NATIONAL RADIO ASTONOMY OBSERVATORY

Quarterly Report

April – June 2003

Cover Image: VLBA Shows "Supernova Factory" in Merging Galaxies.
Investigators: J. Ulvestad (NRAO), S.. Neff (GSFC), S. Teng (U. Maryland).

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ALMA

Evaluation of the prototype antenna from VertexRSI is underway at the ATF site. Following holography, the focus will shift to the evaluation of the pointing accuracy and path length errors, and will conclude with radiometric evaluation.

Architectural and engineering design of the civil infrastructure at the Array Operations Site (AOS) is well underway. An architectural plan for the AOS Technical Building is complete, and detailed designs of that building, and of the antenna foundation, are in progress.

A major test of the Local Oscillator subsystem took place during this period. A prototype of the Warm Multiplier Assembly (WMA) was tested using the GBT Spectrometer, and was shown to meet all of the ALMA specifications.

The Computing IPT held a Preliminary Design Review, and the review panel was generally pleased with the software design. One area of concern was insufficient detailed planning for the operations phase, and working groups have been set up to address this issue.

EVLA

VLA Antenna No. 13 was taken out of service in April to be used as the EVLA Test Antenna. Modifications to the antenna so that it can function as a testbed for prototypes of EVLA electronic systems were commenced. Installation of the optical-fiber cable along the arms of the VLA progressed well with installation now 50% complete. A prototype of a new EVLA wideband feed was successfully constructed and tested.

Green Bank Telescope

The GBT commissioning has been completed using the seven facility receivers which cover most of the frequencies from 300 MHz to 26.5 GHz. Considerable progress has been made in both the hardware and software of the GBT Spectrometer, and it is now in routine and generally reliable use. It joins the Spectral Processor, the Digital Continuum receiver, the VLBI recorders, and two university-developed systems on the list of available backends.

There has been much activity and considerable progress on the GBT Azimuth Track. Metallurgical analysis of one of the cracked plates indicated a high degree of brittleness and fatigue, and investigations into other materials have begun. The four wear plates with the most serious cracks have been replaced. The total dead load of the telescope on the track was measured with an accuracy of 0.3%. A 2-dimensional finite element model has been developed, and is being reviewed.

Executive Summary

The most significant activity has been the implementation of a trial retrofit of the track which was recommended by the Azimuth Track Review Panel. At one joint in the track the base plate has been welded and then bridged with a staggered wear plate. The test required the design of the joint weld configuration, the design of the bridging wear plate joints, and the development of a technique to perform the difficult welding procedure in the field. The performance of the welded joint will be carefully measured and monitored over the next several months.

Progress has been made in removing the sources of ripples in the spectral baselines of the GBT. Some of the problems arose due to leakage in certain of the waveguide thermal gaps, and these have been redesigned. The causes of the temperature dependent ripples in the IF system proved to be complex. Impedance mismatches are important, but small amounts of cross-talk may also contribute. Investigations in this area continue. Modulators for the optical fiber IF system were identified as producing a gain ripple, and improved devices have been ordered.

A significant effort has been made to understand the improvements which the GBT users desire for data analysis and accessibility. It has been decided to generate a single FITS file which will contain the data preprocessed in the manner specified by the user, and which then will be compatible with such standard analysis packages as IDL, CLASS, and AIPS. The Software Development Division also completed tasks in support of hardware troubleshooting on the spectrometer, continued incremental improvements to the active surface system, made several fixes to support experiments with the laser rangefinders, and made enhancements to the Engineering Measurement System to support trilateration and other PTCS efforts. A highlight is that the errors in the antenna trajectories which have been present for several months have now been significantly reduced.

In April a team of scientists and engineers from Green Bank, Socorro, and Cambridge University (UK) implemented an out-of-focus holography system for GBT surface measurements. The advantage of the technique compared to conventional, phase-coherent holography is that celestial sources and facility receivers can be utilized. The initial results showed a systematic displacement of the fitted aperture illumination, but the problem is largely understood and further observations will be made in July.

Work on the Engineering Measurement System is proceeding well. An antenna temperature sensor system has been designed and developed, and installation of the system is in progress. At the same time the metrology group has been preparing the laser rangefinder units by repair and replacement of some of the oscillators, and by characterizing the rangefinder point performance.

Executive Summary

Very Large Array & Very Long Baseline Array

Scientific results obtained with the VLBA during the third quarter of 2003 include observations of the recent gamma-ray burst GRB 030329, which ruled out a theoretical model of GRB afterglow emission, and the detection of a supernova in the merging-galaxy pair Arp 299. VLA observations of the distant quasar PSS 2322+1944 revealed a star-forming disk surrounding the quasar nucleus, suggesting that stars and supermassive blackholes formed simultaneously in primeval galaxies.

Infrastructure improvements and maintenance activities completed during the quarter include maintenance visits to the St. Croix and Kitt Peak VLBA stations and the installation of 43 GHz receivers on the VLA antennas. Follow-up holography has improved VLA aperture efficiency to 35 percent at 43 GHz.

Many activities in education and public outreach occurred in the third quarter of 2003. A conference celebrating the VLBA's tenth anniversary, entitled "Future Directions in High Resolution Astronomy", was held in Soccoro on June 8-12. A gift shop was opened in a new extension to the Visitors Center at the VLA site. Summer students arrived to participate in the annual REU summer student program.

Central Development Laboratory

A total of 15 amplifiers was completed, keeping pace with the requirements for the VLA and the GBT. Evaluation of some varieties of the Cryo-3 devices showed that because they are unsuitable for cryogenic applications they can not be used for EVLA 1-8 GHz amplifiers. Work continues on devices for these low frequency bands.

Tests of a prototype ALMA Band 6 (211-275 GHz) SIS mixer-preamp have successfully met the ALMA specifications for noise temperature and image rejection over most of the RF and IF ranges. Significant progress was made on the design of the Band 6 cartridge and the dedicated test equipment needed for testing the mixer-preamp and cartridge. A substantially modified mixer simulation program was completed, and the results calculated with the program agreed extremely well with those deduced from the receiver measurements.

The design for the new EVLA 1.2-2 GHz feed was tested and verified. Additional support in electromagnetics was provided to study the problem of the leakage through the thermal gaps in certain GBT receivers; this leakage has been identified as a component in the ripples seen in the spectral line baselines.

The ALMA 2-antenna prototype correlator construction was completed and end-to-end testing began. Design of a new multi-output FIR filter to improve the baseline correlator frequency resolution was advanced to the stage of simulation and demonstration that a preliminary design can be built using available FPGA technology.

Executive Summary

Prototype ALMA local oscillator sources which provide the necessary low-noise output power to drive the SIS mixers were demonstrated and delivered. Work continued on evaluating the final frequency multipliers. Currently the prototypes for Band 9 (614-708 GHz) do not provide the requisite power level but one design holds promise. Frequency multiplier MMICs may be well suited for operation in the submillimeter region, and developments at both the University of Michigan and at JPL are being closely followed.

In June, the NRAO received an NSF MRI grant to develop a high-performance instrument to receive solar radio emissions with adequate temporal and spectral resolution to probe a wide variety of active solar phenomena, including energy released from flares, particle acceleration, coronal shocks, and electron beams. A significant portion of the development work will be performed at the Central Development Laboratory.

Computing and Information Services

During this period, both AIPS++ and Data Management underwent large, structural changes. The AIPS++ consortium was ended, with non-NRAO members withdrawing their resources from the project. The AIPS++ group was removed from Data Management and split between two computing structures, an Interferometric Software Division under Socorro Operations and the Single Dish Development IPT in Green Bank. The Interferometric Software Division now directs the efforts of both AIPS and interferometry AIPS++ developers, led by J. Ulvestad and B. Glendenning. In this new structure the focus is on NRAO project needs, specifically the ALMA and EVLA, and the planning reflects project priorities and timelines.

The prototyping phase of the e2e project (end-to-end data management) continued this quarter. Tim Cornwell stepped down as project manager, and was replaced by Doug Tody as interim project manager. The projects under active development include proposal submission and handling tools; the VLA dynamic scheduling tool; the ALMA prototype pipeline; research and development on the Virtual Observatory; and the NRAO data archive. In the last project the entire VLA tape archive has been loaded, and the loading of VLBA data is in progress. The goal is to release the archive to external users for testing and data retrieval in October 2003.

In the past quarter the NRAO experienced no noteworthy computer security incidents. The Computer Security Policy is under revision to include Virtual Private Networking (VPN), special purpose Web-servers, and wireless networking. VPN testing was completed in Charlottesville, and service there was made available to users in May. The Socorro system will be deployed during the coming quarter.

There has been increased use of the four main internal web “proxy” services, which will result eventually in significant inter-site network bandwidth savings. The use of active content continues to increase on NRAO's web pages, beyond the successful image gallery.

Executive Summary

After detailed price comparisons, the new Intranet contract was awarded to the current service provider AT&T. The basic network to support the Green Bank Educational Center was installed and is now operational. The modems originally shipped to us for the upgrade of the network service to the VLBA Kitt Peak antenna had to be replaced, delaying the completion of that project. The NRAO video system is now routinely used to relay scientific and technical colloquia throughout the Observatory.

Education and Public Outreach

The new Science Center at Green Bank opened Memorial Day weekend for the main summer season. New exhibits and furnishings for classroom facilities are still undergoing their final commissioning installations, with the hope and expectation for a dedication near the end of the summer. The dormitory associated with the Science Center is under construction. At the VLA, the addition of a gift shop wing in mid-June provides a means of funding EPO staff at the Visitor Center on an ongoing basis.

