. (UC, Santa Cruz) Mundy, L. (Maryland) Looney, L. (MPIfEP, Garching) Choi, M. (MPIfEP, Garching) Volgenau, N. (Maryland)	A multiresolution, multiwavelength study of the extended dust emission in NGC 1333.
W415	Webster, Z. (UC, Santa Cruz) Welch, W. J. (UC, Berkeley) Drake, F. (UC, Santa Cruz) Mundy, L. (Maryland) Looney, L. (MPIfEP, Garching) Choi, M. (MPIfEP, Garching) Volgenau, N. (Maryland)	Continuum and CO observations of the prestellar regions L183 and L1544.
W416	Williams, J.	Study of the dense gas dynamics in a filament of Class 0 sources along the Orion ridge.

No.	Observer(s)	Programs
Z147	Zhu, M. (Toronto) Bushouse, H. (STScI) Frayer, D. (Toronto) Seaquist, E. (Toronto)	Study of molecular gas in strongly interacting galaxies.
Z160	Ziurys, L. (Arizona) Apponi, A. (CfA) Savage, C (Arizona)	Confirmation of NaC in IRC+10216.
Z164	Ziurys, L. (Arizona) Savage, C. (Arizona)	A search for interstellar/circumstellar $NaNH_2$.

D. VERY LARGE ARRAY OBSERVING PROGRAMS

The first quarter of 1999 was spent in the following configurations: C configuration from January 1 to February 2; DnC configuration from February 2 to March 3; and D configuration from March 3 to March 31.

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

No.	Observer(s)	Program
AA231	Anantharamaiah, K. (Raman Institute) Kassim, N. (NRL) Lazio, T. J. W. (NRL) Goss, W. M. Lang, C. (Cornell)	Possible new filament near the Galactic Center. 20 cm
AA234	Aschwanden, M. (Lockheed) Bastian, T.	Active region anatomy with TRACE, SOHO, YOHKOH, and VLA. 2, 3.6, 6, 20 cm
AA235	Alvarez, H. (Chile) May, J. (Chile)	Mapping Centaurus A at low frequencies. 90 cm
AA237	Arzoumanian, Z. (Cornell) Yusef-Zadeh, F. (Northwestern)	Search for 1720 MHz OH masers towards unidentified EGRET sources. 0.7, 20 cm line
AB875	Bennett, P. (Colorado/JILA) Harper, G. (Colorado/JILA) Brown, A. (Colorado/JILA) Bauer, W. (Wellesley College)	1997/98 Eclipse of VV Cephei. 1.3, 2, 3.6, 6 cm
AB876	Bietenholz, M. (York U.) Frail, D. Hester, J. (Arizona)	Time-variability in the radio structure of the Crab nebula. 6 cm

No.	Observer(s)	Programs
AB881	Brunetti, G. (Bologna) Bondi, M. (Bologna) Dallacasa, D. (Bologna) Fanti, R. (Bologna) Feretti, L. (Bologna)	FR II radiogalaxy 3C219. 6, 20 cm
AB882	Butler, B. Stern, S. (SWRI)	Observations of Pluto/Charon and Triton. 0.7 cm
AB889	Barlow, T. (Caltech) Lonsdale, C. (Caltech) Xu, C. (Caltech) Hacking, P. (Vanguard Research) Shupe, D. (Caltech) Condon, J.	Radio survey of WIRE mid-infrared fields. 20 cm
AB893	Brogan, C. (Kentucky) Troland, T. (Kentucky)	HI Zeeman observations toward W49. 20 cm line
AB894	Brogan, C. (Kentucky) Troland, T. (Kentucky) Roberts, D. (Illinois) Crutcher, R. (Illinois)	VLA H110 Zeeman recombination line observations toward M17. 6 cm line
AB897	Bhatnagar, S. (NCRA, India) Rao, A. (NCRA, India)	Galactic SNR at low frequencies. 90 cm
AB898	Beck, R. (MPIR, Bonn) Shoutenkov, V. (Lebedev) Shukurov, A. (Newcastle) Sokoloff, D. (Moscow/SSAI)	Magnetic fields in barred galaxies. 6 cm
AB899	Bregman, J. (Michigan) Wakkar, B. (Wisconsin) Miller, E. (Michigan)	High velocity cloud complexes in Milky Way type galaxies. 20 cm line
AB900	Bravo-Alfaro, H. (Guanajuato U.) Brinks, E. (Guanajuato U.) Andernach, H. (Guanajuato U.)	Dwarf galaxies in clusters. 20 cm line
AB901	Blomme, R. (Royal Obs, Belgium) Prinja, R. (U. College London) Runacres, M. (Royal Obs, Belgium)	Radio monitoring of hot-star winds. 3.6, 6 cm
AB902	Browne, I. (Manchester) Wilkinson, P. (Manchester) Garrington, S. (Manchester) Wrobel, J. Dennett-Thorpe, J. (Lisbon)	Selection of high frequency phase calibration sources. 0.7, 2 cm

No.	Observer(s)	Programs
AB904	Brown, A. (Colorado/JILA) Harper, G. (Colorado/JILA) Carpenter, K. (NASA/GSFC) Robinson, R. (Catholic U.)	Mass loss from the K supergiant λVel. 2, 3.6, 6 cm
AB907	Beck, R. (MPIR, Bonn) Kruegel, E. (MPIR, Bonn)	An IR variable compact HII region in M17. 1.3 cm
AC308	Condon, J. Cotton, W. Perley, R.	All sky survey. 20 cm
AC515	Coil, A. (CfA) Ho, P. (CfA)	The circumnuclear disk in ammonia emission. 1.3 cm line
AC517	Ciliegi, P. (Bologna) Zamorani, G. (Bologna) Gruppioni, C. (Imperial College) Giacconi, R. (ESO) Hasinger, G. (API, Potsdam) Schmidt, M. (Caltech) Trumper, J. (MPIfEP, Garching)	Deep VLA survey in Lockman Hole. 6 cm
AC521	Cote, S. (DAO) Broadhurst, T. (UC, Berkeley) Carignan, C. (Montreal) Freeman, K. (Mt. Stromlo) Wyse, R. (Johns Hopkins)	Search for HI emission associated with very nearby Ly absorbers. 20 cm line
AC523	Costa, M. (Tasmania) Ellingsen, S. (Tasmania) Beasley, A.	Positions of and continuum emission near Class I methanol masers. 0.7 cm
AC525	Carilli, C. Menten, K. (MPIR, Bonn)	CO emission from a z = 4 source. 0.7, 1.3, 3.6 cm line
AD421	Dahlem, M. (ESTEC) Ehle, M. (MPIfEP, Garching) Haynes, R. (CSIRO) English, J. (STScI) Lisenfeld, U. (IRAM)	Search for radio halos in late-type spiral galaxies. 20 cm
AD423	DiFrancesco, J. (CfA) Myers, P. (CfA) Lee, C. (CfA) Wilner, D. (CfA) Williams, J. (CfA)	A short search for youngest protostellar sources. 3.6 cm

No.	Observer(s)	Programs
AE124	Eyres, S. (Keele) Bode, M. (Keele) Davis, R. (Keele) Evans, A. (Keele) Ivison, R. (Keele) O'Brien, T. (Keele)	Target of opportunity, and monitoring observations of recurrent and classical novae. 1.3, 2, 3.5, 6, 20 cm
AE125	Edge, A. (Durham) Allen, S. (Cambridge) Crawford, C. (Cambridge) Fabian, A. (Cambridge)	Radio properties of central galaxies in x-ray selected clusters. 2, 3.6, 6, 20 cm
AE126	Estalella, R. (Barcelona) Beltran, M. (Barcelona) Ho, P. (CfA) Anglada, G. (IAA, Andalucia) Sepulveda, I. (Barcelona)	The double H2 bipolar jet in L1634. 0.7 cm
AF328	Feretti, L. (Bologna) Giovannini, G. (Bologna) Arnaud, M. (CNRS, France) Rusco-Femiano, R. (IAS, Frascati)	Cluster-wide radio halo in A2163. 20 cm
AF349	Feretti, L. (Bologna) Giovannini, G. (Bologna) Tordi, M. (Bologna)	Observations of new radio halos and relics from NVSS. 20 cm
AF350	Falcke, H. (MPIR, Bonn) Lobanov, A. (MPIR, Bonn) Wright, M. (UC, Berkeley) Bower, G. (MPIR, Bonn) Aller, M. (Michigan) Terasranta, H. (Helsinki) Patnaik, A. (MPIR, Bonn)	Monitoring extremely variable spiral III Zw 2. 1.3, 2, 3.6, 6, 20, 90 cm
AF354	Furuya, R. (Nobeyama Obs) Wootten, H. A. Claussen, M. Saito, M. (CfA) Kitamura, Y. (ISAS, Japan) Marvel, K. (Caltech) Kawabe, R. (NAO, Japan)	VLA multi-epoch H_20 maser survey toward Class 0/1 protostars. 1.3 cm line
AF356	Frail, D. Kulkarni, S. (Caltech)	Search for faint nebulae powered by magnestars. 20, 90 cm

No.	Observer(s)	Programs
AF358	Fomalont, E. Goss, W. M. Brisken, W. (Princeton) Chatterjee, S. (Cornell) Cordes, J. (Cornell) Kaplan, D. (Cornell)	Checking on inbeam sources for VLBA pulsar calibrators. 6 cm
AG544	Gaensler, B. (MIT) Frail, D. Stappers, B. (Amsterdam) Moffett, D. (Tasmania) Johnston, S. (Sydney)	Survey for pulsar wind nebulae using pulsar-gating. 20 cm
AG556	Grosso, N. (CNRS, France) Feigelson, E. (Penn State) Montmerle, T. (CNRS, France) Tsuboi, Y. (Kyoto) Palazzi, E. (Bologna)	VLA-SAX coordinated observations of the flaring protostar YLW 15. 3.6 cm
AG557	Gaensler, B. (MIT) Gotthelf, E. (Columbia) Vasisht, G. (JPL)	Environment of anomalous x-ray pulsar AX J18448-0258. 3.6, 6 cm
AG561	Gaidos, E. (JPL) Gudel, M. (SFIT, ETH) Blake, G. (Caltech)	Two young nearby solar analogs. 3.6 cm
AG562	Gibb, A. (Leeds U.)	High mass protostar candidate L379-IRS1. 2, 3.6, 6 cm
AG565	van Gorkom, J. (Columbia) Bravo-Alfaro, H. (Guanajuato U.)	E+A galaxies in Coma. 20 cm line
AG566	Golub, L. (CfA) DeLuca, E. (CfA) Bastian, T. Aschwanden, M. (Lockheed)	VLA/TRACE observations of solar active regions. 2, 3.6, 6, 20 cm
AH628	Hjellming, R. Mioduszewski, A. Rupen, M.	Radio and x-ray activity in galactic black holes. 4, 9, 13, 21, 24 cm
AH635	Hong, X. (Shanghai Obs) Jiang, D. (Shanghai Obs) Shen, Z. (SA/IAA, Taiwan) Venturi, T. (Bologna)	Large scale structure in gamma-ray quasars. 6 cm
AH660	Hankins, T. (NMIMT) Weatherall, J. (NMIMT) Kern, J. (NMIMT) Moffett, D. (Tasmania)	Bandwidth of the emission mechanism of Crab pulsar giant pulses. 2, 3.6, 6, 20, 90 cm