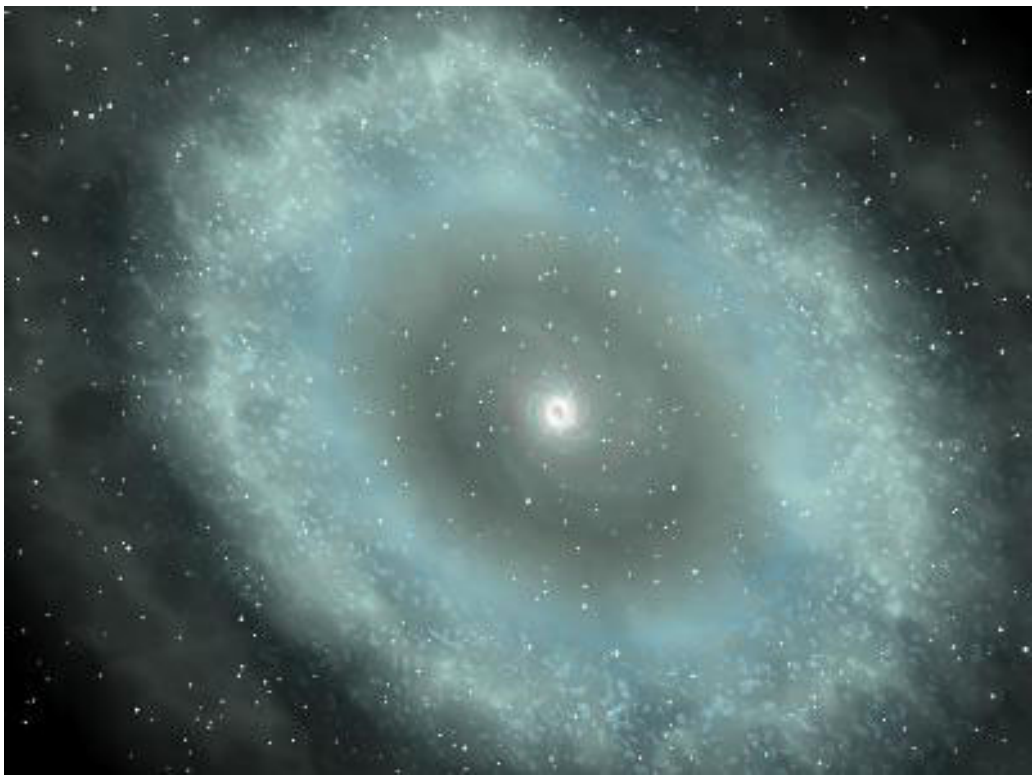
The AUI President, Riccardo Giaconni, joined the Director Fred K. Y. Lo at a ground breaking ceremony for the expansion of the NRAO Headquarters in Charlottesville. As part of the effort to increase awareness of the presence of the NRAO Headquarters in Charlottesville and Albemarle County, Professor Giaconni gave a reprise of his Nobel Lecture, on the development of X-ray astronomy, at the historic Rotunda of the University of Virginia.

Science Highlights

Very Large Array

Star-Forming Disk Revealed in Distant Quasar - VLA observations of the IR-bright quasar PSS 2322+1944 revealed an Einstein Ring of CO emission in this object at a redshift of 4.12. The result is best modeled as a star-forming disk surrounding the QSO nucleus with a radius of 2 kpc. The disk of prolific star formation (900 solar masses per year) around an active nucleus provides strong support for the hypothesis that stars and supermassive black holes formed simultaneously in primeval galaxies.

Investigators: C. Carilli (NRAO), G. Lewis (Sydney), S. Djorgovski and A. Mahabal (Caltech), P. Cox (U. Paris), F. Bertoldi (MPIfR), A. Omont (CNRS, Paris).



Artist's Conception of the Star-Forming Disk.

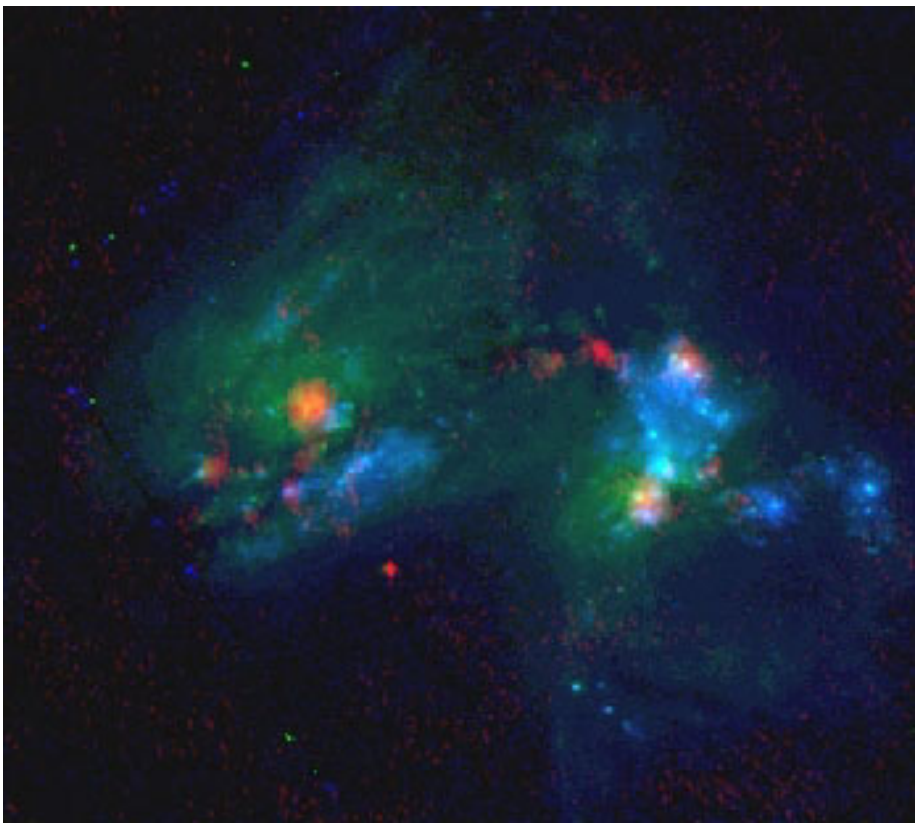
Credit: Geraint Lewis, University of Sydney, NRAO/AUI/NSF

Science Highlights

Very Long Baseline Array

VLBA Shows "Supernova Factory" in Merging Galaxies - Observers used the VLBA to study a "super star cluster" in the merging-galaxy pair Arp 299. Observations in 2002 showed four likely supernova remnants. In early 2003, another observation showed those four plus a new source, shown by follow-on observation to be a supernova. This "supernova factory" is expected to produce a new supernova approximately every two years, and should provide data useful in understanding the star-formation process in merging systems in the early Universe.

Investigators: J. Ulvestad (NRAO), S. Neff (GSFC), S. Teng (U. Maryland).



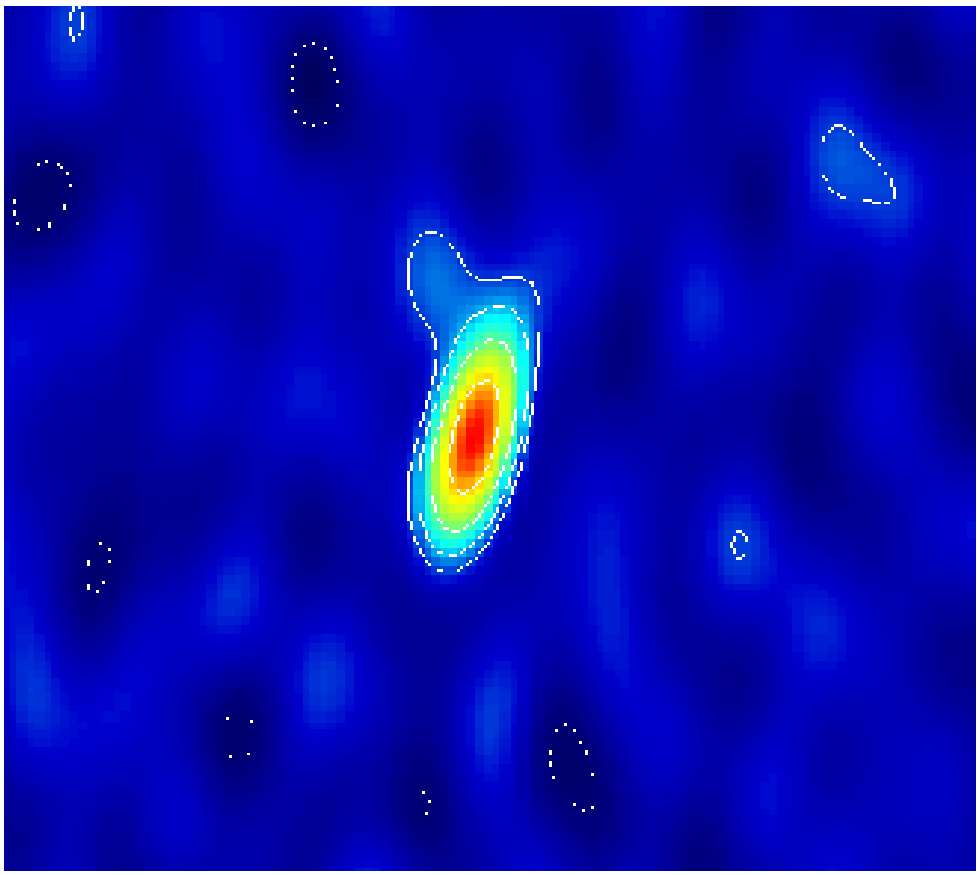
Multiwavelength Image of the colliding-galaxy pair Arp 299 using data from the VLA and Hubble Space Telescope. Here, radio emission is shown as red, infrared as green, and ultraviolet as blue.