No.	Observer(s)	Programs
AH664	Hoffman, G. (Lafayette College) Soares, D. (UFSM, Brazil) Salpeter, E. (Cornell)	Tidally interacting pair UGC 4703A/B. 20 cm line
AH665	Hoffman, G. (Lafayette College) Soares, D. (UFSM, Brazil) Salpeter, E. (Cornell)	Tidal interactions in the NGC 2782 group. 20 cm line
AH667	Hardcastle, M. (Bristol, UK)	Wide angle tail galaxy 3C 130. 2 cm
AH668	Huttemeister, S. (Bonn U.) Aalto, S. (Chalmers, Onsala)	HI in the UGC 2855/UGC 2866 galaxy system. 20 cm line
AH669	Hjellming, R. Rupen, M. Mioduszewski, A.	Galactic black hole x-ray transients. 1.3, 2, 3.6, 6, 20 cm
AH671	Henning, P. (New Mexico) Staveley-Smith, L. (CSIRO)	Galaxies from Parkes multibeam zone of avoidance survey. 20 cm line
AH673	Helbig, P. (Manchester) Browne, I. (Manchester) Jackson, N. (Manchester) Wilkinson, P. (Manchester) Xanthopoulos, E. (Manchester) Blandford, R. (Caltech) Fassnacht, C. de Bruyn, A. G. (NFRA) Koopmans, L. (Groningen/Kapteyn) Marlow, D. (Pennsylvania) Myers, S. (Pennsylvania) Rusin, D. (Pennsylvania)	Study of the source population that forms CLASS gravitational lenses. 6 cm
AH675	Hofner, P. (NAIC) Kurtz, S. (Mexico/UNAM) Cordero, Y. (Puerto Rico)	Search for methanol masers in hot molecular cores. 0.7, 1.3 cm line
AH676	Hameed, S. (New Mexico State) Young, L. (New Mexico State)	HI imaging of six early-type spirals with active star formation. 20 cm line
AH677	Han, J. (Beijing Obs) Yin, Q. Condon, J. Menten, K. (MPIR, Bonn)	Magnetic structure in the galactic halo through Faraday rotation. 20 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)	Programs
AK468	Koerner, D. (JPL) Millares, R. (Pennsylvania) Chandler, C. (Cambridge) Sargent, A. (Caltech)	Radial structure of circumstellar disks. 0.7, 1.3, 2, 3.6 cm
AK471	Kornreich, D. (Cornell) Haynes, M. (Cornell) van Zee, L. Lovelace, R. (Cornell)	Kinematic studies of optically asymmetric disk galaxies. 20 cm line
AK472	Kulkarni. S. (Caltech) Frail, D.	Radio counterpart to SGR 1900+14. 20, 90 cm
AK475	Keto, E. (CfA) Ho, P. (CfA)	Disk or envelopes around Herbig Ae/Be stars. 0.7 cm
AK485	Kulkarni, S. (Caltech) Frail, D. Bloom, J. (Caltech) Djorgovski, S. (Caltech) Harrison, F. (Caltech)	Radio afterglows of gamma-ray bursts. 2, 3.6, 6, 20 cm
AK486	Kurtz, S. (Mexico/UNAM)	Massive star formation in W75N. 1.3 cm line
AL471	Lo, K. (SA/IAA, Taiwan) Young, L. (New Mexico State) van Zee, L.	Phase structure of the HI medium and its effect on star formation. 20 cm line
AL472	Lang, C. (Cornell) Morris, M. (UCLA) Goss, W. M.	H92 observations of unusual arched filaments. 3.6 cm line
AL475	Lucas, P. (Oxford) Blundell, K. (Oxford) Roche, P. (Oxford)	Search for a radio counterpart to HH30. 3.6 cm
AL478	Lim, J. (SA/IAA, Taiwan) Nung, S. (NCU, Taiwan) White, S. (Maryland)	Ammonia of the molecular core around UC HII region G45.07+0.13. 1.3 cm line
AL479	La Rosa, T. (Kenesaw State) Kassim, N. (NRL) Anantharamaiah, K. (Raman Institute) Lazio, T. J. W. (NRL) Lang, C. (Cornell)	New candidate galactic radio sources near the Galactic Center. 6, 20 cm
AL481	Lefloch, B. (IAA, Andalucia) Cernicharo, J. (IAA, Andalucia) Anglada, G. (IAA, Andalucia)	Ammonia observation of the quiescent SiO emission region in NGC 1333. 1.3 cm line

No.	Observer(s)	Programs
AL486	Lang, C. (Cornell) Anantharamaiah, K. (Raman Institute) Kassim, N. (NRL) Lazio, T. J. W. (NRL)	Polarization of the recently discovered filament G359.83+0.48. 3.6 cm
AM610	Molinari, S. (IPAC) Rodriguez, L. (Mexico/UNAM) Zhang, Q. (CfA)	Continuum survey in massive protostars. 2, 3.6 cm
AM613	Martin-Pintado, J. (Yebes Obs) Gaume, R. (USNO) de Vicente, P. (Yebes Obs) Rodriguez, N. (Yebes Obs) Wilson, T. (MPIR, Bonn) Huttemeister, S. (Bonn U.)	High excitation ammonia in Sgr B2. 1.3 cm line
AM615	Malhotra, S. (IPAC) Rupen, M. Helou, G. (IPAC)	HI in the elliptical galaxy NGC 1155. 20 cm line
AM616	McHardy, I. (Southampton) Cordova, F. (UC, Santa Barbara)	Radio spectral indices of sources in a deep x-ray survey. 6 cm
AN080	Nordgren, T. (USNO) Cote, S. (DAO)	Probing the dark halo of NGC 3800A at very large radii. 20 cm line
AN081	Mohan, R. N. (Raman Institute) Anantharamaiah, K. (Raman Institute) Goss, W. M.	Radio recombination lines from starburst galaxies. 3.6 cm line
AO140	O'Neil, K. (Oregon) McGaugh, S. (Maryland) Verheijen, M.	HI distribution and kinematics in UGC 12695. 20 cm
AP379	Pisano, D. (Wisconsin) Wilcots, E. (Wisconsin)	Extended HI and the formation of isolated galaxies. 20 cm
AR402	Rudnick, L. (Minnesota) Treichel, K. (Minnesota) Katz-Stone, D. (USNA) Giovannini, G. (Bologna)	Non-relativistic sheaths around extragalactic jets. 3.6, 6, 20 cm
AR403	Rivers, A. (New Mexico) Henning, T. (New Mexico) Kraan-Korteweg, R. (Guanajuato U.)	Galaxies discovered by the Dwingeloo Obscured Galaxies Survey. 20 cm line
AR406	Rosati, P. (MPIfEP, Garching) Shaver, P. (ESO) Kellermann, K. Fomalont, E.	Survey of the AXAF Deep Field. 6 cm

No.	Observer(s)	Programs
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
AS632	Sahu, K. (STScI) Baum, S. (STScI) Kaiser, M. (NASA/GSFC) O'Dea, C. (STScI) Shaw, R. (STScI)	The most luminous x-ray cluster RXJ 1247.5-1145. 6 cm
AS644	Scuderi, S. (Bologna) Stanghellini, C. (Bologna) Panagia, N. (STScI)	Survey of radio emission from O and B supergiants. 2, 3.6, 6 cm
AS649	Sancisi, R. (Bologna) Oosterloo, T. (Milano Obs) van Moorsel, G.	Vertical structure of the HI disk of the spiral galaxy NGC 2403. 20 cm line
AS653	Saito, M. (CfA) Kawabe, R. (NAO, Japan)	Continuum emission toward low-mass protostars in Taurus. 3.6 cm
AT211	Taylor, G. Fabian, A. (Cambridge)	X-ray to radio correlations in cooling flow clusters. 6, 20 cm
AT219	Testi, L. (Caltech) Hofner, P. (NAIC) Kurtz, S. (Mexico/UNAM) Rupen, M.	Deep radio continuum imaging of G9.62+0.19 F hot core. 0.7, 1.3 cm
AT224	Tahmoush, D. (MIT) Hewitt, J. (MIT)	Survey of gravitational lenses at high frequencies. 0.7, 2, 3.6 cm
AU072	Uson, J. van Gorkom, J. (Columbia) Shambrook, A. (UC, Santa Cruz)	HI mapping of Abell 2029. 20 cm line
AV237	Verheijen, M. Tully, B. (Hawaii) Trentham, N. (Cambridge) Zwaan, M. (Groningen/Kapteyn)	The HI mass function in Ursa Major. 20 cm
AW362	White, S. (Maryland)	The stellar activity cycle on active stars. 3.6, 6, 20 cm
AW498	Wilcots, E. (Wisconsin) Bershady, M. (Wisconsin) Jangren, A. (Penn State)	HI observations of a sample of compact, luminous star forming galaxies. 20 cm line

No.	Observer(s)	Programs
AW500	Williams, B. (Delaware). Verdes-Montenegro, L. (IAA, Andalucia) Yun, M.	HI synthesis of three compact groups of galaxies. 20 cm line
AW509	Wilner, D. (CfA) Downes, D. (IRAM) Ho, P. (CfA)	Molecular gas in APM 08279+5255 at z=3.9. 1.3, 6 cm line
AW513	Willson, R. (Tufts) Lang, K. (Tufts)	VLA/TRACE observations of blinkers and microflares on the sun. 2, 3.6 cm
AY099	Yusef-Zadeh, F. (Northwestern) Wardle, M. (Sydney) Roberts, D. (Illinois)	Continuum study of IRS 7 and OH 359.88-0.08. 0.7 cm
AY102	Yun, M. Hibbard, J.	Giant radio plumes around IR luminous galaxies. 6 cm
AZ097	van Zee, L.	Gas distributions and kinematics of isolated irregular galaxies. 20 cm
AZ107	van Zee, L. Salzer, J. (Wesleyan U.) Skillman, E. (Minnesota)	Kinematic constraints on BCD to dE evolutionary scenarios. 20 cm line
AZ108	van Zee, L. Haynes, M. (Cornell)	HI in five nearby dwarf irregulars, and relation to chemical enrichment. 20 cm line
AZ111	Zwaan, M. (Groningen/Kapteyn) van Dokkum, P. (Leiden) Verheijen, M. Briggs, F. (Groningen/Kapteyn) Franx, M. (Leiden)	HI imaging of galaxy cluster ABell 1689 at z=0.181. 20 cm line
AZ114	Zhang, Q. (CfA) Hunter, T. (CfA) Sridharan, T. (CfA) Ho, P. (CfA)	Ammonia near four high mass young stars. 1.3 cm line
AZ118	Zabludoff, A. (UC, Santa Cruz) Mulchaey, J. (Mt. Wilson) Wilcots, E. (Wisconsin) Williams, B. (Delaware) van Gorkom, J. (Columbia)	The HI content of loose groups of galaxies. 20 cm line
BD046	Diamond, P. (Manchester) Kemball, A. Boboltz, D. (USNO)	Monitoring SiO masers through a cycle of Mira TX Cam. 0.7 cm

No.	Observer(s)	Programs
BG086	Gomez, J-L. (ESA, Spain) Marscher, A. (Boston) Alberdi, A. (IAA, Andalucia) Gabuzda, D. (Lebedev)	Mapping the twisted parsec-scale structure of BL Lac object 0735+178. 1.3, 2 cm

E. VERY LONG BASELINE ARRAY OBSERVING PROGRAMS

No.	Observer(s)	Program
BA029	Alberdi, A. (ESA, Spain) Gomez, J-L. (ESA, Spain) Marcaide, J. (Valencia) Perez-Torres, M. (Valencia) Marscher, A. (Boston)	Superluminal source 4C39.25. 0.7, 1.3, 2 cm
BB099	Blundell, K. (Oxford) Willott, C. (Oxford) Rawlings, S. (Oxford) Beasley, A.	Core structure and spectra of a complete sample of radio sources. 3.6 cm
BB101	Bower, G. Backer, D. (UC, Berkeley)	Gamma-ray blazar NRAO 530. 0.7, 1.3, 3.6 cm
BB102	Beasley, A. Herrnstein, J.	VLBA monitoring of WR140. 2, 3.6, 6, 18 cm
BB103	Blundell, K. (Oxford) Close, L. (Oxford) Leahy, P. (Manchester)	Low frequency study of hotspots in powerful radio sources. 90 cm
BB105	Blundell, K. (Oxford) Beasley, A.	Motion in a radio quiet quasar. 3.6 cm
BC084	Cotton, W. Saslaw, W. (Virginia)	Search for gravitational lensing of 3C 455B by stellar object. 3.6 cm
BC087	Carilli, C. Menten, K. (MPIR, Bonn) Reid, M. (CfA)	Imaging the HC_3N absorption in 1830-211. 1.3, 2 cm

No.	Observer(s)	Programs
BC091	Clark, T. (NASA/GSFC) Ma, C. (NASA/GSFC) Johnston, K. (USNO) Fey, A. (USNO) Gaume, R. (USNO) Eubanks, M. (USNO) Gordon, D. (NASA/GSFC) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) Shaffer, D. (Radio Metrics) Boboltz, D. (USNO) Kingham, K. (USNO) Fomalont, E. Walker, R. C.	VLBA geodesy/astrometry observations for 1999. 3.6 cm
BC092	Coles, W. (UC, San Diego)	Measurements of solar wind speed near the sun using IPS. 2, 3.6, 6 cm
BD046	Diamond, P. (Manchester) Kemball, A. Boboltz, D. (USNO)	Monitoring SiO masers through a cycle of Mira TX Cam. 0.7 cm
BD057	Diamond, P. (Manchester) Kemball, A.	Continuation of the VLBA monitoring of SiO masers around TX Cam. 0.7 cm
BD059	Desai, K. Lestrade, J-F. (Paris Obs) Fey, A. (USNO) Brisken, W. (Princeton) Chatterjee, S. (Cornell) Lazio, T. J. W. (NRL)	Extreme scattering event towards PSR J1643-12. 18 cm
BE017	Engels, D. (Hamburg U.) Winnberg, A. (Chalmers, Onsala) Yie, J. (Chalmers, Onsala)	Structure of H_2O masers in OH/IR stars. 1.3 cm
BF043	Fey, A. (USNO) Gaume, R. (USNO) Eubanks, M. (USNO) Johnston, K. (USNO) Ma, C. (NASA/GSFC)	Southern hemisphere astrometry for the celestial reference frame. 3.6 cm
BF045	Fey, A. (USNO) Gaume, R. (USNO)	Gravitational lens candidate PKS 1445-161. 3.6, 6, 18 cm
BF052	Faison, M. (Wisconsin) Goss, W. M. Marscher, A. (Boston)	Imaging small scale structure in galactic molecular gas. 6 cm

No.	Observer(s)	Programs
BG073	Gomez, J-L. (ESA, Spain) Marscher, A. (Boston) Alberdi, A. (ESA, Spain)	3C 120 rapid variations. 0.7, 1.3 cm
BG077	Gurvits, L. (NFRA) Kellermann, K. Fomalont, E.	Resolution matching survey of VSOP survey sources. 2 cm
BG084	Guirado, J. (Valencia) Marcaide, J. (Valencia) Perez-Torres, M. (Valencia) Ros, E. (MPIR, Bonn)	Millimeter VLBI astrometry: absolute kinematics of 1928+738. 0.7 cm
BG085	Gallimore, J. Baum, S. (STScI) Kukula, M. (STScI) O'Dea, C. (STScI) Pedlar, A. (Manchester) Thean, A. (Manchester)	Searching for mini-jets in Seyfert galaxies. 4, 13 cm
BG086	Gomez, J-L. (ESA, Spain) Marscher, A. (Boston) Alberdi, A. (ESA, Spain) Gabuzda, D. (Lebedev)	BL Lac object 0735+178. 0.7, 1.3, 2 cm
BG087	Gaume, R. (USNO) Boboltz, D. (USNO) Fey, A. (USNO) Johnston, K. (USNO) Hajian, A. (USNO)	Astrometric observations of two radio stars with the VLBA and NPOI. 3.6 cm
BK053	Krichbaum, T. (MPIR, Bonn) Lobanov, A. (MPIR, Bonn) Britzen, S. (NFRA) Witzel, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	Broad band variability and jet bending in PKS 0528+134. 0.7, 1.3, 3.6 cm
BK056	Kemball, A. Patnaik, A. (MPIR, Bonn) Porcas, R. (MPIR, Bonn)	Faraday rotation in the gravitational lens system B0218+35.7. 0.7, 1.3, 2, 3.6 cm
BK066	Koratkar, A. (STScI) Antonucci, R. (UC, Santa Barbara) Gallimore, J.	Testing the accretion disk model: radio jets in UV polarized QSOs. 4, 13 cm
BJ028	Jones, D. (JPL)	Proper motion jet in NGC 4261. 4 cm

No.	Observer(s)	Programs
BL058	Lonsdale, C. (Haystack) Diamond, P. (Manchester) Smith, H. (UC, San Diego) Lonsdale, C. (Caltech)	Radio supernovae in OH megamaser galaxy Arp220. 3.6, 6, 18 cm
BL073	Lister, M. (JPL)	Low optical polarization blazars. 0.7, 1.3 cm
BL074	Lazio, T. J. W. (NRL) Cordes, J. (Cornell)	G359.28-0.92, the Mouse. 6 cm
BL077	Lister, M. (JPL) Preston, R. (JPL) Tingay, S. (JPL) Piner, B. (JPL)	Pearson-Readhead sources at 43 GHz. 0.7 cm
BL078	Lobanov, A. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	New flare in 3C345. 0.7, 1.3, 2 cm
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. (JPL) Forster, J. (UC, Berkeley)	Monitoring bright AGNs. 0.7 cm
BM104	Minier, V. (Chalmers, Onsala) Booth, R. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala) Phillips, C. (NFRA)	12.2 GHz methanol masers in star forming regions. 2 cm
BM106	Mutel, R. (Iowa) Molnar, L. (Iowa)	Astrometric mapping of HR 1099: test of polar emission model. 3.6 cm
BM108	Moellenbrock, G. (ISAS, Japan) Roberts, D. (Brandeis) Wardle, J. (Brandeis)	Polarization monitoring of gamma-ray blazars. 0.7, 1.3, 2, 3.6 cm
BM109	Molnar, L. (Iowa) Mutel, R. (Iowa)	Coordinated VLBA and x-ray observations of Algol. 3.6 cm
BM110	Mutel, R. (Iowa) Denn, G. (Iowa)	Monitoring BL Lac. 0.7, 1.3, 2 cm

No.	Observer(s)	Programs
BM112	Moran, J. (CfA) Greenhill, L. (CfA) Herrnstein, J. Diamond, P. (Manchester) Bragg, A. (CfA) Trotter, A. (CfA) Henkel, C. (MPIR, Bonn)	Next generation study of NGC 4258 accretion disk physics. 1.3 cm
BM116	Marscher, A. (Boston) Cawthorne, T. (Lancashire) Gear, W. (Cambridge) Stevens, J. (Cambridge) Marchenko, S. (St. Petersburg) Lister, M. (JPL) Gabuzda, D. (Lebedev) Yurchenko, A. (St. Petersburg) Forster, J. (UC, Berkeley)	Monitoring millimeter-bright AGN. 0.7 cm
BP047	Preuss, E. (MPIR, Bonn) Kellermann, K. Alef, W. (MPIR, Bonn)	Third epoch VLBI of FR II radio galaxy 3C390.3. 0.7, 1.3, 6 cm
BP048	Perlman, E. (STScI) Carilli, C. Minter, A. Langston, G. Ghigo, F. Stocke, J. (Colorado/JILA) Conway, J. (Chalmers, Onsala)	Monitoring PKS 1413+135. 0.7, 1.3, 2, 3.6 cm
BP050	Peck, A. (NMIMT) Rupen, M. Mioduszewski, A.	HI absorption towards SS 433. 18 cm
BR057	Roberts, D. (Brandeis) Moellenbrock, G. (ISAS, Japan) Wardle, J. (Brandeis) Gabuzda, D. (Lebedev) Brown, L. (Connecticut)	Four 3C quasars with VSOP observations. 0.7, 1.3, 2, 3.6 cm
BR061	Ramachandran, R (Amsterdam). Galama, T. (Amsterdam) Stappers, B. (Amsterdam) Strom, R. (Amsterdam)	Anisotropic scattering in the ISM. 20 cm

No.	Observer(s)	Programs
BR063	Ratner, M. (CfA) Bartel, N. (York U.) Bietenholz, M. (York U.) Lebach, D. (CfA) Lestrade, J-F. (Paris Obs) Ranson, R. (York U.) Shapiro, I. (CfA)	Astrometry of HR 8703 in 1999 for the gravity probe B mission. 3.6, 6 cm
BT043	Tingay, S. (JPL) Jauncey, D. (JPL) Preston, R. (CSIRO) Reynolds, J. (CSIRO) Tzioumis, A. (CSIRO)	Observations of the nearby FR-II radio galaxy, Pictor A. 4 cm
BT044	Taylor, G. Beasley, A. Frail, D. Kulkarni, S. (Caltech)	Observations of gamma-ray bursters. 6 cm
BU012	Ulvestad, J. Vestrand, W. (New Hampshire) Stacy, J. (New Hampshire) Biretta, J. (STScI)	Flaring CGRO Blazar 2255-282. 0.7, 1.3, 2 cm
BU016	Ulvestad, J.	Radio quiet quasars. 6 cm
BV027	Venturi, T. (Bologna) Dallacasa, D. (Bologna) Bondi, M. (Bologna) Stanghellini, C. (Bologna)	Polarimetric monitoring of blazars. 1.3, 3.6 cm
BV030	Venturi, T. (Bologna) Morganti, R. (Bologna) Spagnesi, S. (Bologna)	Low luminosity radio galaxy 3C 317. 3.6, 6, 18 cm
BV032	Vermeulen, R. (NFRA) Taylor, G.	Neutral hydrogen in CSO 0831+557. 18 cm
GB029	Bartel, N. (York U.) Bietenholz, M. (York U.)	VLBI imaging of Supernova 1986J in NGC 891. 6 cm
GJ009	Junor, W. (New Mexico) Biretta, J. (STScI) Livio, M. (STScI)	Structure on light week scales in the nucleus of 3C274. 0.7 cm
GP021	Peck, A. (NMIMT) Taylor, G.	HI in absorption toward 1946+708. 18 cm

No.	Observer(s)	Programs
GS014	Snellen, I. (Cambridge) Schilizzi, R. (NFRA) de Bruyn, A. G. (NFRA) Miley, G. (Leiden) van Langevelde, H. (NFRA)	Self similar evolution of young sources. 18 cm
V008	Linfield, R. (JPL)	Brightness temperature measurements of two very compact sources. 6, 18 cm
V022	Wilkinson, P. (Manchester)	Investigation of three gravitational millilens candidates. 6 cm
V026	Walker, R. C.	3C120 structure from 0.1 to 250 pc. 6, 18 cm
V030	Preston, R. (JPL)	Pearson-Readhead survey from space. 6 cm
V047	Gurvits, L. (NFRA)	Structure of extremely high redshift quasars. 6, 18 cm
V050	Kollgaard, R. (Fermilab)	Subparsec scale structure of x-ray selected BL Lacertae objects. 6 cm
V057	Gabuzda, D. (Lebedev)	VSOP polarization monitoring of 4 BL lacertae objects.
V080	Xu, W. (JPL)	Observation of selected gamma-ray blazars: 0917+449. 6 cm
V085	Schilizzi, R. (NFRA)	GPS galaxies and quasars: 0552+398. 6 cm
V129	Inoue, M. (NAO, Japan)	Obscuring system in 3C84. 6 cm
VT741	VSOP Group	Orion maser. 1.3 cm
VT743	VSOP Group	Orion maser. 1.3 cm
VT751	VSOP Group	Test observation. 1.3 cm
W015	Claussen, M. Ulvestad, J. Diamond, P. (Manchester) Braatz, J. (CfA) Wilson, A. (Maryland) Henkel, C. (MPIR, Bonn)	Low frequency structure of the NGC 1052 jet. 18 cm
W016	Gabuzda, D. (Lebedev) Pushkarev, A. (Lebedev) Kochanev, P. (Moscow/SSAI) Cawthorne, T. (Lancashire)	Polarization of BL Lac objects. 6 cm

No.	Observer(s)	Programs
W018	Snellen, I. (Cambridge) Tschager, W. (Leiden) Schilizzi, R. (NFRA) de Bruyn, A. G. (NFRA) Miley, G. (Leiden) Rottgering, H. (Leiden) van Langevelde, H. (NFRA) Fanti, C. (Bologna) Fanti, R. (Bologna)	GPS galaxies and quasars. 18 cm
W022	Reid, M. (CfA) Greenhill, L. (CfA) Argon, A. (CfA) Moran, J. (CfA)	Nuclear jet in M87. 18 cm
W030	Tingay, S. (JPL) Jauncey, D. (CSIRO) Reynolds, J. (CSIRO) Tzioumis, A. (CSIRO) King, E. (CSIRO) Edwards, P. (ISAS, Japan) Lovell, J. (ISAS, Japan) Hirabayashi, H. (ISAS, Japan) McCulloch, P. (Tasmania)	Gamma-ray loud and quiet AGN. 6cm
W032	Romney, J. Alef, W. (MPIR, Bonn) Backer, D. (UC, Berkeley) Benson, J. Dhawan, V. Kellermann, K. Readhead, A. (Caltech) Vermeulen, R. (NFRA) Walker, R. C.	Core of 3C84. 18 cm
W040	Junor, W. (New Mexico) Biretta, J. (STScI)	Proper motion in the Vir A jet. 6 cm
W044	Krichbaum, T. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Kraus, A. (MPIR, Bonn) Lobanov, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	Intraday variables: J0808+49. 6 cm
W056	Bartel, N. (York U.) Bietenholz, M. (York U.)	Structural variability in the core-jet of the galaxy M81. 6 cm

No.	Observer(s)	Programs
W059	Kedziora-Chudczer, L. (Sydney) Jauncey, D. (CSIRO) Reynolds, J. (CSIRO) Tzioumis, A. (CSIRO) Wieringa, M. (CSIRO) Nicolson, G. (HartRAO) Quick, J. (HartRAO) Walker, M. (Sydney) McCulloch, P. (Tasmania)	Complete sample of intra-day variables. 6 cm
W066	Lobanov, A. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Kraus, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	0836+710 jet kinematics. 6, 18 cm
W068	Zensus, J. A. (MPIR, Bonn) Carrara, E. (Sao Paulo) Abraham, Z. (Sao Paulo) Lobanov, A. (MPIR, Bonn) Unwin, S. (JPL)	Quasar 3C 273. 6 cm
W079	Meier, D. (JPL) Tingay, S. (JPL) Preston, R. (JPL) Murphy, D. (JPL) Jones, D. (JPL) Fujisawa, K. (NAO, Japan) Hirabayashi, H. (ISAS, Japan) Kobayashi, H. (ISAS, Japan) Edwards, P. (ISAS, Japan)	Centaurus A. 6, 18 cm
W088	Roberts, D. (Illinois) Moellenbrock, G. (ISAS, Japan) Wardle, J. (Brandeis) Gabuzda, D. (Lebedev) Brown, L. (Connecticut)	Polarization monitoring of four bright quasars at 5 and 1.6 GHz. 18 cm
W094	Hirabayashi, H. (ISAS, Japan) Wehrle, A. (JPL) Unwin, S. (JPL) Makino, F. (ISAS, Japan) Kii, T. (ISAS, Japan) Kobayashi, H. (ISAS, Japan) Edwards, P. (ISAS, Japan) Okayasu, R. (ISAS, Japan) Valtaoja, E. (Turku)	3C279. 6 cm

F. SCIENCE HIGHLIGHTS

Socorro

VLBA Shows Motions in Star's Outer Atmosphere - A series of VLBA observations of the red supergiant TX Cam have shown proper motions of SiO maser spots in the star's outer envelope. This is the first direct observation of gas motions surrounding a star other than the Sun. The project involves regular observations through a full 557-day pulsation period of this star. Already, the results have contradicted expectations, showing that expansion of the envelope continued past the point in the cycle where models predicted contraction to begin.