Credit: NRAO/AUI/NSF, STScI, NASA

Science Highlights

Gamma-Ray Burst Observation Rules Out Alternate Model - The gamma ray burst of 29 March 2003 (GRB 030329) was the closest yet known, and was repeatedly observed with the VLBA, both alone and in conjunction with Effelsberg, the VLA, and the GBT. One important early result of these high-resolution studies was to test a prediction of the "cannonball model" of afterglow emission. Soon after GRB 030329 was detected, the proponents of that alternate model predicted that VLBI monitoring would reveal a specific amount of proper motion. Instead, the VLBI observations show no proper motion.

Investigators: G Taylor and D. Frail (NRAO), S. Kulkarni and E. Berger (Caltech).



VLBA IMAGE of GRB 030329.

Credit: NRAO/AUI/NSF

Science Highlights

Green Bank

HI Satellites around M31 - Within the Local Group, simulations of galaxy formation predict an unseen population of dark, low mass halos, far exceeding the census of catalogued dwarf galaxies. Observational evidence for such a population is scarce, leading to a "missing satellite" problem. We have obtained Green Bank Telescope (GBT) observations which reveal numerous atomic hydrogen (HI) clouds within ~50 kpc of the Andromeda Galaxy (M31). These objects, seemingly under the gravitational influence of M31's halo, may be interpreted as gaseous counterparts of the "missing" satellites and their merger remnants. Alternatively, the clouds could be tidal debris unrelated to dark matter halos, or in-falling condensations of the Local Group's intergalactic medium. A mix of these origins seems likely, but the evidence for ongoing galactic accretion of gas is convincing.

Investigators: David A. Thilker (JHU), Robert Braun (ASTRON), Rene Walterbos (NMSU), Edvige Corbelli (Arcetri), Felix J. Lockman (NRAO), Edward Murphy (Virginia), Ronald Maddalena (NRAO).

ALMA

The official bimonthly reports to the NSF on the ALMA Project can be found on the NRAO web site at *http://www. alma.nrao.edu/news/*. A summary of significant items during the period of this report is given below.

Evaluation of the prototype antenna from VertexRSI is underway at the ATF site located at the VLA. Early activities concentrate on holographic measurement of the surface. These measurements will be used to adjust the surface to the specified accuracy of 20μm RMS. Following holography, focus will shift to the evaluation of the pointing accuracy and path length errors. Evaluation will conclude with radiometric evaluation. A report of the evaluation of the VertexRSI antenna will be complete by January 2004.

Architectural and engineering design of the civil infrastructure at Array Operations Site (AOS) is well underway. An architectural plan for the AOS Technical Building is complete and detailed design is underway. In addition, detailed design of the antenna foundations is in progress. The scope of this task had to be increased to assure that the foundation could accommodate either the VertexRSI or the Alcatel antenna as the selection will not be made prior to starting civil work on the site.

Fabrication of the two antenna prototype Correlator is well underway. Software integration with the Correlator is occurring in parallel with the population of the racks with circuit cards. The prototype Correlator is scheduled to be shipped to the ATF in December 2003.

A major test of the Local Oscillator subsystem took place during this period. A prototype of the Warm Multiplier Assembly (WMA) was tested using the GBT Spectrometer to demonstrate spectral purity of the output. The WMA accepts the photonically generated 100 GHz reference, locks a YIG tuned oscillator and amplifies the output to drive the final multiplier. The test demonstrated that the WMA meets all of the ALMA specifications.

The Computing IPT held a very successful Preliminary Design Review (PDR) during this period. The PDR panel was chaired by Rodger Doxsey of the STScI. The panel was pleased with the progress of the software design and made some specific recommendations that have been incorporated in the IPT plans. One area of concern to the panel was insufficient detailed planning for the operations phase. Several working groups have been set up in the project to address this issue.

Expanded Very Large Array

Expanded Very Large Array Highlights

VLA Antenna No. 13 was taken out of service in April to be used as the EVLA Test Antenna. Modifications to the antenna so that it can function as a testbed for prototypes of EVLA electronic systems were commenced. Installation of the optical-fiber cable along the arms of the VLA progressed well with installation now 50% complete. A prototype of a new EVLA wideband feed was successfully constructed and tested.

Expanded Very Large Array Progress

Milestones	Original Date	Revised Date	Date Completed
T302 L/S/C-band converter prototype assembled	10/31/02	04/01/03	04/01/03
L302 10.8-14.8 GHz synthesizer prototype assembled	10/04/02	04/23/03	04/01/03
C-band receiver design ready for drafting	02/25/03	04/04/03	04/04/03
Finalize K-band receiver requirements	02/28/03	04/07/03	04/07/03
L302 ICD for MIB software	04/01/03	04/07/03	04/07/03
MIB Service port specification	04/24/03		04/07/03
L301 ICD for MIB software	04/08/03		04/08/03
Start Antenna Outfitting	04/14/03	04/08/03	04/09/03
Assemble feed cone housing for test antenna	04/11/03		04/11/03
Fiber cable acceptance test at station W10	04/14/03		04/14/03
L350 Central reference generator prototype assembled	09/13/02	04/18/03	04/18/03
Rudimentary VLA M&C from CMP	03/31/03	04/30/03	04/30/03
Develop software requirements for VLA Operations	04/30/03		04/30/03
MIB network connection in AOC	05/15/03		05/01/03
West arm trenching of fiber cable completed	05/01/03		05/01/03
Fiber cable acceptance test at master pad	05/02/03		05/02/03
Assemble fiber optics driver board	05/05/03		05/05/03
MIB Service port implementation	05/16/03		05/06/03
L302 10.8-14.8 GHz synthesizer prototype added to bench	04/07/03		05/07/03
MIB RFI tested	05/09/03		05/09/03
Scaled L-band feed measurements completed	05/12/03		05/12/03
M/C network tested - CB to MP	05/15/03		05/15/03
Fiber Installation West Arm	06/27/03		05/25/03
L-band receiver design completed	05/02/03		05/27/03
MIB->technical screens	05/31/03		05/31/03
Design for C-Bank OMT prototype	04/29/02	06/02/03	06/09/03

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
Operational bench integration of the IF data path	06/15/03		06/15/03
T303 U/X-band converter prototype assembled	05/23/03		06/16/03
Correlator wall penetration for fiber	06/23/03		06/23/03
Present results of the EVLA RFI tight enclosure development project at the URSI conference	06/26/03		06/26/03
Fabricate module package for test antenna hardware	06/30/03		06/30/03
EVLA post processing requirements	07/03/03		
Archive ready for test antenna	06/30/03	07/07/03	
Engineering software requirements	07/11/03		
Alpha testing of the correlator backend	06/30/03	07/14/03	
L350 ICDs due for MIB software	11/22/02	07/14/03	
Backend Alpha Version Production Code	06/27/03	07/14/03	
Begin MIB/module integration H/W & S/W	02/24/03	07/15/03*	
L304 LO reference receiver module assembled	07/17/03		
Sampler/DTS module assembled	07/22/03		
Start MIB board assembly	07/22/03		
Antenna fiber internal review	07/23/03		
L301/302 synthesizer modules assembled	07/23/03		
L353 LO transmitter prototype assembled & tested	07/23/03		
Start new M&C system on test antenna	07/25/03		
L305 Antenna reference generator/distributor bench prototype	12/03/02	07/25/03	
Repair feed horn ring machine	07/30/03		
Establish NRAO-NM VPN capability	06/30/03	07/31/03	
Deformatter assembled	07/31/03		
Examine antenna HW module readiness	07/31/03		
Deformatter assembled for test antenna	03/07/03	07/31/03	
Purchase initial computing platforms for embryonic hybrid array control	07/31/03		
Model the performance of all EVLA receivers to determine the predicted noise figure and dynamic range	07/31/03		
Feed cone housing on test antenna	08/01/03		
Electronic racks on test antenna	08/06/03		
Complete hardware bench integration	03/03/03	08/08/03	
T304 down converter module assembled	08/08/03		
Ka-band feed prototype drawings available	04/24/03	08/11/03	
Test antenna on master pad	08/11/03		
Ka-band feed prototype drawings	08/11/03		

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
High level diagrams of stages of hybrid array control system	08/15/03		
Verify that the performance of the Zote Foam LD33 is acceptable for the L, S, and C band RF window	08/15/03		
L305 reference generator module assembled	08/15/03		
Project book chapter updates	08/15/03		
Band switches assembled	08/20/03		
Ka-band receiver design ready for drafting	08/21/03		
Ka-band receiver design completed	02/05/03	08/21/03	
L354 Central reference distributor bench prototype assembled	01/17/03	08/22/03	
Fiber installed on test antenna	08/27/03		
Start RTP testing - antenna to CB	08/28/03		
L354 central reference bench prototype assembled	08/29/03		
Software requirements for real-time system	08/29/03		
Establish and verify the schedule for LNA delivery from CDL	08/30/03		
L-band feed horn assembly structure	03/31/03	08/30/03	
C-band feed horn assembly structure	08/30/03		
High level EVLA M&C functional specification	10/01/02	08/31/03	
Config. EVLA computing infrastructure	03/31/03	08/31/03	
Design the prototype L and C band OMTs	08/31/03		
Manual control of VLA from EVLA AMCS	08/31/03		
Card cage bias card layout	09/08/03		
Advisory Committee Meeting	09/08/03		
Software development plan for hybrid array control system	09/15/03		
Issue draft FY2004 Budget/plan	09/19/03		
Draft correlator M&C software design	02/28/03	09/30/03	
Re-scoping of EVLA M&C software effort after computing reorganization	09/30/03		
Draft EVLA CMIB drive manual	09/30/03		
Take delivery of the 50 GHz vector network analyzer	09/31/03		
New M&C system on test antenna ready for start of array tests	08/29/03	10/10/03	

* waiting for availability of hardware

Expanded Very Large Array

Management

A major update of the EVLA WBS and Schedule was completed during the quarter. The overall budget plan for the project shows that remaining contingency funds are 14% of remaining expenditures. The EVLA baseline cost and 2003 earned value predictions, required for GPRA reporting, were submitted to the NSF.