Investigators: P. Diamond (Manchester); and A. Kemball.

Spectacular New Structure Revealed in Radio Galaxy - Low-frequency (P-band) VLA observations of M87 showed large, bubble-like, radio-emitting lobes, apparently powered by the galaxy's central engine. These lobes are within the x-ray emitting region of the galaxy. The new observations indicate that the energy pumped into this region by the central engine exceeds that being lost as x-rays. This provides an alternative explanation for the x-ray emission that previously was attributed to a cooling flow.

Investigators: F. Owen; J. Eilek (NM Tech); and M. Kassim (NRL).

VLA Reveals Gas Flow in Barred Galaxy - Sensitive polarization observations with the VLA have shown that shocked gas in the barred galaxy NGC 1097 is diverted by nearly 90 degrees to flow directly down the bar toward the galaxy's nucleus. The polarization observations showed the magnetic field orientation, which is a tracer of the gas velocity. The results are in general agreement with computer simulations, but show that the shock front where the diversion occurs is closer to the bar's center, not at its edge, as the simulations suggested. In addition, the observed magnetic field near the center of the galaxy indicates that magnetic stress may serve as the mechanism for feeding the central black hole with the amount of material required to account for the observed activity.

Investigators: R. Beck (MPIR, Bonn); M. Ehle (MPIfEP); A. Shukurov (Newcastle); and D. Sokoloff (Moscow State Univ.)

Green Bank

The 140 Foot Galactic Plane HI Survey - The 140 Foot Galactic Plane HI Survey is essentially completed. Jay Lockman and Ed Murphy have used the 140 Foot Telescope to image HI between longitudes of 65 and 185 degrees within 10 degrees of the galactic plane. A major goal of the survey is to provide the zero spacing flux for the Canadian Galactic Plane Survey (CGPS), an aperture synthesis HI survey. Moreover, the 140 Foot Survey will extend beyond the CGPS to provide additional information on extended objects. The Survey will be corrected for stray radiation and is fully sampled at the Nyquist spatial frequency.

Investigators: F. J. Lockman, E. Murphy (Johns Hopkins Univ.)

Tucson

The 12 Meter Telescope continues to produce high-quality science in areas of research which are on the cutting edge of many fields of investigation. The sensitivity, flexibility, and efficiency of the 12 Meter allows investigators to engage in a diverse set of scientific pursuits, which include planetary atmospheres, cometary structure and composition, Galactic structure and star formation, astrochemistry, normal galaxies, and high-redshift galaxies.

Discovery of the Rhomboidal Molecular Ring SiC_3 - The most stable molecule with the elemental formula SiC_3 has been calculated to be the rhomboidal isomer with a transannular bond (Alberts, Grev, & Schaefer 1990; Gomei et al. 1997). It has recently been detected for the first time in the laboratory, and its rotational spectrum measured to high precision in both the centimeter and millimeter-wave bands (McCarthy, Apponi, & Thaddeus, J. Chem Phys, submitted; Apponi et al., ApJ Lett, in press). Observing at the laboratory frequencies, seven transitions of this unusual molecular ring have been detected in the rich molecular envelope of the evolved carbon star IRC+10216 using the 12 Meter Telescope.

IRC+10216 is a source where three silicon-carbon molecules have already been detected: the diatomic radical SiC (Cernicharo et al. 1989, ApJ, 341, L25), the closed-shell ionic ring SiCC (Thaddeus et al. 1984), and the closed-shell linear chain SiC_4 (Ohishi et al. 1989, ApJ, 345, L83). Rhomboidal SiC_3 is the fifth and largest cyclic molecule so far identified in space [after SiCC, C_3H_2, c-C_3H, and ethylene oxide c-C_2H_4O (Dickens et al 1997, ApJ, 489, 753), the only stable ring so far detected]. On the assumption that SiC_3 has the same 40 arcsecond diameter shell as SiCC, the mean column density of SiC_3 is 4.3x10(12) cm(-2). The rotational excitation of SiC_3 is similar to that of SiCC, with a low rotational temperature within the K-stacks of 10 - 20 K, and a high rotational temperature across the K-stacks of roughly 50 K, which is probably close to the kinetic temperature of the shell.

Investigators: A. J. Apponi, M. C. McCarthy, C. A. Gottlieb, and P. Thaddeus (CfA).

OTF Mapping of CO in NGC 6946 - On-the-fly images of the CO 1-0 and 2-1 emission from the nearby spiral galaxy NGC 6946 have been made using the 12 Meter. NGC 6946 is a relatively normal, SAB(rs)cd, gas rich, slightly barred spiral galaxy at a distance of 10 Mpc. Comparison with IRAS high resolution images at 60 and 100 micron wavelengths, as well as with Digital Sky Survey optical (red), have shown that:

- CO emission correlates with the IRAS detected flux;
- temperature variations indicated by CO(1-0)/CO(2-1), correlate with the 100μm/60μm temperature variations;
- the extent of the CO emission is equal to or greater than the optical extent.

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

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 MAP project was to have ended in this quarter, but one final production difficulty made it necessary to commence construction of two additional amplifiers which are to be completed by W. Lakatosh in April 1999. For the VLBA, a special version of the MAP W-band amplifier was designed by M. Pospieszalski and built by W. Lakatosh, which was optimized for the spectral region 80-95 GHz. This amplifier has better input return loss over this limited band than the MAP design. Two such amplifiers were made using two different NRAO InP wafers supplied by Hughes. It was determined that, although the gain of the devices on the wafer labeled #513 is slightly less than that of the wafer labeled #518 which has been used for all previous W-band amplifiers, the noise is the same and thus devices from the #513 wafer can probably be used successfully. An additional W-band amplifier was built as a test bed for other transistors of potential interest.

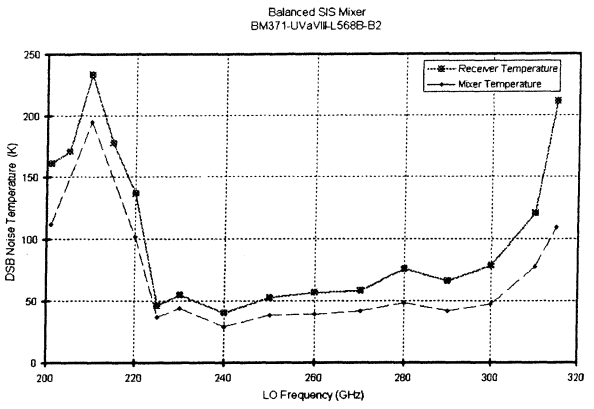
Design work was begun by M. Pospieszalski on an 8-12 GHz amplifier using InP devices. The first step in this process will be to build experimental amplifiers to test the feasibility of making a stable amplifier at (for InP devices) low frequencies. One goal of this development is to make it possible to design a stable low-noise amplifier for integration within an SIS mixer block, thereby producing simultaneously low noise and wide IF bandwidth.

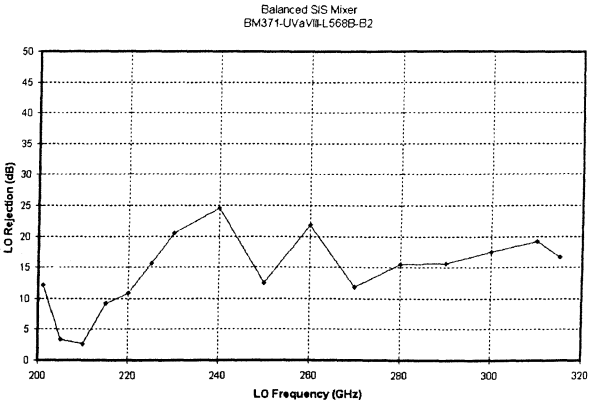
The conclusion of the MAP effort freed engineer and technician time to begin work on amplifiers for the VLA, VLBA, and some outside contracts which were accepted long ago and awaiting attention. For the VLA, four new K-band and four new Q-band amplifiers were built by T. Boyd, R. Harris, and W. Wireman, and tested by G. Petencin and S. Thacker. Two of the 80-95 GHz amplifiers described above were delivered to the AOC for use on the VLBA. Five new 4-6 GHz amplifiers using commercial GaAs devices were built by W. Wireman and are in the test phase. Five 26-40 GHz amplifiers were built by R. Harris, three for the European Space Agency, and two for the National Research Council of Italy (Bologna).

The final balanced amplifiers for the GBT receivers were delivered, with the exception of two spares for the 800 MHz band.

Superconducting (SIS) Millimeter-Wave Mixer Development

Balanced SIS Mixers - A *balanced* SIS mixer has two characteristics which distinguish it from the usual single-ended SIS mixer with a beam-splitter LO coupler: the balanced mixer requires typically 17 dB less LO power, and it has inherent LO noise rejection. Both are desirable for MMA receivers, where it is planned to use an LO source without mechanical tuners to cover the full frequency span of each receiver. The first single-chip balanced SIS mixer from a new wafer fabricated at UVA has been tested with encouraging results (see diagrams). This mixer is tuned slightly higher than the intended 200-300 GHz band, but has low noise and moderate LO rejection.





It is planned to combine the balanced mixer with the sideband separating mixer design demonstrated last year to obtain a balanced sideband separating mixer on a single chip.

600-720 GHz SIS Mixer - We have begun designing an SIS mixer for the 600-720 GHz MMA band. This is a single-ended mixer which will later be used as a building block in balanced and sideband-separating mixers. The design will be compatible with the 4-12 GHz IF proposed for the MMA.

SIS Mixer Fabrication and Testing - A contract is now in place with SUNY at Stony Brook to make Nb SIS mixers for the MMA. SUNY supplied bonding test pieces which allowed us to test the Au-to-Nb adhesion and to verify that we could solder and weld to the Au contact pads on their mixers (this has sometimes been a difficulty with Nb circuits from other sources). Their standard Ti/Au contact pads passed all tests with no failures.

We have modified our type 373 SIS mixer design to suit the SUNY fabrication process; the type 373 mixer is the building block for the single-ended, balanced, and sideband separating mixers produced successfully at UVA and JPL, and provides a good point of comparison between devices fabricated at the different foundries.

Crucial to the timely development and construction of the MMA receivers is an automated test system for SIS mixers and SIS receivers. We have completed software and interfacing for: (i) the refrigerator controller, which controls vacuum valves and pumps during cooldown and warm-up; (ii) the 4-K coaxial (IF) switch controller, which permits accurate determination of the conversion loss, noise temperature, and IF output impedance of the mixer; and (iii) the SIS mixer bias monitor, which allows SIS bias data to be recorded and plotted. The next, more difficult, task is to write software which will optimize the receiver performance and permit unattended receiver measurement across a full receiver band.

During this quarter we have assembled and tested six SIS mixers for the 3, 2, and 1.3 mm bands. These mixers were from five wafers made at UVA.

Recruiting

Considerable time this quarter was spent recruiting and interviewing potential engineering staff for MMA work. It is very hard to find good engineers and technicians during the present technology boom. Few have training or experience in microwave electronics, and those are being aggressively sought by industry.

Publications

A. R. Kerr, "Surface Impedance of Superconductors and Normal Conductors in EM Simulators," Millimeter Array Memorandum 245, National Radio Astronomy Observatory, Charlottesville, VA, Jan. 1999.

A. R. Kerr and S.-K. Pan, "Mixer-Preamp Design Using MMICAD," Millimeter Array Memorandum 249, National Radio Astronomy Observatory, Charlottesville, VA, 6 Feb. 1999.

A. R. Kerr, "Suggestions for Revised Definitions of Noise Quantities, Including Quantum Effects," *IEEE Trans. Microwave Theory Tech.*, vol. 47, no. 3, pp. 325-329, March 1999.

Electromagnetic Support

GBT - The performance of a feed array in the focal plane at 46 GHz and 90 GHz was studied. For various feed offsets, beam throw, half-power beamwidth, antenna gain and efficiency were calculated. At 46 GHz, a feed offset of 75 wavelengths resulted in about 12 percent loss in efficiency as compared to a feed at the secondary focus. At 90 GHz, the loss is about 12.5 percent for an offset of 100 wavelengths. For small feed offsets in the symmetric plane, the beam scans in elevation at the rate of about 10.6 arcsec/centimeter of offset.