Systems Integration

Bench testing of prototype electronic modules continued. The first production models of module enclosures and racks designed for high RFI suppression were received and tested.

Civil Construction

Installation of the fiber-optic cable along the arms of the VLA continues to go well. By the end of the quarter, installation on the West arm was complete and the cable had reached station AE6 at the midpoint of the East arm after boring under highway 52. This means that fiber installation is now 50% complete and is approximately 6 months ahead of schedule. Fiber burial is expected to slow as trenching proceeds through the rocky terrain past AE8. Rental of a rock saw is scheduled for mid-July.

Antenna

VLA Antenna No.13 was taken out of service in April to be the EVLA Test Antenna. Overhaul of the antenna and the structural modifications required for the EVLA design were begun. The Feed Cone is ready for installation and the prototype AZ cable wrap, which will carry antenna fiber transmission lines, was installed and tested in Antenna 6.

Front End

A scaled model of the L-band feed was constructed and successfully tested, demonstrating that good feed performance over the wide 2:1 bandwidth EVLA bands is attainable. The machine for making L-, S- and C-band feed rings was completed. The machine shop made L-band Feed assembly fixture parts that hold components in place for fiberglassing. Design work for the L-band, G& H racks, and L-band OMT continues. ES Drafting is doing 3-D modeling of L-band OMT parts for possible casting of the L-band OMT parts. Requirements documents for the initial three new receivers, L, C and Ka band, were completed. Design of a new card-cage for the new suite of receivers was commenced as were the wide-bandwidth modifications required for the K and Q band receivers on Antenna 13.

Expanded Very Large Array

Local Oscillator (LO)

Bench prototypes of most of the LO modules were completed and testing and programming was commenced.

Fiber Optics

The fiber paths required for the Test Antenna in the VLA Control Building were installed. The fiber path from the Control building to the Master Pad, where initial outfitting of the Test Antenna will occur, was successfully tested.

Intermediate Frequency System

Bench testing of the prototype Down Converter continued and construction of an integrated version, using MMICs and surface mount components, was proceeding. At the request of the Mexican partners, an attempt was made to have the Mexican partner procure an integrated version of the U/X Converter. This effort failed when the Mexican funding entity refused to fund development work and so this work is proceeding from within the US EVLA project.

Correlator

With Canadian funding for the correlator secured, work continued by the Canadian Partners on the detailed design of the correlator. One important focus of the work was on the issue of whether to build the prototype correlator using Field Programmable Gate Arrays, as originally planned, or to bypass the FPGA step and develop the final Application Specific Integrated Circuit (ASIC) for the prototype correlator. The final decision on this issue should be made next quarter. The Canadian Partner worked with a management consultant to set up a detailed WBS and Schedule for the correlator project and hired an administrative aide to maintain this documentation. They also hired a senior software engineer to head their correlator software effort.

Monitor and Control

Good progress was made on the design and debugging of the new Module Interface Board (MIB) which will be used to Monitor and Control all EVLA hardware. Functionality of the prototype MIB has now been demonstrated. Construction of transition modules, required to Monitor and Control some of the old VLA hardware using the new EVLA M/C system, was commenced. A monitor data archive, required for the monitoring of the EVLA Test Antenna, was provided.

Expanded Very Large Array

Data Management and Computing

A major activity during the quarter was participation in the discussions concerning the re-organization of the AIPS++ and e2e projects. Requirements documents for EVLA work in these two software areas were drafted.

Green Bank Telescope

Green Bank Technical Highlights

In early April, a team of scientists and engineers from Green Bank, Socorro, and Cambridge University (UK) joined to implement an out-of-focus (OOF) holography system for GBT surface measurements. In the OOF holography technique, holography maps are taken at two focus settings and processed to give a phase map of the surface. The advantage of the technique compared to conventional, phase-coherent holography is that celestial sources and regular, facility receivers can be utilized. The sources can be tracked over the sky to show how the surface may change with elevation angle. The OOF reduction software was developed at Cambridge. The OOF technique usually does not provide as high a surface resolution as phase-coherent holography. The two techniques can be combined such that conventional holography gives fine resolution data at one elevation angle (toward a geostationary satellite beacon), and the OOF holography gives the large scale structure as a function of elevation angle. The initial results of the project are described in the PTCS section below. This project was an excellent example of both inter-site and external group cooperation.

GBT Antenna & Operations

Milestone	Original Deadline	Revised Deadline	Date Completed
Inspection of GBT welds/structure	06/30/02	09/30/03	
Continue site access improvements	12/31/02	deferred	
Cracked wear plate replacement	03/15/03	04/09/03	04/09/03
Track retrofit shop weld demonstration	04/30/03	04/30/03	05/23/03
Azimuth track trial retrofit field weld	06/10/03	06/10/03	06/11/03
Complete Phase I of track analysis	07/31/03		
Complete Phase II of track analysis	10/31/03		
Complete Retrofit trial period	12/31/03		
Complete Development of non rail concepts	12/31/03		
Hold Review Panel Meeting	01/31/04		

Green Bank Telescope

GBT Electronics

Milestone	Original Deadline	Revised Deadline	Date Completed
K band receiver upgrade	09/30/03		
Spectrometer sampler rework	01/30/03	07/30/03	
Spectrometer Spigot card completion, expert mode	02/28/03	09/30/03	
X band receiver upgrade	01/30/03	05/01/03	05/01/03
C band receiver upgrade	02/28/03	04/15/03	04/15/03

GBT Mechanical Engineering and Central Instrument Shop Work

Milestone	Original Deadline	Revised Deadline	Date Completed
K band OMT's for GBT & VLA (10)	06/02/03		04/14/03
Q band feeds for VLA (2)	05/30/03		05/08/03
Ka band feed for GB (Re-designed)	05/30/03	07/15/03	
ALMA Module boxes	07/08/03		
VLA K-band front-ends (5)	07/25/03		
Ku band Phase shifter mandrel (4)	09/04/03		

GBT Software and Computing

Milestone	Original Deadline	Revised Deadline	Date Completed
Visiting observers infrastructure & facilities	06/30/01	8/31/03	
1st Use of Project Office for Development Cycle Planning	04/23/03		04/23/03
Institute Software Customer Satisfaction Surveys	06/30/03	08/31/03	
M&C v3.13 -Active Surface Improvements Phase 2 (Add new samplers, Enforce splitting of actuator commands) -Spectrometer Improvements Phase 6 (Reliability Improvements, Port to Linux) -Ease of Use Initiative Support (At least 3 MRs TBD)	04/23/03		04/23/03

Green Bank Telescope

Milestone	Original Deadline	Revised Deadline	Date Completed
EMS v1.0 -Support for Trilateration Experiment -Data Capture and Playback from Laser Rangefinders -Matlab Interface -Database Interface	05/16/03		05/16/03
M&C v3.14 -Temperature Monitoring Manager -Active Surface/Antenna Issues in support of PTCS (At least 2 MRs TBD) -Ease of Use Initiative Support (At least 3 MRs TBD)	06/04/03		
Complete Linux Migration Project Charter	05/31/03		05/31/03
M&C v3.15	07/02/03	07/09/03	
M&C v3.16	08/20/03		
M&C v3.17	10/01/03		

GBT Projects

Milestone	Original Deadline	Revised Deadline	Date Completed
PTCS: LRF calibration problem resolved	1/31/03	5/16/03	5/16/03
Antenna temperature sensor initial operation capability	6/4/03		6/4/03
PTCS: In-progress review	10/6/03		
PTCS: Feedarm tip trilateration experiment	8/15/03		
PTCS: Antenna temperature sensor installation complete	8/15/03		
PTCS: Ready for Q-band observing	9/30/03		

Science Center at Green Bank

Milestone	Original Deadline	Revised Deadline	Date Completed
SC main building informal opening	05/24/03	05/24/03	
SC main building construction complete	10/15/02	07/31/03	
SC Dedication	05/26/03	08/29/03	
SC dormitory construction complete	07/18/03	09/30/03	

Green Bank Telescope

GBT Commissioning and Observing Activities

GBT commissioning has been completed for frequencies of 26.5 GHz and below. Seven facility receivers cover most of the frequencies from 300 MHz through 26.5 GHz. Six of these receivers are now in routine use, and the seventh (Prime Focus 2) will follow this summer. Backends include the GBT Spectrometer, which is available in most of the priority bandwidth and resolution modes, the Spectral Processor, the Digital Continuum Receiver, the Berkeley-Caltech Pulsar Machine (BCPM), VLBI recorders, and the Cornell/JPL Fast Sampler radar system. Basic observing modes are available for spectral line, continuum, on-the-fly mapping, pulsar, VLBI, and radar observing.

During the second quarter, refereed observing programs were scheduled for about 45% of total telescope time. Most of the remaining time was allocated to summer maintenance activities, which include a major azimuth track retrofit and structural painting. Structural inspections will be conducted in July and August. By the fourth quarter of this year, we expect that the fraction of observing time will rise to 60-70%.

Structural painting and inspections will be an annual, summertime activity on the GBT. Typically, work on these activities will be scheduled for 10-12 hours per day, 4 days per week, during 2-3 months each summer. The structural inspection work will be done by an outside contractor, and the painting by temporary workers under NRAO supervision. We have scheduled our own work groups to work this same schedule, with the intention of getting as much maintenance done during the summer as possible, so that maintenance time can be minimized during the other months of the year. We plan to reduce maintenance time to three days per week by October, and will attempt a further reduction to two days a week during the winter months. Because of the number and complexity of GBT systems, preventative maintenance, repair work, and scheduled equipment changes, maintenance will likely require 2 -3 days a week during the fall, winter, and spring months.

The staff has made considerable progress in both the hardware and software of the GBT Spectrometer, and it is now in routine and generally reliable use. There are still occasional crashes that require the system to be restarted, but these becoming less frequent and are being resolved more quickly. To achieve best reliability and to reduce our maintenance costs, we will likely make a number of hardware modifications and retrofits over the coming year. We have formed a project team to develop and execute these changes.

Work will continue in a number of key areas during the 3rd and 4th Quarters. Prime Focus 2 Receiver (PF2), which covers 900-1200 MHz, has been installed and will be commissioned in July. The 40-50 GHz (Q-band) receiver underwent successful initial engineering checkouts in the first quarter, and scientific commissioning will be completed this autumn. Several pointing and surface control improvements as part of the Precision Telescope Control System project will improve scientific performance in the 40-50 GHz band this year.

Green Bank Telescope

Azimuth Track

There has been much activity and considerable progress over the past quarter on the GBT Azimuth Track. The work included the track retrofit trial, replacement of cracked wear plates, metallurgical analysis of a cracked plate, finite element modeling of the track, determining an accurate weight and wheel loading for the GBT, and continuing field tests of shimming materials.

A primary recommendation of the Azimuth Track Review Panel, which met in Green Bank last October and November, was to perform a trial retrofit of the track at one joint in which the base plate joint is welded and then bridged with a staggered wear plate. This project required a number of detailed steps that were carried out over the past few months. First, the joint weld configuration was designed and analyzed. The bridging wear plate joints were designed and specified as chevron configurations, as opposed to the existing 45-degree miter, to provide balanced loading as the wheel passes over the joint. Two different opening angles were used on the opposite ends, and will be evaluated to determine best performance. A contract was let to manufacture the retrofit wear plates, as well as in-kind replacements of cracked plates. A weld procedure was specified for a shop test weld on a base plate mockup, and the contract was awarded to an experienced industrial welding firm. The procedure is quite extensive, and includes first machining a slot down the sides of the plates, then a 3-inch deep V-groove across the 38-inch diagonal of the base plate joint, weld pre-heating, machine welding of the base plate, drilling a horizontal hole along the base of the weld over the full 38-inch diagonal to remove the root of the weld, and final grinding of the top surface. The contract firm performed the test machining and welding in their shop in mid-May. The entire process was witnessed by two NRAO engineers, and was quite successful. A contract was then awarded to perform the field weld on the GBT. This work, including the attachment of side braces and the installation of the new wear plates by NRAO staff, was carried out over a 10-day period in early June. The firm's field technicians, aided by a large number of NRAO staff, worked around the clock to carry out the work. Follow-up ultrasound and boroscopic inspections showed that the weld was excellent - no flaws were detected. The work was completed and full telescope operations were resumed on 11 June. While azimuth motion was restricted during the project, the telescope was successfully used for two drift scan experiments.

The performance of the welded joint will be carefully measured and monitored over the next several months. We are measuring wheel tilts at the joint and have measured with a laser interferometer the deflections of the wear plate and base plate as a wheel traverses the modified joint. These measurements, together with the performance of the joint over the next several months, will determine whether it is a suitable solution for the azimuth track problems and can be applied to the other 47 joints.

As described in previous reports, 13 of 48 wear plates were found to have cracks on their ends in mid-January. The cracks were serious on four of these plates, and more minor on the remaining ones. The four most seriously cracked plates have now been replaced. No additional new cracks or any obvious progression of existing cracks have been observed. The plate with the most serious crack was cut into sample sections and sent to a metallurgical laboratory for analysis. Microscopic and Charpy impact

analysis indicated a high degree of fatigue and brittleness. An additional sample from the cracked plate and a comparison sample of the stock of new plate material are now being analyzed. Both the old and new steel material are AISI 4140, with a minimum hardness of 360 Brinnell. Investigations into other materials that may have longer fatigue life are underway.

Our current status on the three, main action items recommended by the Azimuth Track Review Panel is as follows:

Task 1. *Analytical Effort*. The total dead load of the telescope on the track was determined to be 16,727,000 ±48,000 pounds. A 2-dimensional finite element model has been developed, and is being reviewed. A 3-dimensional model will then be developed during a second phase. Undulating loads on the wear plate bolts have been measured, and some experiments are being planned to investigate and mitigate the effects of these forces.

Task 2. *Retrofit of existing rail and data gathering*. The three most seriously cracked plates were replaced, and monitoring of the wear plates for cracks continues. Metallurgical analysis of the wear plates determined that the failure was due to operational fatigue of the plates and was not a material defect. Four spare plates will be on hand if propagation of existing cracks, or detection of new cracks, warrant replacement of plates. Alternative plate material is being researched concurrent with track modeling and new track design. Deterioration of the zinc shim material was noted, and is being replaced with the Teflon-bronze composite, which was the other material under evaluation. The Teflon-bronze material continues to hold up well. Both the shop demonstration weld and the field modification of the track itself were completed by June 11, and evaluation of improvement and durability is in progress.

Task 3. *Development of New Rail Concepts*. Definition of criteria is in progress, as well as material research as noted above.

Spectral Baseline Improvement Program

Most of the effort on GBT spectral baselines has involved more detailed measurements of electronics subsystems. On the Ku-band (12-15 GHz) receiver we verified that the spectral peaks in system temperature were due to leakage from the waveguide thermal gap exciting flange and/or dewar cavity resonances. Electromagnetic modeling of the thermal gap verifies what is seen experimentally. A new, lower leakage gap structure has been designed and is being fabricated. The X-band (8-10 GHz) feed was found to have several fabrication defects that allowed energy to leak into resonant gaps in the feed-waveguide structure, which, evidently, were causing this receiver system to have much finer scale structure in its system temperature spectrum than was seen on other receivers. When these fabrication defects were corrected the spectrum was measured to be much smoother. More work on characterizing and possibly improving receiver noise spectra remains to be done.

The causes of the temperature-dependent spectrum ripples in the IF system have proved to be even more complex than first measurements indicated. The initial hypothesis that impedance mismatches at the ends of IF cables were causing frequency and temperature dependent gain structure in the spectra is still probably correct, but small amounts of cross-talk between IF channels and leakage into the LO ports of the second mixer were discovered to have substantial effects on wideband spectra. The exact mechanism for these effects manifesting themselves as temperature-dependent spectrum ripples is not yet firmly established, so this work continues.

Modulators for the optical fiber IF system were identified as producing gain ripple with period of 2.4 MHz. Small instabilities in the gain ripple introduces corresponding ripple in spectral baselines. Last year a next generation modulator was purchased that produces much reduced ripple. A full complement of these compensated modulators are now on order for delivery in the third quarter. An internal report on the baseline investigation to date is nearly complete.

GBT Operations and Maintenance

Telescope Operations Activities

A Contract has been awarded to Modjeski & Masters to inspect the telescope structure. The critical members of the tipping structure will be inspected in the 3rd Quarter, and the alidade and one-half of the back-up structure will be inspected in the summer of 2004. Painting of the structure, (according to a multi-year schedule) is in progress, and will follow inspected areas.

GBT Electronics

PTCS Project Work

Support was provided to the PTCS project at a level of about 5 FTE's. These activities included project engineering, system design, electronics design, electronics maintenance and construction, and installation activities.

Digital Group

Spectrometer work

We continue with commissioning and repair activities on the GBT spectrometer. The Long Term Accumulator cards have been found to be slot-dependent, that is, they work better in some slots than others. The cause of this is unknown at this time, but is thought to be related to marginal timing.

Green Bank Telescope

We, along with the Software Development Division, replaced the obsolete SPARC VME-based data collection computers with standard PCI Linux computers tied to the spectrometer with a VMEbus adapter card. This was done to allow troubleshooting the LTA problems that would result in occasional bus lockups, necessitating a long reboot and reset cycle. This was successful, and the system was brought back to life with the ability to debug failures in the data transfer subsystem.

The clock speed of the system monitor board was doubled to 32 MHz. This work was necessitated by the 1.3 ms interrupt handler taking longer than a character time, which resulted in occasional system lockups and data failures. There have been no failures of this type since the clock speed was doubled. Work continues on investigating the need for changing the clock speed of the other boards in the system. The LTA card probably requires this. It is not clear if any other cards will need the clock speed increased.

Pulsar spigot card work continues. A problem in the system design was found and fixed. This problem was a failure to synchronize the card with the 1 PPS tick to which the rest of the system was synchronized. This resulted in an apparent phase jump at startup.

Work on a hardware reset system for the spectrometer microcontrollers was nearly completed this quarter. This will allow remote reset of the microcontrollers under software control. This modification will be installed in the next quarter. Design of the new test fixture continues at a low level. This test fixture will support of polarization cross correlation tests.

A formal spectrometer completion project is being started up this quarter to address all commissioning, reliability, and performance issues in the spectrometer. This will include a timetable for the implementation of pulsar modes. About three electronics FTE's were spent on the spectrometer this past quarter.

Antenna Support

The digital group also provided engineering and technician support to antenna operations for GBT servo systems and electrical systems support. About 1.5 FTE's were supplied this quarter.

Network and Infrastructure support

Support was provided to maintain printers, install fiber optic connectors, move computing equipment, and so forth. About 0.5 FTE was provided for this task.

RFI Mitigation Support

The digital group supplied technicians and considerable engineering help to RFI mitigation projects. The GBT vendor-supplied feedarm servo system RFI was brought under control. The doors and windows in the Jansky Lab were repaired. About 1.2 FTE's were supplied to this effort.

Microwave Group

GBT Baseline Improvement Project

The microwave group spent much of its time on baseline improvements. Much of the work of characterizing the baseline defects is complete. Problems have been found in the front ends, Fiber IF transmission system, and the converter racks. Mitigation strategies for these are being determined (see the Spectral Baseline Improvement report above).

Receiver Maintenance

Various other routine receiver problems were solved, including broken cables, failed transfer switches, refrigerator failures, and so forth.