VLA - A computer program which uses the physical optics method to calculate currents on a reflector surface was modified for analyzing shaped reflectors. Using this software, the subreflector scattered pattern for the VLBA antenna at 1.5 GHz was calculated and it agrees very well with the VLBA pattern calculated at JPL. The program can be used to accurately calculate gain and near sidelobes of an antenna using shaped reflectors such as the VLA/VLBA antennas. It will be useful for future studies connected with the VLA upgrade project.

Spectrometers/Correlators

During this quarter most of the time was spent working on the MMA correlator design. Only about five percent of the time was spent supporting the GBT and Tucson spectrometers. All of this support was to fix software bugs or supply new software options.

Much of the time on the MMA was spent learning new Orcad schematic capture software and Xilinx FPGA design software. In the process of learning this new software, however, substantial progress was made on the design of the MMA filter card and the MMA memory card.

The (mental) definition of the antenna-based logic required for the MMA correlator was advanced to the point where actual design of the logic card could begin. In the case of the MMA filter card, this design effort took the form of an FPGA that would fulfill the FIR chip requirements as stated in MMA Memo No. 204. The FPGA chip designed actually has twice the level of integration as that proposed in MMA Memo No. 204. The FIR design was put into a Xilinx XCV600 FPGA. This design full routed and, according to the Xilinx design software, would work at the 125 MHz system clock rate. Eight such chips are required per filter card.

The proposed MMA filter card was simulated using a C-language computer program, and a MMA memo (#248) on the results of these simulations was released.

A specification for the correlator chip required for the MMA was written and several approaches for the actual design of this chip were investigated.

Construction of a test correlator based on the GBT spectrometer design was started during this quarter.

I. GREEN BANK ELECTRONICS

GBT Spectrometer

Not much progress was made on programming the Spectrometer. Other activities occupied the time of the people assigned to this project. This is slowly gaining momentum, however, and progress is accelerating.

The cooling problem is being addressed, with the addition of an additional cooling stage in the supplied air. It is anticipated that a further 10 degree C will be gained by pre-cooling the air. This change should be installed during April 1999.

GBT Fiber IF System

Two channels of the production prototype are being manufactured and should be finished by February. Plans call for these to be tested. When these tests pass, the additional seven channels will be built.

GBT Servo System

A two-week test of the Prime Focus mount was begun, but the mount failed and the test was abandoned. COMSAT has disassembled the feed arm to move it into position for lifting, and so the tests will not be completed.

The subreflector actuators do not perform adequately in cold weather, with the current drawn from the motor controllers exceeding the limits before developing sufficient power to move the subreflector properly. The solution to this problem, as proposed by COMSAT, is to heat the actuators above ambient to keep them working in cold weather. Testing by NRAO indicated that the problem is in the gearboxes and not in the ball screw assembly, so experiments were undertaken to determine how to reliably heat the gearboxes without adding RFI to the environment. A self-regulating heat tape was selected, based on recommendations from the COMSAT electrician and NRAO personnel. Analysis of the effectiveness of heating the subreflector positioner gearboxes with the heat tape is underway.

An actuator on the subreflector has failed, and will be removed by COMSAT and returned to the factory for disassembly and repair. NRAO intends to send a representative to witness this repair.

Analyzing the data from the 30-day subreflector test revealed some unsettling encoder jumps in the electronics. These jumps are too large to be actual position errors, so they are in fact electronic readout errors. Investigations are on-going in this matter.

A meeting is held regularly between NRAO, COMSAT, and RSI/PCD to address the current Servo issues.

GBT Active Surface

Work continues on cutting the actuator cables to length and dressing them. Most of the cables are cut and dressed. Installation of the electronics can begin as soon as the climate control to the room is working.

Much progress is being made on the active surface software. One engineer is working full-time on this system.

An apparent bug has been found in the intelligent I/O Processors used to communicate with the actuators. The vendor is working on isolating the problem.

GBT Mockup

The Mockup has been used over the past quarter to help integrate the electronics for the GBT with the Monitor and Control (M&C) software. This testbed has proven to be very beneficial. A stable version of the M&C software is available for system tests, and a test version of the software is available for the M&C group to test new software features.

Quadrant Detector

Work on linearity improvements continues. The signal level on the detector is critical for linearity. Improvements in the optics and mounting details are being worked out.

Holography System

A test of the GBT holography system is planned for the second quarter of 1999 at the 140 Foot Telescope.

Equipment Room

Some glitches in the Equipment Room IF equipment are being monitored. Fiber optic receivers for the IFs have yet to be installed.

GBT Receiver Systems

Prime Focus Receiver - It was decided to repackage band 5 of the prime focus receiver into its own front-end box. The new receiver will be completed once the original four bands are working properly.

C-Band Receiver - The receiver is still in use at the 140 Foot Telescope. Improvements were made in the vacuum on the system, and some card cage improvements were made.

Q-Band Receiver - The test dewar is assembled and testing has begun. The testing will be completed in April.

S-Band Receiver - Some of the parts for this receiver are still awaiting shop time. All electronics are purchased and waiting for machine shop parts to become available. Many machined parts are becoming available, and assembly of this receiver is progressing.

GBT Cryogenics

A significant problem was discovered in the planned installation of cryogenic tubing for the GBT. The 6000 feet of tubing that we planned to use is incompatible with the compression fittings we planned to use due to the wall-thickness of the tubing. A decision was made to abandon the compression fittings and use a fully-welded cryogenic tubing system on the GBT. This will give the GBT a much more reliable cryogenic gas supply system at an affordable cost. The order for the welder has been let, and the tubing installation will begin soon. Installation of the GBT cryogenics will continue on until the telescope is delivered to us.

Site Operations

OVLBI - Overall, the station is in good shape. Work is underway to replace the antenna control system with modern, reliable components. An intercom system is being designed to allow the operators to monitor noises generated by the station from the Jansky Lab control room.

Interference Protection Group - Electronics is an integral part of the Interference Protection Group. Four engineers and a technician work part-time on this program, along with staff scientists. Over the past quarter we have tested and re-tested many subsystems, identifying sources of RFI in each subsystem. Work was completed on a data acquisition system for the anechoic chamber. Work has begun on an interference monitoring station for the Green Bank site. An enclosure for a microwave oven was designed and is being procured.

Telescope Support - Work to move the interferometer control system to the Jansky Lab was begun. A new control computer was purchased, and plans are being made to use the old Digital Delay Rack with the new control computer.

A significant amount of cryogenics work is being done to improve the reliability of our cooled receiver systems. Inspections by people from other sites have identified deficiencies in our procedures and equipment, and those are being rectified. This work will continue throughout the next two years, causing a significant drain on resources in the Electronics Division.

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 all cooled receivers in Green Bank. Normal day-to-day support of UNIX workstations, weather stations, time systems, and local area networks is also provided.

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.

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 Wide-band 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 gather 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

A new digital spectrometer, called the Millimeter Auto Correlator (MAC), has been installed at the 12 Meter Telescope. The MAC, which is a GBT correlator clone, has twice the instantaneous bandwidth currently available for our multibeam systems, and uses a single wideband sampler for each IF channel. This new design should avoid the persistent platforming problems experienced with our now decommissioned hybrid correlator spectrometer. The MAC will support the existing 1.3 mm and 3 mm, and any future, multi-beam systems on the telescope. The MAC currently functions with all of its available bandwidth modes, and is in routine operation at the telescope.

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.

K. SOCORRO ELECTRONICS

VLA-Pie Town Link

Testing of the Pie Town link equipment proceeded through November and December. The first real-time single-IF fringes were obtained at X-band on December 3. Subsequently, fringes were obtained on all seven common VLA/VLBA bands from 327 MHz to 43 GHz. Progress is approximately following the schedules that were detailed in early 1998.

Efforts now continue on the following:

1. Efforts continue toward understanding the low level variations in differential group delay of the fiber optic link and/or Maser drifts by measurement of the 1200 MHz round trip phase between sites.
2. Multimoding in the third replacement high power 1550 nm laser may further delay this exercise.
3. Components for completion of the 4-IF analog transmission system have been ordered.
4. All VLA delay cards have been modified in readiness for the piggyback cards. Ten pre-production delay cards were tested and were okay. A 300-card production run has been initiated. These will be assembled at a contract assembly house and then tested at the AOC.
5. A working 4-IF, 3-antenna system is still scheduled for early June, with a complete 27 antenna system soon after.

For further details refer to http://www.nrao.edu/~julvesta/vla_pt.html

VLA K-Band Front End

The H_2O sub-system is under going further testing. Production of cardcages and cards has begun. They will be used for receivers that will be built here and elsewhere. The shielding and layout of RF components for the K-band water vapor radiometers has been improved. Oscillations due to feedback of RF leakage seem to be eliminated.

Components for eight more K-band front ends have been received. Fabrication of front ends numbers 5 to 8 has started. Front End #5 is under going lab testing. Installation of Front Ends 5, 6, and 7 on the antennas is planned during the second quarter. Two F14s were built and tested last quarter. An additional six units will be assembled and tested at a rate of two per quarter. As each antenna rotates through the AAB, the F-rack will be wired to accept the units.

Q-Band Front Ends

Components for six more Q-band front ends have been received. Three Q-band dewars are being fabricated in the VLA machine shop. We will start fabrication of these new front ends early in the second quarter.

VLBA 3-mm Front Ends

Front End #3 was installed on the Mauna Kea VLBA Antenna. Front End #4, with only LCP, was installed at Fort Davis. The four front ends will be returned to the AOC lab in early May to be outfitted with the new LNAs from the CDL during the second and third quarters.

VLA Site Testing Interferometer

The VLA Site Testing Interferometer is back on-line and taking data after improvements to the infrastructure were made. The wood shack built five years ago and sitting on a gravel pad was replaced with a military grade communications shelter on a concrete slab and the cabling to the antennas was dressed to be more durable. The addition of the communications shelter, a metal-clad box the size of a pickup camper, will help both with reducing RFI from the interferometer and increasing the interferometer's reliability by keeping the temperature in the shelter stable.

Interference Protection

The RF-Environmental Monitoring System (RF-EMS) hardware at the VLA continued to be upgraded, tested, and improved over the fall/winter months. The system control software has been converted to run under the Linux OS, and real-time spectrum display and receiver control is now available over the Internet. The networking and site facilities groups have installed a fiber optic LAN connection to the RF-EMS trailer, which now allows direct access and control from the AOC (or at home!). A problem with the P- and L-band FE amp was found and fixed. Simultaneously, high UHF band, RFI survey data has been logged and plotted at the request of Observatory astronomers. The new plots will provide better insight to future, VLA- Upgrade RFI concerns. Preliminary equipment tests have started in order to determine the lowest cost design for a satellite tracking station at the VLA, using the military surplus 3 meter dish and mount acquired from Tucson last year.

Electromagnetic compatibility (EMC) tests of new and proposed equipment continued over the winter. Lab and field tests were conducted in order to determine the extent of undesirable emissions from a room light with dimmer control and a new PC ordered for the VLA site. In addition, special local RFI "hunts" were performed at VLBA-PT, and the VLA site in order to track down internally generated RFI at 4-band, low L-band, and X-band.

Frequency coordination efforts worked on during the winter included a re-statement of our concerns about the proposed addition of a new electronic site at Mt Withington by the US Forest Service. In addition, a detailed test procedure was written for testing the MLRS radar bing proposed for near the VLBA-FD site, and a letter of complaint was filed with the WSMR Public Affairs Office for failure to notify NRAO operations of a Ft Wingate-to-WSMR missile test in early December. Technical discussions were opened up between our DC lawyer and the FCC concerning a new, 50 cm DTV assignment for Mesa, AZ. Recurring notifications and coordination efforts with seven US Air Force Frequency Coordinators continued, as well as special coordination with the US Space Command for GPS tests.

VLBA Data Acquisition

NRAO has received two "Square Groove" triple cap headstacks from Spin Physics. Tests are being done to determine whether future purchases of headstacks will include this design of headstack. The square-groove triple can be manufactured more easily than the triple-cap with a slanted groove. It is also advantageous because the dimensions of the outriggers will remain more stable with headstack wear, and because there will be more volume in the groove even when the headstack is near the end of its life.

The plan is to outfit ten more VLBA tape drives with dry air kits in 1999. These kits will be installed in playback drives. Currently, eight drives have been outfitted with the kits.

The formatter expansion project is expected to continue in 1999. Four sites have been outfitted so far.

VLA Correlator

All 234 VLA Delay Line Cards have now been modified to accept the extended delay range piggyback board required for the Pie Town to VLA connection. An additional 12 prototypes of the piggyback board with the new Xilinx chip were built and tested. Purchase orders have now been issued for 300 piggyback boards. It is likely that the installation of all piggyback boards in the VLA correlator will be done in the first half of May. An additional Field Program Gate Array is being added to the new VLA correlator

controller serial I/O card which will significantly reduce the amount of time it will take to send program words to the delay lines and samplers during data invalid.

Amplitude Equalizers for the VLA

The average passband for the VLA antennas has a large slope across the 50 MHz bandwidth. This affects the observing center frequency during continuum observations. We plan to implement a simple equalizer circuit to correct bandpass shapes after the bandwidth has been expanded to 70 MHz.

Increasing the VLA Continuum Bandwidth

Work on increasing the VLA continuum bandwidth on all four IFs continues. The parts for the 27 antennas have been received to increase the bandwidth to 70 MHz. The 240 IF filters needed in the F7 and F8 front-end modules will be fabricated by the VLA machine shop during the third quarter. The 70 MHz low-pass filters in the screen room are being tested and retuned as necessary to match group delay. Approximately 70 percent of the filters are now complete. The T3 modules are having several new filters installed. The mixers are being biased and retuned to lower secondary mixer products. Approximately 20 percent of the T3s are complete. The existing 50 MHz passband will not be affected by this upgrade but the narrowband filters installed for JPL/Voyager have been eliminated.

VLBA Power Supply Upgrade

The P103 5-volt power supply in the VLBA D-rack is near its current limit when eight baseband converters are present. This supply is being upgraded to a P107 5 volt-supply capable of supplying enough current for 12 BBCs. Currently, all VLBA sites and the VLA have been retrofitted. This project is complete.

VLA Final LO Replacement

We have been informed that Fluke will no longer support the 6061 Fluke Synthesizers by the year 2000. These synthesizers are used as the final LO in the back end at the VLA. We are currently working on plans to do an in-house design to replace these synthesizers. Preliminary design studies are ongoing.

Wye-Com Phone Replacement

When the Wye-Monitor system was installed a couple of years ago, this freed up enough pairs on the wye-com cable to allow installation of regular telephones in the antennas. We are currently testing the spare pairs to see if telephones can be viably installed. We have been able to talk over the lines as far as A7 without the use of line extenders. This project will be a joint effort between electronics personnel and New Mexico Tech.

Analog Sum Fiber Link

Efforts are under way to study the feasibility of linking the analog sum outputs of the correlator with the VLA VLBI equipment. This link would be an effort to eliminate spurious 60 Hz components which are caused by ground loops between the correlator screen room and the VLBI equipment. These 60 Hz components are most prevalent in pulsar observations.

GPS Receivers

The remaining Truetime GPS receivers for the VLBA stations are on order with a June delivery date promised. A dual-frequency GPS receiver has been procured and has been installed at the AOC for testing. This receiver will then be moved to the VLA and will be used for ionospheric monitoring.

VLBA Masers

Maser #11 continues to have problems with IF degradation. The problem is still under investigation. Maser # 4 has been returned to the factory for repairs.

VLBA FRM Rotation Improvements

The control system for the VLBA FRM is being studied in order to improve the response for the rotation axis. The current effort is focused upon a firmware, rather then hardware solution. The VLBA Hancock site was chosen for testing purposes. Work on this project will continue into the second quarter.

HTRP VME Timing Card

Most features of this unit have been tested. Improvements within the main Xilinx circuit core were made. Additionally some hardware modifications were added to this prototype. Testing of the features will continue into the second quarter. Additionally, a final version of this card will be developed in order to produce a cleaner and clearer design. This will take place in the third or fourth quarter, while the prototype will be used in the system integration effort.

HTRP Fast A/D Card

Most of the preliminary technology choices have been limited to a small number of possibilities. Prototyping has begun and parts for the system have been ordered.

F8 Phase Control Interface

The FE group requested a DCS to F8 Phase Control interface. Some preliminary design work has been completed. Work on this will continue into the second quarter.

L. COMPUTING AND AIPS

Observatory-wide Computing

Planning - The 1999 version of the Computing Status Report and Long-Range Plan was completed this quarter. Future updates to this document will be made toward the end of each year, including a proposed budget for Observatory-wide Computing for the following year. It is expected that the NRAO Long Range Planning Retreat, to be held in Green Bank in April, will provide input from the scientific staff which will help to produce a longer-term vision for computing at the Observatory.

Personnel - The recent vacancies in system support at all sites have now been filled. New employees have started work at Charlottesville and Tucson, and are expected to begin shortly in Socorro and Green Bank. While staffing levels are still lower than is desirable in this area at most sites, this will help considerably to reduce the backlog of system administration tasks and allow improvements in such areas as security, Y2K preparation, and user support. This development is particularly important in Tucson, which has not had dedicated system administration staff in the past.

Hardware - Much of the Observatory-wide Computing effort this past quarter has centered around networking. First, the Observatory submitted a successful proposal to the NSF Computer and Information Sciences and Engineering (CISE) directorate for an upgrade of our intranet between the major four sites to full T1 (1.544 Mbps). The grant will permit video conferencing capabilities between the sites and with the astronomy community. Since Green Bank is currently connected to the outside world via the intranet link to Charlottesville, this upgrade will also provide a 3-4 fold improvement in access to the Internet from Green Bank. In addition, the grant includes a fiber connection to Kitt Peak for improved network access to the 12 Meter Telescope , and equipment that will be required to connect Green Bank to the wide-area network for real time remote access to the GBT.

The Observatory is also taking steps which we hope will significantly improve our wide-area connectivity, probably via access to vBNS and/or Abilene ("Internet2"). To this end, we are exploring arrangements with the universities to which the major NRAO sites have, or can get, fiber connections, with a view to increasing the bandwidth of our WAN connections. Possible applications include real-time data transfers to other institutions on these high-speed networks from NRAO telescopes, including the 12 Meter, the VLA, and

the GBT, as well as better access to archival data and to the high-performance computers at the NCSA, with which NRAO has an ongoing software development collaboration.

AIPS

Versions - The current TST version of AIPS (15APR99) is distributed nightly to 27 sites throughout the US, Europe, and Japan. Full support for SVLBI processing has been available since 15APR98.

The 15OCT98 version of AIPS has been distributed to over 243 sites, running Solaris, Linux, DEC Alpha, HP and SGI versions. The overall number of AIPS installations has grown over the last two years; 15APR98 and 15OCT98 are amongst the most widely-distributed versions ever.

The majority, 70 percent, of AIPS distributions are now received by ftp, although the CD-ROM distribution is growing rapidly in demand. One attractive feature of the CD ROM is the ability to use the binaries directly from the CD, keeping only data and a small footprint (10 MB) on the processing machine. This is particularly attractive for laptop computers.

Personnel - There are approximately four full-time equivalent employees in the AIPS group. Early in 1999 Tony Beasley transferred full-time to Charlottesville.

Documentation - The AIPS Cookbook has been converted from TeX to LaTeX as the first stage in placing the cookbook on-line. All help documentation is now available through a browser (using the command XHELP inside AIPS), with complete cross-referencing.

Hardware - AIPS running on Linux PCs continues to show impressive absolute and cost-relative performance, the best PC AIPSMARK so far is 16.1. A new benchmarking suite will need to be produced within a year or two to more adequately measure the performance (current suite now completes in under five minutes, which may be too short to be representative).

Using the g77 EGCS 1.0.3 compiler, the AIPS group has now produced a native port of AIPS to Linux running on a DEC Alpha; AXLINUX has now been added to the list of supported architectures.

Further Y2K testing of AIPS was performed by using the VLBA correlator to produce a dataset seemingly observed in February 2001. Loading the correlated data into AIPS did expose small deficiencies in date reading in tables which have been addressed. We believe AIPS is Y2K compliant. A stand-alone workstation with AIPS installed was clocked through January 1, 2000, with no apparent AIPS problems.

Real-time filling of VLA data to Linux machines was enabled in early 1999.

General Issues -

- Consolidation and version numbering of the tasks involved in porting VLBA correlator data to the USNO/GSFC Calc/Solve package has been completed.
- CONFI - A task CONFI was added to find optimal configuration of an array using the criteria of minimizing side lobes. This task has been written for MMA studies but can be used for general array design.
- Image sizes throughout AIPS are now fully parameterized; the system can now deal with images of 16384 pixels on a side.
- The new task UVCON will generate a u-v database for an interferometric array whose configuration is specified by the user. Visibilities corresponding to a specified model, and Gaussian noise appropriate for the specified antenna characteristics are calculated for each visibility. The array geometry can be specified in three different coordinate systems: equatorial, local horizon, and geodetic. There is an option of using set of different frequencies to improve UV coverage.
- A new verb TAPES was added, allowing a user to see what tape drives are attached to their system at any time (only shown at startup at present). The remote tape system can now interrogate remote tape drives as to their status (i.e. available or not).
- FITAB is a new AIPS task intended to replace FITTP (gradually). It has a number of advantages to FITTP and would replace it directly except that its output cannot be read by older versions of AIPS and by other software systems which do read AIPS random-groups uv-data format. The advantages of FITAB are: (1) for images, FITAB allows the specification of the value of the least bit, allowing more compression if the least bit is controlled to have a value related to the image RMS (e.g., RMS/4). FITTP uses the full range of integer and floating output values and is, therefore, not particularly compressible; (2) for uv data, FITAB writes out the data in a binary-tables form rather than in a random-groups form. This has the advantage that the data may be written in "compressed" format identical to that used on disk inside AIPS. FITS files that take advantage of this option can be as much as three times smaller than those written by FITTP; (3) for uv data, FITAB is able to break up the output into multiple files, each containing a "piece" of the AIPS file. Each of these files contain the full contents of many of the descriptive files (source, flag, index, antenna) as well as the corresponding time range for any calibration files (CL, SN, IM, TY, etc.). These tables appear in the files before the uv data. Each piece of an AIPS data set can be read and used individually or together with some or all of the other pieces. FITAB is currently being tested within NRAO.

Bugs -

- A bug involving INTEGER*2 arithmetic in a number of subroutines when compiled with the Linux EGCS g77 compiler (Version 1.1 and above) was found. This bug silently corrupts data when writing out FITS files using Linux. These routines have been modified in 15APR99 and the EGCS people informed.
- A serious bug affecting the w-term correction of visibilities when imaging fields distant from the phase center was fixed. This bug occurred if the first channel of a uv dataset being imaged was not at the reference frequency of the file. Note, this bug was introduced sometime before 1990.
- A bug in the Linux glibc library concerning the interaction between AIPS sockets and the YP network services was identified and addressed. The bug has been brought to the attention of the Linux community.

Software

Security - The recent purchase of sufficient licenses of Windows anti-virus software to cover all PCs on NRAO's networks has proven extremely useful this quarter in protecting several NRAO systems against computer viruses. Most have been Microsoft Word "macro" viruses embedded in documents attached to email sent from outside sources.

Real-time - An internal workshop on real-time computing will be held in Socorro in April. The workshop will bring together approximately 35 people, including programmers, engineers, and scientists, who are involved with this area of computing at the Observatory. Most of the attendees will present short talks, and there will also be opportunities to discuss issues relevant to major projects currently underway, such as the VLA online system rewrite, GBT software, and planning for the MMA. This workshop will be extremely beneficial for the many staff members actively involved in this field, which is critical to the operation of NRAO telescopes. We hope to organize similar workshops in future years in other areas which affect all sites, such as system administration.

Other - As part of the Observatory's Y2K preparations, an inventory of third-party software installed and supported by the computer divisions, for both UNIX and Windows, was made during the first few months of 1999. NRAO staff members will be requested to review this list and inform the support staff of additional packages that may be installed on individual workstations' disks. While the driving purpose is to track Y2K compliance status for programs essential to employees' everyday work, the inventory will also be useful more generally.

Green Bank Computing

Last year, as part of the Observatory-wide computer upgrade, we replaced the central server (sadira). Several other Suns are to be replaced by PCs running Linux. A primary server for Linux applications, including AIPS, AIPS++, and IDL, has been installed; another PC has been configured as a replacement public workstation for one of the older Suns. These public systems have sufficient memory and disk space to be used for data reduction in either AIPS or AIPS++. In all, four Linux systems running RedHat 5.2 are installed in Green Bank.

Unfortunately, progress on planned Unix upgrades and installations has not proceeded as fast as hoped. This is due to the temporary lack of a Unix system administrator. Fortunately, a replacement, who will begin in May, has been hired. This has also put considerable strain on other areas, since other manpower had to be used to cover the need. In particular, the Monitor and Control system of the GBT has suffered.

For low volume data, observers can now take their data away on CDs. We have re-writable CD drives installed on a public NT computer and a public Linux system.

The Observatory submitted a successful proposal to the NSF Computer and Information Sciences and Engineering (CISE) directorate for an upgrade of the intranet at the major four sites to full T1 (1.544 Mbps). This will provide a 3-4 fold improvement in access to the Internet from Green Bank. In addition, the grant will provide video conferencing capabilities between the sites and with the community.

Last year, we embarked on a massive program to upgrade PCs used as personal workstations. One of the primary reasons for this was to give everyone a computer that would ride through the millennium change. As a result, no one has a personal workstation that has less performance than a Pentium 100 MHz. We are now concluding the work to complete the installation of the upgrades.

To protect against PC virus infection, we have begun the deployment of Norton Anti-Virus. Updated virus definitions are downloaded to the main NT server, and are regularly downloaded to personal workstations without user intervention from the server. All diagnosed viruses are reported immediately to the PC system administrator.