Cryogenics

Routine support for Green Bank and the CDL was provided by the cryogenics group. This includes compressor repairs and maintenance, refrigerator maintenance, and emergency repairs to receiver cryogenics.

RFI Group

Jansky Lab shielded rooms

The shielding effectiveness of the control rooms has been repaired. The complete testing has yet to be done, due to more pressing business, but it is anticipated that the rooms now provide the 60 dB of shielding that was originally specified.

Servo System RFI suppression

This work was completed this quarter, with testing at L-band and 300 MHz successfully completed.

Green Bank Telescope

Anechoic Chamber RFI testing

The RFI group tested many items for GB personnel, including security cameras and badge readers for the Safety division, stepper motor drivers for the Penn Array receiver, and DC motor testing for the laser rangefinder covers.

Site RFI Testing

Tests were performed on the GBT to isolate troublesome RFI problems. The LO Reference receiver was found to be a source of RFI, as well as the GBT's HVAC system. The LO reference receiver is being rebuilt to be RFI-tight, and will be completed this quarter. The HVAC system is being evaluated for impact on observations, and may be mitigated next quarter.

NRQZ Management

More license applications and site visits were processed this quarter. Our new NRQZ administrator has assumed much of the routine processing workload. More time can now be spent on technically challenging applications and those requiring radiated power limits.

A technical seminar was given to the GB staff on the topic of RFI management. This seminar will be given to the Charlottesville staff next quarter.

Metrology Group

The metrology group spent much of the time this quarter preparing for the PTCS Engineering Measurement System (EMS) experiments. The laser rangefinders were tuned and calibrated, and the software tested.

The laser rangefinder cover prototype was received. Various problems with the prototype were found, and the prototype was returned to the vendor for rework. We expect the prototype to be returned to NRAO shortly for evaluation.

GBT Mechanical Engineering Development

During the second quarter of 2003 the Mechanical Engineering Division has been working with the PTCS group to develop the hardware necessary to install the temperature monitoring system on the GBT. The division has also been working with Telescope Operations and Lee King to complete implementation of the track modification trials outlined by the track review panel. Mechanical Engineering has also completed work on a handling system for the GBT PF2 receiver. Third quarter work will include continued work in the outdoor antenna range rotator and will begin a concentrated investigation into new track design elements.

Green Bank Software Development and Computing

GBT Software Development

In late Q2 2003, the Software Development Division (SDD) became the Single Dish Software Development Integrated Product Team (SDD IPT), as it grew to become a more diverse group of software engineers and astronomers from both telescope control and data analysis disciplines. The combined team will begin to execute work jointly in Q3 2003. Please visit *http://projectoffice.gb.nrao.edu* for comprehensive information about SDD IPT strategy and goals extending throughout the remainder of 2003 and 2004, in addition to Project Charters and Modification Requests which can be reviewed to examine project progress at any level of detail.

Significant analysis work has been performed during the most recent quarter to understand the improvements that GBT users desire for data analysis and accessibility. Two projects are in place and are being refined to support data analysis goals: the Ease of Use initiative, which spans telescope configuration, observing, status, and user satisfaction, and Data Handling Improvements, which covers data export and accessibility, data preprocessing components, data display and eventually imaging.

A major decision has been made to make it easier for observers to reduce their data in packages other than AIPS++ . A key limitation in the past has been that the GBT produces a suite of FITS files that contain information important to both engineers and astronomers. The solution being explored is to generate a single FITS file, which contains data that has been preprocessed in a user specified manner. From this, SDD IPT will then work to enable a data path for users who prefer IDL, CLASS, and AIPS; this is intended to be done through collaborations with observers who extensively use those packages for their own research programs.

Prototypes have already been developed for generating the SDFITS file, and are now being examined and validated for accuracy. Early returns in Q2 2003 show that the SDFITS step makes it much easier to produce plots in IDL, and several of these plots have been produced already for both continuum and spectral line modes. The processing speed and response time is impressive, and will be explored further in the second half of 2003.

Green Bank Telescope

This prototype work has been extensively conducted in this area during Q2, making use of tools developed within the SDD such as FITS Query Language (FQL). Python is also being explored for its utility to solve complex data analysis problems quickly and easily. In support of PTCS experiments, two Python scripts with associated visualization components were crafted to show how pointing and focus data could be reduced. A "modular algorithm" design was used, meaning that specific algorithms for preprocessing data can be swapped in and out interactively, allowing for extreme flexibility while retaining simplicity.

Non-data analysis work this quarter by the Green Bank SDD focused on completing software tasks in support of hardware troubleshooting for the spectrometer, continued incremental improvements to the active surface system in support of October 2003 goals for the PTCS project, antenna improvements, releasing software to support PF2 commissioning in July, several fixes to support experiments with the laser rangefinder system, and enhancements to the Engineering Measurement System (EMS) to support trilateration and other PTCS experiments. The SDD completed enough components for the EMS by mid-June that trilateration experiments were able to be conducted quickly and easily by PTCS scientists and engineers. Manager software was put in place for the new PTCS temperature monitors. A Project Charter was developed to guide the group as it migrates key systems to Linux over the next 18 months, in accordance with the SDD goals set in 2002. Also, a design was completed for Phase 1 of the Antenna Test Range, which is being continued from last summer, targeted for completion at the end of August.

The SDD produced two regular, monthly releases of its key product, M&C, with v3.13 on April 23, 2003, and v3.14 on June 16, 2003. Changes to the schedule were made for the second release to accommodate the telescope shutdown in early June, as well as PTCS experiments that required improvements in antenna behavior. A highlight of this quarter is that the errors in the antenna trajectories which have been visible for the past several quarters were remarkably improved. Although additional work may be necessary, this represents a key accomplishment.

The suite of astronomical regression tests that was developed in Q4 2002 in conjunction with the AIPS++ group were executed for both releases this cycle. Due to recent organizational changes, the regression tests will be formally executed by members of Scientific Services Division in the future, and the process for conducting the tests will be learned by additional members of the team in an effort to automate these tests by the end of 2004.

Progress towards 2003 goals in software operations were furthered during Q2 2003. Building upon the framework that was established last year at this time, the SDD expanded its unit tests for the M&C product from 250 to 309 by the end of the period. Continuous refactoring was continued and build warnings dropped slightly from 59 to 44. This continuous improvement effort will result in 0 Errors and 0 Warnings by the end of 2003.

Green Bank Telescope

Work continued on establishing and utilizing management metrics during Q2. By the end of the year, the goal is to have sufficient metrics in place and to understand their use so that slowdowns in productivity can be readily identified and remedied. As described in last quarter's report, delivery velocity is one metric being explored. This shows how well the group estimates and executes on the commitments that it agrees to at the beginning of the development cycle. Although the SDD aimed to keep its delivery velocity at or above 1.0, real measures were well below this value showing that there is plenty of room for improvement.

One of the group's primary goals for the first half of 2003 is to improve responsiveness to small, high impact requests. In Q2, several responses and resolutions were provided and included in releases where appropriate to support GBT goals.

A standard, semi-quarterly development cycle will be put in place at the beginning of July to align software development activities with engineering, operations, and science activities in support of achieving site-wide goals for the GBT. This implies that there will be two, and only two releases each quarter in the future.

Green Bank Computing

Over this quarter there has been a focus on the accelerated Common Computing Environment (CCE) project. One of the highlights of this was finally eliminating all the UID and GID clashes between sites. With this done the possibility of observatory wide unix logins can now be explored. This work has also cleared the way for the deployment of RedHat 9.0. Green Bank has taken a leading role in the preparations for this, helping to ensure that differences between sites will be minimal and invisible to users as much as possible.. On the Windows side there has been considerable progress towards bringing the Windows 2000 AD domain into active testing prior to the roll out scheduled for later this year. Another aspect of the CCE work that will make life easier for users is the redesign of the NRAO "Gold Book" which brings together much information on computing at NRAO. Staff are strongly encouraged to take a look at this.

As is usual this quarter the division has been making arrangements for the annual crop of summer visitors. Specifying and purchasing 20 new machines, finding space for them, arranging network connectivity etc. The computing division was also able to support the highly successful Autocad Inventor training class held in May. Setting up the 20 new machines plus a few others in the auditorium and installing the appropriate software went very smoothly. These 20 machines are now mostly deployed for the use of summer students and those attending the upcoming single dish summer school. As the students finish the new machines will be redeployed to replace aging machines and ensure that all those who need to run Autocad Inventor have a machine that is capable of doing so.

More changes have been made to help improve the reliability of the telescope control systems, further decreasing their dependence on the general computing. Critical applications and system tools are now mirrored to those machines that are required for telescope control instead of being mounted across the network. In addition the disc storage available for raw telescope data and logs has been doubled. Two new astronomical data reduction packages have been installed: the UK starlink software collection and the CLASS package.

GBT Development Projects

PTCS

As noted in the previous report, the PTCS Conceptual Design Review was held on April 8 and 9, and was very successful. All of the review material, including the panel's report, is available from the PTCS web site at: *http://www.gb.nrao.edu/ptcs*.

Since the review, we have made considerable progress in most of the areas identified in the Project Plan, with a goal of being ready for Q-band operation by October 2003.

In April, Claire Chandler from NRAO Socorro and Bojan Nikolic of Cambridge, UK visited to work on "out-of-focus" holography development. The primary aims of this trip were to install the Cambridge analysis software at the GBT, to develop appropriate data taking and processing strategies, and to generate scripts to automate the data acquisition and reduction. All of these aims were achieved. Test observations were performed in continuum and using the 22.2GHz water and 12.2GHz methanol lines. The initial reduction of these observations resulted in a systematic displacement of the fitted aperture illumination, throwing doubt on the fitted phases. This problem is now largely understood, although some details remain to be resolved. Some further traditional holography was attempted in May, but was again hampered by instrument problems. These have now been resolved, and further observations will be made in July.