M. AIPS++ PROJECT

This quarter we have focused intensively on preparation for the first release. This includes finishing areas of functionality, integrating different applications, improving robustness and documentation. The code freeze for the release occurred on April 1 (two weeks later than originally planned about six months ago). We expect testing and debugging to be complete by mid May, in time for a release at the Chicago meeting of the American Astronomical Society starting May 29.

In Single Dish support, much work was done on preparing the dish package for the release:

- Bob Garwood and Tim Cornwell visited Arecibo for a demonstration of dish and other single-dish processing inside AIPS++. This visit was very useful in confirming our view of the usefulness of dish and in learning of priorities for further improvements. Following discussions there concerning the calculator capabilities of the NAIC analysis program Analyz, a spectrum calculator was added to dish. This allows easy manipulation of numbers, vectors, and spectra so they may be added, subtracted, Fourier transformed, etc.
- A new dish plotter based on the pgplotter tool was implemented. This is a simpler interface which will be more familiar to non-single-dish AIPS++ users than was the previous dish plotter. This should also ease long term maintenance by reusing other AIPS++ Glish plotting tools. It also allows the user to fine-tune the presentation of final plots.
- A mouse controlled copy and paste facility was added to the dish results manager and the calculator interface.
- An operation to compute statistics over an interval of spectrum was also added.
- The internals of dish have been largely rewritten so that, apart from the plotter, it no longer requires that the GUI interface be present in order for the dish environment to be usable.
- We have opened the data path from Unipops to AIPS++, thus allowing, for example, the analysis of 12 Meter data inside AIPS++.

Both Bob Garwood and Joe McMullin continue to be involved in supporting the GBT. This includes regular two to three day visits by at least one of them to Green Bank for most weeks during the quarter. The AIPS++ position in Green Bank was filled during this quarter and the new person, Jim Braatz, starts in the next quarter. The primary focus during this quarter was the complete rewrite of the GBT filler and the reworking of the dish plotter.

The GBT filler rewrite was nearly complete by the end of this quarter. This was necessary in order to improve the speed of the filler in time for planned tests of the GBT holography backend in April. The rewritten filler is about 50 times faster than the old filler and holography data is supported as of the end of the quarter. Some additional fine tuning of the filler for additional backends, and to be more flexible and automatic while handling on-line data, remain to be done in the next quarter.

Other work in support of the GBT included further iterations with the Green Bank staff on GBT pointing issues. Two avenues for solving the pointing equations have been demonstrated and documented. Some small additions to the Green Bank tipper data reduction were also implemented. The old plotter used with the gbtlogview utility was replaced by the pgplotter tool.

In Synthesis support, the overall development priorities have remain unchanged during this quarter, with a continued focus on expanding the high-level scientific capabilities and user base of the package. We have continued the strategy of working on high-level imaging and calibration facilities to test the completeness of the design and to provide advanced capabilities, while simultaneously allocating resources for completing "thin-path" capabilities for end-to-end reduction for the simpler scientific cases.

An additional and specific focus during this quarter has been the process of preparing for the public release. This has included the incorporation of integration developments adopted since the Applications Integration meeting held last November, and expanded documentation and testing. A high-level cookbook for synthesis reduction is under development in this regard, and will be integrated with the "Getting Started" tutorial document (Anantharamiah, NRAO) and the new GUI-based recipes contributed by R. Hjellming (NRAO). Synthesis has benefitted from the re-structuring of the user interface, described elsewhere in this report, and the associated rationalization of object-oriented terminology at the highest scientific interface to the package.

The "thin-path" development efforts have included the VLA filler, for which an initial implementation has been completed (R. Marson) and is under testing, and an initiative to incorporate uv display capabilities in the Display Library (P. Barnes, in collaboration with ATNF). The filler will be in the public release. It has been designed to be easily extendible to real-time filling, and to form the basis for the VLBA filler.

The high-level imaging and synthesis capabilities developed during this release include a significant continuing effort in mosaicing (M. Holdaway and T. Cornwell), and wide-field imaging (T. Cornwell). Developments in mosaicing include enhanced primary beam correction options, an implementation of MEM, Lattice-based CLEAN and the incorporation of multi-scale CLEAN in mosaicing. Testing of these options with real data is underway. The simulator has been upgraded (T. Cornwell), and will be developed further by M. Holdaway as part of the mosaicing development plan. T. Cornwell has expanded the wide-field prototype into a functioning capability. The projection algorithm is that suggested by W. Brouw, L. Stavely-Smith, and R. Sault (ATNF), and thus differs from

previous implementations in SDE and AIPS. The low-level wide-field capability has been packaged as a scientific module in Glish, called dragon, and expands and extends the previous capabilities available under this name in SDE. A collaborative arrangement with the group at NRL (N. Kassim) has been established for testing and evaluation of the wide-field software. The members of this group are primary users of the VLA at 74 MHz, and have significant experience in this type of reduction. The new AIPS++ Visiting Scientist, Kumar Golap, who joined NRAO in the parallelization group in early April, will work closely with T. Cornwell and A. Kemball in extending and parallelizing the wide-field imaging capabilities.

In support of the wide-field imaging work, we have developed tools for reading information from various radio catalogs (WENSS, NVSS, FIRST) into AIPS++ component models. This, together with the positions for standard sources available from the measures system, gives a large degree of convenience in, for example, using the outlier capability of dragon to remove confusing sources. In addition, star files from AIPS and Caltech package model files can also be read.

A meeting with the commercial Pixon company (R. Puetter and A. Yahil) took place during this quarter (T. Cornwell and A. Kemball). General terms were agreed for making the pixon deconvolution method available in AIPS++ later this year. This will include parallelization development. In broad terms, AIPS++ will provide an interface to the pixon libraries in a set of imaging applications. The end-users will be responsible for obtaining these licensed libraries from the Pixon corporation separately, to be able to use these applications.

Calibration development has continued in this quarter, primarily in increasing the robustness and cross-calibration capabilities (A. Kemball). This development has followed the plan and design outlined last year, without significant deviation. Expanded testing with real and simulated data has been undertaken during this quarter. Work has started on an assisted imaging tool (analogous to DIFMAP (Caltech)), and it is planned that a preliminary version will be included in the public release.

M. Wieringa has implemented all code infrastructure to support the new MS v2.0 uv-data format, which holds significant advantages for VLBI, advanced synthesis and single-dish reduction. This format has benefitted from significant scientific contributions from throughout the consortium. In order to meet pressing priorities for this release and to ensure maximum reliability, it has been decided to adopt the format after the public release. The user impact will be transparent at that time.

Work has started on integrating an existing site-testing interferometer at the VLA into AIPS++, and moving the current software into Glish and C++. This work is being undertaken by K. Desai, under partial loan from the AIPS project. On a related matter, real-time imaging remains an important area for AIPS++ after the release, and preliminary discussions are underway in this area for the VLA. The use of AIPS++ in a similar context at the ATCA (M. Wieringa) is further developed at present, and is being moved to AIPS++.

The parallelization initiative with NCSA continues to have important scientific implications for synthesis development, and a full description can be found in the appropriate section of this report. This collaboration is very helpful in opening up new challenges in radio astronomy data reduction and imaging.

An important focus in synthesis planning for the period up to the release is the expansion of the active scientific user base. To date, this has involved directed testing with small groups, and beta-testing program. Expanded internal testing is planned for the period immediately preceding the release of the public CD, with follow-on visits to external sites planned for the summer (T. Cornwell and A. Kemball). We regard this as the most effective way in which to expand the number of scientific users of the package, and it will be pursued actively.

In Glish, all of the problems were worked out to allow dynamic loading the Display Library (DL) along with necessary portions of AIPS++ into the glishtk widget client. This allows the glishtk client to remain uncoupled from AIPS++ and the DL, but still permits the DL to be loaded on-demand.

Also, a garbage collector was added to an experimental version of Glish in an attempt to resolve memory leaks seen in Green Bank with long-running Glish processes. These leaks are the result of cyclic references in records and functions, and as a result, require higher level analysis than is possible with the simple reference counting mechanism which Glish employs. However, as a result of the extra heap overhead which the collector requires, we haven't decided how this collector should be integrated into the main Glish distribution.

In AIPS++ Infrastructure, we have again focused on integration of the user interface. Much effort has been expended on fine details of the user interface, with the work shared by Tim Cornwell, Neil Killeen, and David Barnes, and feedback coming from our testers. We have added an automated scripting capability to the GUI, with the possibility of submission to a batch system where appropriate.

The table tool can now read and write ASCII files. We expect this to considerably aid the use of AIPS++ for ad hoc processing and plotting.

In Image Analysis, a substantial number of new capabilities have been added via the efforts of Neil Killeen (aided by Ger van Diepen). The highlights (of a huge amount of work!) are:

- The imagefitter tool was finished and integrated with the Display Library.
- The regionmanager was improved and integrated with the user interface system.
- Separable and non-separable convolution was added to image.

- Persistent image masks are now available and controllable from Glish.

In Display, the main achievement was the successful deployment of the display library inside Glish. In addition, Harold Ravlin developed a postscript driver for the Display Library, and Darrell Schiebel worked to allow dynamic loading of the DL by Glish.

The system was unstable for some period. The main reason was that shared libraries has to be used by Glish to be able to dynamically load the Display Library code. Towards the end of the quarter things settled down and the Display Library could be used. However, it has not been tested on all platforms yet.

In the area of Parallelization, the parallelization group has been involved with development, profiling, and scientific processing during the first quarter of 1999. The group is processing a large four-pointing HI data set of Dave Westpfahl (NMT) using the NCSA AIPS++ system. Roberts carried out tests on imaging and deconvolving up to ten channels at a time (6000 x 6000 pixels on a side). Execution time appeared to be anomalously high and Young and Kemball have been carrying out profile experiments to identify inefficiencies in the serial performance using the SGI profiling tools (SpeedShop, CaseVision, and perfex).

A graduate student in the UIUC Computer Science department, Enkelejda (Ledi) Imeraj, has been working with the parallel group to put in I/O instrumentation into the AIPS++ I/O routines. She is now testing I/O performance on the NCSA Origin2000 on the test M33 data set of Dave Westpfahl. The same Origin hardware/software problems have affected her analysis. The system now seems stable enough for her to continue.

In Documentation, we revised Getting Started in AIPS++, started on a cookbook, decided on a format for GUI-based recipes, and implemented a FAQ. We also deployed an ask() function inside AIPS++ for asking help from an AIPS++ expert. We also started work on issues related to the release such as a design for the CDROM cover. We issued on edition of the newsletter (Feb99).

In Management, we started gearing up our outreach program with a presentation at the January AAS meeting, presentations inside NRAO at Tucson and Charlottesville, at the AUI Board, and with a visit to, and presentation at, Arecibo.

N. GREEN BANK TELESCOPE

Connecting the Backup Structure (BUS) to the Box

The installation of the permanent supports on the BUS was completed in December, and the work is now focused on the Box supports and connecting beams. As of mid-March the rework on all but two of the Box supports has been completed, and 26 of the 30 permanent support beams are in place. All of the materials necessary to complete the permanent support system have arrived in Green Bank from the fabricator in Texas. Inspection of the welding on the remaining Box supports will be completed by the end of March, after which the support beams will be installed. The permanent supports are scheduled to be completed by the middle of April.

The program of removal of the temporary supports has begun. The first temporary chosen is one in the center of the structure, surrounded by three installed permanent supports. Removal of most of the temporary supports must await completion of the permanent supports.

Installation of the Vertical Feed Arm & the Upper Feed Arm

COMSAT has continued to review the procedure for completing the installation of the Vertical Feed Arm (VFA), and has modified the order in which the tasks occur, so that more of the welding is done on the ground where it is easier and better controlled. The welding of the intermediate VFA modules K and L is now complete. Selected members of the transition module M will be fitted and bolted to the completed module L on the ground. Other members of M will be bolted to the Upper Feed Arm, and then the Upper Feed Arm will be trial-assembled to KL, again on the ground. Because the alignment of the Upper Feed Arm will be done under controlled conditions on the ground, rather than with the structures suspended from cranes in the air, it is anticipated that the process will proceed much more rapidly. Moreover, this modified procedure ensures that the Vertical Feed Arm will fit well, and will be properly aligned with respect to both the VFA and the vertex of the dish.

Installation of the Feed Arm will be completed by raising the welded modules KL and the bolted module components M, installing the transition module J between H and K, raising and attaching the Upper Feed Arm, and welding the members of module M. It is anticipated that the entire Feed Arm will be completed by the end of May.

Other Activities

Although the principal focus continues to be on the permanents and the Feed Arm, COMSAT is making progress in other significant areas. The effort to install shim packs and to align the elevation gear segments is about one-third complete. Servo engineers

from Precision Control came in March and continued the installation of the permanent drive controls in both azimuth and elevation. And the long process of providing the electrical distribution on the structure is nearing completion.

Major activities anticipated for the late spring are the resumption of the alignment of the actuators and the final installation of the actuator cables. The actuator alignment will begin after the load of the backup structure has been transferred to the permanent supports, and the work on the cables can begin shortly thereafter.