Excellent progress has been made on the design, development and installation of the antenna temperature sensor system proposed at the Conceptual Design Review. In its final form this consists of approximately twenty YSI 083 thermistors, installed at strategic locations on the feed-arm, alidade and backup structure, communicating back via RS232 to a small number of terminal servers. Considerable attention has been paid to the thermal, RFI and ESD design of the system to ensure robust, reliable and accurate operation. Performance tests of the initial prototype sensor, now installed on the antenna, demonstrate that the measurement repeatability is better than 0.05C and accuracy is better than 0.2C. All design and development is now complete. The initial sensor was installed on the telescope at the start of June, and the full installation will be completed in August.

Work on the Engineering Measurement System has also been proceeding well. The Software Development Division has completed the initial WiT framework, as described at the CoDR. Kim Constantikes has planned the initial experiment, which will be to trilaterate retros on the tip of the feed-

arm as the antenna is tipped in elevation, and is developing the algorithms required to analyze that experiment. At the same time, the metrology division have been preparing the laser rangefinder units. This has included checks of the alignment of the monuments and the rangefinders themselves, and refurbishments of a number of units, including repair/replacement of some 1500MHz oscillators and IRIG cards. Work has also been performed to better characterize the rangefinder pointing performance. A dry run of the experiment was performed on 1st July, and the actual experiment (including real-time data analysis) is scheduled for the end of July.

A number of upgrades have been made to the Antenna Manager, both to improve it's performance, and to allow more direct measurement of local pointing corrections. A number of problems with antenna trajectory calculations had been identified, which primarily affected the antenna position at the start of the scan. The worst of these was a problem which caused a slight misalignment between the end point of the slew trajectory and the start point of the scan. This could cause vibrations to be induced when the servo attempted to move to the target position. This, and some more minor problems were fixed with the release of M&C V3.14, and further upgrades are planned for the next release. At the same time, additional information has been written to the Antenna FITS file, to allow local pointing offsets to be determined directly in (az,el) co-ordinates, and new data analysis scripts are being written, using python and FQL, to streamline the fitting and analysis of pointing data.

Penn Array Receiver

During this quarter, the Penn group has started to work much more closely with Green Bank engineering staff in order to finalize mechanical, electrical, and software interfaces with the GBT. Significant progress on the interfaces was achieved but there was more work here than the initial schedule had allowed for and this has delayed the CDR to later in the year. However, we have been able to do this without delaying the delivery date. During this period the Penn group also finalized designs for the cryogenic and optical systems and these are ready for review. The Goddard group has made good progress with the detectors, and in particular has solved an excess noise issue which had not previously been understood.

Somewhat independently, Brian Mason and Bill Cotton have been investigating analysis strategies for the Penn Array data. Don Wells and Fred Schwab have also contributed, and in Q2 Penn graduate student Michelle Caler joined the effort. Michelle will be working first on the quick-look and pointing software for the array. Since resources for software were not allocated in the agreement signed with Penn in January of 2002 these activities are not within the scope of the upcoming Critical Design Review, but they are important for the success of the receiver and an analysis software status report will be given at that time.

Green Bank Telescope

1cm & 3mm Receivers and Continuum Backend

Caltech completed the software interface library for the Caltech continuum backend and delivered this in June. This package includes a simulator for the backend, an innovation which should make the job of writing a device manager significantly quicker and easier for the Green Bank Software Development Division. Following a personnel reorganization at Caltech, Martin Shepherd has taken on the task of designing and building the digital electronics as well as the software and late in Q2 reported good progress. The project is moving towards a CDR in fall of 2003 with a delivery date in Q1 2004. After being placed on hold to free efforts for IF and spectral baseline improvements, the 1cm receiver was again placed high on the priority list in Q2. Lab testing and integration is proceeding apace with an intended commissioning date of January 2004. 3mm heterodyne receiver development is currently on hold.

Mechanical Engineering and the NRAO Central Instrument Shop

Work was completed on ten K-band OMT's for both the VLA and Green Bank and on two Q-band Feeds for the VLA. The Central Instrument Shop has also worked with Operations to implement the track modification trials outlined by the track review panel. Early next quarter the shop will complete a large run of electronic module boxes for ALMA and the revised Ka-band feeds for the GBT. Work is also expected to start next quarter or early in the 4th quarter on a cryostat for the GBT Penn Array. Work will continue on various parts for the GBT Ku-band receiver including efforts to improve the Ku phase transition mandrel.

Very Large Array and Very Long Baseline Array

VLA Highlights

We have completed instrumentation of all 28 VLA antennas with 43 GHz receivers, in a project that began in the 1990s. This project has made use of a combination of funding over the years from Conacyt (Mexico), the Max-Planck Institut fur Radioastronomie (Germany), the National Science Foundation Major Research Instrumentation fund, NRAO operations funding, and EVLA Project funds. Holographic measurements and the resulting panel resetting, together with much-improved pointing capabilities, enable the VLA to make effective use of the 43 GHz frequency. This frequency is a factor of two higher than the original design specification of the VLA; it provides resolution of better than 50 milliarcseconds, and enables new scientific investigations in the areas of star formation and galaxy formation. The detection of CO 3-->2 in the highest redshift quasar, described in the scientific highlights, is a prime example of the use of this system.

VLBA Highlights

A scientific symposium entitled "Future Directions in High Resolution Astronomy," in honor of the 10th anniversary of the dedication of the VLBA, was held in June 2003. Over 100 scientists attended, including a significant number of early-career scientists who are using the VLBA for their scientific research. A wide range of topics was covered in addition to the "traditional" VLBI science. Examples of the new applications that have been enabled over the last 10 years included studies of Galactic star formation and evolved stars, time-lapse photography of supernovae and microquasars, and the study of bursts of star formation in external galaxies.

Management and Scientific Services

Milestones	Original Date	Revised Date	Date Completed
Begin Third Session of VLA-Pie Town Link Observing	06/10/03		06/01/03
VLA/VLBA Proposal Deadline	06/02/03		06/02/03
VLBA 10th Anniversary Symposium	06/30/03	06/12/03	06/12/03
VLA Visitor Center Gift Shop Opening	02/28/03	06/30/03	06/16/03
Summer Student Arrival Completed	06/20/03		06/18/03
Automated Monitoring of AIPS Software Downloads	06/30/02	05/31/03	06/18/03

Very Large Array and Very Long Baseline Array

Milestones	Original Date	Revised Date	Date Completed
EVLA Completion Plan Draft Finished	03/31/03	04/07/03	06/22/03
VLBA Automatic Experiment Release Implemented	07/15/03		
Announce new Rapid Response Science Procedures	07/31/03		
VLA Loses One Antenna as EVLA Prototype	06/30/03	08/11/03	
VLA/VLBA Proposal Deadline	10/01/03		
VLBI Calibration Transfer for 1 VLA Antenna	05/26/03	10/15/03	
VLBI Calibration Transfer for GBT	10/15/03		
VLBI Future Report Completed	09/30/03	10/30/03	
Complete Tests of Resurfaced Subreflector at Pie Town	05/15/03	10/30/03	
New Mexico Symposium/Jansky Lecture	11/15/03		
Modular Office Space Occupied	05/10/03	12/15/03	
VLA/VLBA Target of Opportunity Implementation	10/31/03	01/02/04	
Release frozen 31DEC03 AIPS version; begin 31DEC04	01/02/04		
Complete VLBA Pilot Program for Spacecraft Navigation	01/30/04		
VLA Large Proposal Deadline	02/02/04		
VLA/VLBA General Proposal Deadline	02/02/04		
Santa Fe Workshop on Radio/X-ray Connections	03/31/04		
Synthesis Imaging Summer School	06/30/04		

Electronics

Milestones	Original Date	Revised Date	Date Completed
Pie Town Link (LO/IF)			
Complete construction & checkout of spares	01/31/01	05/30/03	05/30/03
Lab Services			
Develop a dynamic drafting scheduling tool	07/31/03		
Receivers (FE)			
Install 2nd prototype, LDPE L-band window	01/15/03	05/30/03	05/30/03
Build and install one more 86 GHz receiver for a total of nine	12/30/02	Pending funding	
VLBA Improvements			
Replace the Maser at Mauna Kea, HI	09/31/03		

Very Large Array and Very Long Baseline Array

Milestones	Original Date	Revised Date	Date Completed
Develop a new VLBA recorder idler with better forward/reverse characteristics	11/30/03		

Engineering Services

Milestones	Original Date	Revised Date	Date Completed
Complete A array reconfiguration	05/30/03		05/30/03
Complete BnA array reconfiguration	09/19/03		
Complete B array reconfiguration	10/10/03		
Mechanical Group			
VLA antenna 7 Panel adjustments			04/17/03
Build Dicroic panel			04/20/03
VLA antenna 15 Panel adjustments			04/28/03
Build spare VLBA drive wheel assembly			05/01/03
Rebuild 2 VLBA drive motors	06/21/03		05/21/03
Complete 6 month PM on all VLA antennas			06/20/03
Resurface spare subreflector	04/30/03	10/30/03	
Paint all ST Croix VLBA HVAC equipment	06/21/03		06/21/03
Kitt Peak maintenance visit	07/22/03		06/14/03
St. Croix Elevation Bearing Change	07/27/03		
Paint Transporter #2	08/31/03		
North Liberty maintenance visit	08/18/03	09/17/03	
Antenna #15 azimuth bearing change	09/01/03	10/31/03	
Mauna Kea azimuth rail repair	06/16/03	06/16/04	
Electrical Group			
High Voltage Switch replacement	04/05/03		04/05/03
Transformer preventive maintenance	05/12/03		05/12/03
Repair Correlator UPS	06/12/03		06/12/03
Repair Antenna #1 pointing error	08/01/03		
VLBA production Tach	09/30/03		
Site & Wye Group			
Complete track repairs between BN6-AN5*	12/31/02	07/18/03	
Complete track repairs between BW8-AW5	09/30/03		
ES Engineering Group			
1000 Gallon Diesel Fuel Tank Procurement	07/02/03		

Computing Division

Milestones	Original Date	Revised Date	Date Completed
Ingres Conversion to Oracle	12/01/02	04/15/03	04/15/03
NRAO-wide UID/GID normalization	04/30/03		04/15/03
Plan Alternative to 9 track at VLA	03/31/02	06/30/03	06/23/03
VLBA Recorder Test Software	01/31/02	06/30/03	06/30/03
Start tests alternative VLA data path	07/01/03		
Radio Telescope at Visitors Center	11/01/02	07/01/03	
Establish NRAO-NM VPN capability	06/30/03	07/31/03	
Phase 2 AOC rewire	07/31/03		
Correlator Controller Support Line Mode	12/31/02	08/31/03	
Configure/Build Filehost Replacement	11/30/02	08/31/03	
Migration to Windows 2K domain	07/30/03	09/30/03	
Upgrade to RedHat 9.0	09/30/03		
Correlator Controller Bug Fixes	03/31/03	11/30/03	
Correlator Controller Integrate line/continuum	06/30/03	11/30/03	
Transcribe VLA observer/system files	11/30/02	05/31/04*	

*Driven by need to vacate correlator area, low priority for now.