The Surface Panels

Work on the GBT panels is continuing at the RSI facility in Sterling, VA, with good progress. In March, 11 measurements of the panels from three more tiers were forwarded to NRAO for evaluation. The panels, 158 in number, are from tiers 22, 24, and 31. They were accepted in an inspection visit to Sterling, VA, on March 19. At this time 1683 panels have been assembled, and 834 have been measured and accepted.

The installation of the robotic painter was completed after some delays, and the machine has been successfully checked out. Selected panels from tier 26 were painted with the new system and the paint coats passed the evaluations for uniformity, thickness, and adhesion. RSI reports that 98 panels have now been painted.

Project Coordination

A detailed review of the GBT project was held on February 3, 1999, with Phil Jewell, Paul Vanden Bout, and Bob Hall. All group leaders reported on the status of their work. A number of problem areas were identified at the meeting including manpower shortages in both Monitor and Control and Green Bank cryogenics, the need for information on how to accommodate VLBI observations on the GBT, the need for a "Friend of the GBT Spectrometer," and the continual struggle with the contractor's problems on servos. The primary action item generated in the meeting was to produce schedules which show how NRAO completes its work before the end of 1999. McKinnon circulated scheduling guidelines to insure uniformity and consistency in group schedules. The group leaders have completed their draft schedules. An overall project schedule is being consolidated.

Goeran Sandell is developing detailed plans and schedules for telescope commissioning that are based upon McKinnon's general commissioning plan.

The general plan for tests of the GBT holography system on the 140 Foot Telescope was finalized and scheduled. The initial proposal that evolved into the plan was developed by Ron Maddalena. Hardware will be tested during a one day session in April 1999. A contingency test session has also been set aside for mid-May. The actual holography observing runs (observations of satellites and astronomical sources) are scheduled for a two day session in mid-June. The holography tests are being designed to have essentially no impact upon the GBT M&C group.

Group leaders estimated the cost to complete NRAO systems for the GBT and made specific recommendations to senior management on how to complete major portions of the project within the project's budgetary constraints. It was found that sufficient funds were available in the project budget to provide the equipment needed for a Phase II GBT: receivers with frequencies up to and including K-band, hardware to support optical fiber transmission of eight GBT IFs, open loop active surface, and "static" laser rangefinder measurements. Funds previously earmarked for operator workstations and data analysis computers were placed into project contingency. Equipment required for a Phase III GBT (e.g. high frequency receivers and closed loop active surface) must be purchased with other funds.

RF engineers have not been able to combine all five prime focus (PF) receivers into a single box. The combined design also requires swapping dewars in the box for certain frequency changes. In order to expedite the completion of the PF receivers and to avoid the operational headaches inherent to a dual-dewar design, McKinnon decided to construct two separate PF boxes. The existing PF receiver 1 will be completed with GBT project funds. PF receiver 2 will be completed with RE money: $25K from 1998 RE and $25K from 1999 RE.

In late 1998, a number of items required for the GBT site were purchased for GBT operations. All of the items were identified in a GBT site list in March 1998, and include safety equipment, radio communications equipment, an operations vehicle, a manlift, components for remote emergency stops, and furniture for the GBT control room.

McKinnon proposed project priorities for the 1999 RE budget. The proposed priorities are, in order, Q-band receiver, prime focus receiver 2, interference monitoring station, L-band array feed prototype, and Ka-band receiver. A meeting will be held to discuss these priorities as well as other projects requiring RE funds.

Issues affecting metrology integration and pointing are identified, addressed, and sometimes resolved at weekly meetings. Michael Goldman, Dana Balser, and Don Wells developed analytical methods to convert laser rangefinder measurements to telescope pointing

coefficients. Goeran Sandell proposed an optical guide telescope for the GBT. The proposal was well received, and the guide telescope should be particularly helpful in measuring tracking stability of the GBT. Phil Jewell has indicated that a turnkey guide telescope may be available from NRAO-Tucson. Multipose-photogrammetry has not accurately calibrated the lengths of the actuators on the subreflector, and the pointing group is exploring alternative calibration methods.

The position of the GBT subreflector needs to be measured with the laser rangefinders to (1) align the foci of the primary and secondary reflectors and (2) verify the motion of the subreflector for proper operation and calibration. Two methods, which placed mutually exclusive requirements upon the orientation of the retroreflectors within their mounts on the subreflector, had been proposed to achieve these objectives. One method required that the limited opening angle of the retroreflectors be aligned with the feed arm lasers, and the other method required an alignment that is optimized to the ground lasers. It was decided that the ability to range on the subreflector retroreflectors from the feed arm lasers would give us more flexibility in measuring subreflector motions, particularly during the commissioning of the telescope. The retroreflectors are being installed accordingly.

GBT Computing

During the GBT program review at the beginning of February, it was clear that we only have just enough staffing to finish the important pieces of M&C by the time of acceptance of the GBT antenna. We should have sufficient staffing to be able to use the Metrology system for static measurements of the pointing coefficients by that time, but we will not be able to use it for dynamic measurements.

The remaining budget for the GBT contains sufficient to complete the M&C systems, with money for the computers to interface to the backends, the Redundant Array of Inexpensive Disks (RAID) system, and the archive.

The lack of a Unix system administrator for Green Bank will continue to impact the M&C development, since the people in this group must pick up most of the system administration duties. Many of the software targets have been extended or deferred because of this. The good news is that we have hired a person to fill this position; he will start in May.

Monitor and Control

We have spent much effort trying to find a an elusive problem with the Digital Continuum Receiver (DCR). Since this will be needed for acceptance and commissioning of the GBT, it is important that it work reliably. Because of these efforts and the continuing support of computer operations in the absence of a full-time system administrator, progress on the Spectrometer has been slower than hoped, especially in the data flow handling. We have made progress on the control parameters for the device. About half of the total number are implemented and tested.

The re-engineering of the software driver for the Monitor and Control Bus (MCB), needed to improve reliability, has been completed. In addition, the code to support the new General Purpose Interface Bus (GPIB, or IEEE 488) prototype board has been finished. The main obstacle to completion is that there seems to be a problem with the software driver distributed by the manufacturer with the device.

Monitor data and error messages are now accessible to the Metrology system, including the weather data from all three weather stations. Because this now works well, the distribution of the commanded position of the GBT should be straightforward, since it will be based on a similar design. The commanded position is needed by the Metrology system to track the retro-reflectors on the structure from the ground lasers.

The access of Green Bank weather information on the web has been redesigned. Previously, any access from the web caused the on-line GBT weather systems to be interrogated. Weather data for the web pages is now sampled every five minutes, and this static data is displayed when the web page is accessed. The page also now displays all times and dates in a consistent format.

Operators' and Engineers' displays

By popular request, audio has been engineered into the Operators' Interface. The sound server processes audio alerts from multiple applications and also displays color-coded messages indicating their origin. Although the underlying network controls are not yet in place, there is now a management tool to allow the operator to permit and deny access to parts or all of the GBT systems by the various users of the system.

O. MILLIMETER ARRAY PROJECT

In the first quarter of 1999 substantial progress has been made to secure the merger of the MMA project with the European LSA project. A Memorandum of Understanding (MOU) for the design and development phase of a joint US-European array has been agreed upon and initialed by both the NSF and a confederation of five European organizations. A joint MMA-LSA scientific and technical workshop was held to begin defining the specific division of tasks in the design and development phase. The MMA project released a request for proposals for a prototype antenna and the LSA project released a statement of inquiry to antenna manufacturers in preparation for release of a request for tender for a second prototype antenna. A name was adopted by the NSF and European organizations for the joint array.

The third meeting of the NSF and representatives of the participating organizations in Europe collectively known as the European Negotiating Team, led to an initializing of a MOU for design and development of a joint, large, millimeter/submillimeter array. The five European organizations are: (1) the European Southern Observatory (ESO); (2) the French Centre National de la Recherche Scientifique (CNRS); (3) the German Max-Planck-Gesellschaft (MPG); (4) the Netherlands Foundation for Research in Astronomy; and (5) the UK Particle Physics and Astronomy Research Council (PPARC). The MOU will take effect as soon as it is signed by all parties and it will expire on 2001 December 31 or on the date that an agreement for the construction phase of the joint project is signed. A joint project Coordination Committee will be established upon initiation of the MOU; the Coordination Committee is to be comprised of six representatives named by the NSF and six named by the European organizations. Management of the joint project is the responsibility of an Executive Committee made up of the MMA Project Director and Project Manager and the LSA Project Manager and Project Scientist. The Executive Committee is assigned the task of producing a Project Work Program and Management Plan in 120 days for approval by the Coordination Committee. Two joint advisory committees will be appointed by the Project Coordination Committee. These are a Science and Technical Advisory Committee and an Oversight Committee. The former is expected to subsume the present US MAC and European SAC.

In late February a meeting was held between the MMA Division Heads and counterpart representatives of the LSA project. The goal of the meeting was to identify ways in which the two groups could effectively collaborate on the tasks needing to be accomplished in the design and development phase of the joint project. Time was spent reviewing what is being done for the MMA project and reviewing resources and interest among the European groups in tasks to augment that effort. The report of this meeting is available on the MMA web pages. A highlight of the meeting was the desire of all the technical groups for access to a test interferometer to be made up of one antenna supplied by the US and the other supplied by Europe. The two antennas are to be prototypes from different contractors. Such an approach has the advantage of permitting a comparative evaluation of the two prototypes and of keeping competition in the antenna procurement process through the prototype phase.

The February meeting was very timely in that the US RFP for the prototype antenna was nearing the date of its release. The meeting allowed several remaining specifications to be established or refined. The US RFP was issued to contractors on March 30 with responses due in three months. The European request for tender, using the same technical specifications as are in the US RFP, is expected to be released approximately one month later. The US and European groups will collaborate on their respective bid evaluations so that the two prototypes come from different contractors.

Finally, the joint array project needed a name. Suggestions for a name were solicited via an emailing to all those receiving the MMA electronic newsletter and similar groups in Europe. A list of approximately 30 suggested names was circulated in the same manner as a straw ballot. An ordered list of the "top ten" names receiving votes was presented to the NSF and ENT groups at their March 30 meeting. These bodies agreed on the name Atacama Large Millimeter Array (ALMA) for the joint project. The acronym ALMA is a Spanish word meaning soul.

The transition from MMA to ALMA has begun with every prospect that the remaining three quarters of 1999 will be as eventful as the first.

P. PERSONNEL

New Hires

Battle, J.	Electronics Engineer	1/18/99
Brooks, M.	Electronics Engineer	2/02/99
Edmans, D.	Electronics Engineer	2/09/99
Effland, T.	Systems Analyst	1/04/99
Greenberg, J.	Electronics Engineer	3/19/99

Jackson, J.	Electronics Engineer	1/12/99
Jewell, P.	Scientist/Director, Green Bank Ops	1/01/99
Martinez, R.	Systems Analyst	3/29/99
Moorey, G.	Electronics Engineer	1/14/99
Pisano, J.	Senior Scientific Programmer	2/16/99
Revnell, M.	Electronics Engineer	1/11/99
Shores, Kerry	Junior Engineering Associate	1/04/99
Waters, B.	Scientific Programmer Analyst	1/04/99
Williams, J.	Research Associate	3/09/99

Terminations

Diamond, P.	Scientist/Dep Assistant Director, Socorro Ops	1/22/99
Mioduszewski, A.	Assistant Scientist	2/26/99
Ray, J.	Junior Engineering Associate	1/04/99
Sumner, M.	Junior Engineering Associate	1/04/99
Weimer, R.	Electronics Engineer I	1/03/99

Promotions

Beasley, A.	to Assoc Sci/Assist Director, Program Development	3/01/99
Carilli, C.	to Associate Scientist - Socorro Operations	1/01/99
Claussen, M.	to Associate Scientist - Socorro Operations	1/01/99
Ferraro, R.	to Electronics Engineer I	1/01/99
Flatters, C.	to Associate Scientist - Socorro Operations	1/01/99
Ghigo, F.	to Scientist - Green Bank Operations	1/01/99
Kogan, L.	to Associate Scientist - Socorro Operations	1/01/99
Maddalena, R.	to Scientist - Green Bank Operations	1/01/99
Rupen, M.	to Associate Scientist - Socorro Operations	1/01/99
Taylor, G.	to Associate Scientist - Socorro Operations	1/01/99
Ulvestad, J.	to Scientist - Head, Socorro Scientific Services	1/01/99
van Moorsel, G.	to Scientist - Head, Socorro Computing	1/01/99
Wells, D.	to Scientist - GBT Project	1/01/99

Other

Behrens, G.	transferred from Green Bank to Tucson	1/01/99
Heald, R.	return from Leave of Absence	2/01/99
Langston, G.	return from Leave of Absence	3/21/99
Lockman, F. J.	return to Scientist (Tenure)	1/01/99
Milner, R.	to Leave of Absence	2/15/99
Ross, D.	deceased	3/05/99

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TURNER, B.E.; HERBST, E.; TERZIEVA, R. The Physics and Chemistry of Small Translucent Molecular Clouds. XIII. The Basic Hydrocarbon Chemistry.

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