AIPS

Key Developments

1. FILLM, the task that reads VLA archive data into AIPS, was improved in several ways. The ability to read the data in real time was made substantially more robust, continuing to work through shutdowns at the VLA and other disruptions. It has the options to use somewhat more correct weights and omit data for which the last reference pointing failed.

2. The tasks which smooth calibration data were given much more flexible smoothing options. In particular, CLCAL, which merges and smooths calibration solution tables and applies the result to the master calibration table, was revised to give the user much more control over the smoothing operation. CLCAL was revised to give the user more control over which solution tables are merged and to allow a sensible merge/smooth operation to be done for single-source files.

3. New verbs to draw lines on the TV based on image pixels rather than TV pixels, to convert between these units, and to measure distances between image pixels were written. The image statistics routines IMEAN and IMSTAT can now operate on round apertures as well as rectangular.

4. The moment fitting task MOMNT has been corrected to handle blanked pixels and to do a primary beam correction on the cutoff value.

5. The suite of array simulations tasks was increased with a new task to compute the loss of sensitivity due to antenna shadowing.

6. A few minor corrections were made so that AIPS will compile on the latest Linux systems from RedHat.

Goals for Third Quarter 2003

The following efforts are expected:

1. Continue user support and bug fixes, as the major portion of AIPS effort.

2. Revise the real-time filling of VLA data into AIPS using a system that fills the disk archives in real time.

3. Add more flexible colored-line drawing to the AIPS plotting package to allow multiple colors to represent, for example, velocity or position angle or simply to differentiate multiple IFs combined in a single plot.

4. Investigate the use of overlapping solution intervals to minimize lobe ambiguities in fringe fitting.

5. Continue the moderate-term project to explore improved troposphere calibration. Develop methods for fitting and correcting residual zenith delay.

6. Add Tsys values for a single VLA antenna into the calibration data supplied with VLBA correlator output.

7. Test and enhance AIPS performance on McIntosh computers with the G4 processor (dependent on availability of a machine for testing).

Central Development Laboratory

Central Development Laboratory Highlights

Amplifier production continued to keep pace with requirements for NRAO telescopes, including the VLA and GBT. Evaluation of some varieties of new Cryo-3 devices showed that they are not useful for EVLA 1-8 GHz amplifiers, and work continued on devices showing promise for these low frequency bands.

Tests of a prototype ALMA Band 6 (211-275 GHz) SIS mixer-preamp have successfully met the ALMA specifications for noise temperature and image rejection over most of the RF and IF ranges. Significant progress was made on the design of the Band 6 cartridge and the dedicated test equipment for Band 6 mixer-preamp and cartridge testing.

The design for the new EVLA 1.2-2 GHz feed was tested and its performance verified.

The ALMA 2-antenna prototype correlator construction was completed and end-to-end testing began. Design of a new multi-output FIR filter to improve the baseline correlator frequency resolution was advanced to the stage of simulation and demonstration that a preliminary design can be built using available FPGA technology.

Prototype ALMA local oscillator sources which provide the necessary low-noise output power to drive the SIS mixers were demonstrated and delivered. Work continued on evaluating the final frequency multipliers.

Major Developments

Milestone	Original Date	Revised Date	Date Completed
Amplifier Design & Development: 1) Evaluation of TRW Cryo-3 devices from the point of noise, signal and dc properties at cryogenic temperatures 2) Design/redesign of cryogenic amplifiers using Cryo-3 TRW devices for EVLA, VLBA, GBT and ALMA covering frequency range from 1 to 120 GHz	 04/01/02 04/01/02	 04/01/04 04/01/04	
1) Freeze Band 6 SIS mixer design 2) Freeze Band 6 cartridge design	07/01/03 12/31/03		06/30/03

Central Development Laboratory

Milestone	Original Date	Revised Date	Date Completed
Electromagnetic Support:			
1) Feed pointing optimization of the VLA antenna	06/30/02	12/31/03	
2) Testing of EVLA L-band prototype feed horn	03/31/03	05/01/03	06/30/03
3) GBT L-band pattern simulations	03/31/03	09/30/03	
4) Testing of GBT Ka-band feed horn	06/30/03	09/30/03	
5) Testing of EVLA C-band prototype feed horn	09/30/03		
6) Design EVLA Ka-band feed	09/30/03		
ALMA Correlator:			
1) Complete VLBA data recoding project	12/31/02	12/31/03	
2) Complete initial study of a new advanced digital filter for the ALMA correlator	03/31/03	06/30/03	06/30/03
3) Test the fiber optic receiver card to filter card interface in the prototype system using a FO simulator card	06/30/03	07/09/03	
4) Perform first end-to-end test of the prototype system	06/30/03		06/30/03
5) Advance the design of the new filter card	06/30/03		06/30/03
6) Correct the station motherboard problem	06/30/03		06/30/03
7) Improve the status of the ALMA correlator documentation	06/30/03		06/30/03
8) Hold a critical design review of the baseline ALMA correlator	09/30/03		
9) Use the fiber optic simulator card to test the system	09/30/03		
10) Achieve error-free station bin to correlator bin data transmission in all signal cables	09/30/03		
11) Continue software and firmware development	09/30/03		
12) Start the process of ordering parts for the first quadrant build	09/30/03		
ALMA LO Source:			
1) Delivery of the first LO driver	12/31/03		
2) Integration and test of bandpass filters and LO drivers	06/30/03		05/30/03
3) Build and deliver improved LO to SRON	06/30/03	07/31/03	
4) Verify leveling using power amplifiers	06/30/03	07/31/03	
5) Complete testing of UMS wafer	06/30/03	07/31/03	
ALMA Frequency Multipliers:			
1) Band 9 frequency quintupler evaluation at spot frequencies	03/31/03	07/31/03	
2) Fabrication and evaluation of micro-machined WR-10 and WR-03 waveguides and FGC structures	06/30/03	08/15/03	
3) Complete design and mask layout for MMIC tripler	09/30/03		
4) Complete fabrication of MMIC devices (at UM)	12/31/03		
5) Complete testing of MMIC tripler	03/31/04		
6) Band 9 frequency quintupler swept frequency evaluation with actual driver amplifiers	09/15/03		

Central Development Laboratory

Amplifier Design and Development

Work continues on the evaluation of Cryo-3 devices and their applications in new designs. This quarter 300-μm wide devices were evaluated from the point of view of applications in L- ,S- and C-band designs. Unfortunately, these devices exhibit discontinuous drain current vs. gate voltage characteristics at cryogenic temperatures which make then unsuitable for cryogenic applications. Consequently, the best candidate for good designs at these frequencies is a Cryo-3 4200 device. The cryogenic properties of L- and S-band hybrids needed for balanced designs were evaluated. In addition, an effort was expended in support of the Cosmic Background Imager and Planck Mission 30- and 44-GHz radiometers.

Amplifier Production

A total of 15 amplifiers was completed during the second quarter. These included ten K-band LNAs for the VLBA receiver upgrade, four Ka-band, and one Q-band. The amplifier group provided support to Dr. Bradley's balanced amplifier production in the final assembly and wirebonding of four L-band amplifiers. An additional eight amplifiers were repaired or modified during the quarter.

The group continues to support ALMA activity with assembly and wirebonding services for both integrated SIS-IF amplifiers and various multiplier and MMIC development efforts. An existing liquid nitrogen cold load was extensively modified to serve as a cooled attenuator noise source to allow for quicker noise performance testing of Socorro's new EVLA receivers.

Other Projects

The plating lab continues to meet all requests as needed for both surface plating and electroforming of waveguide components.

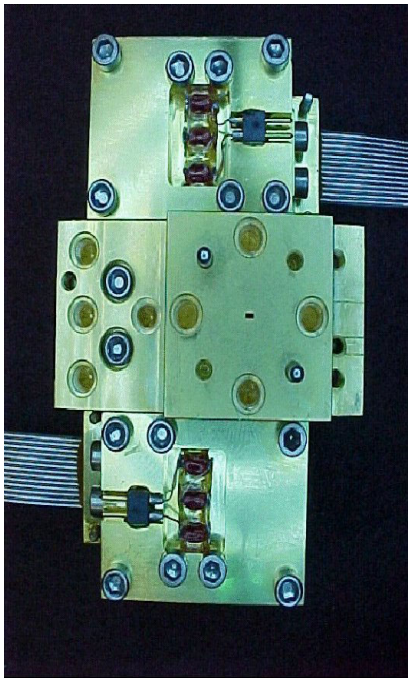
Superconducting (SIS) Millimeter-Wave Mixer Development

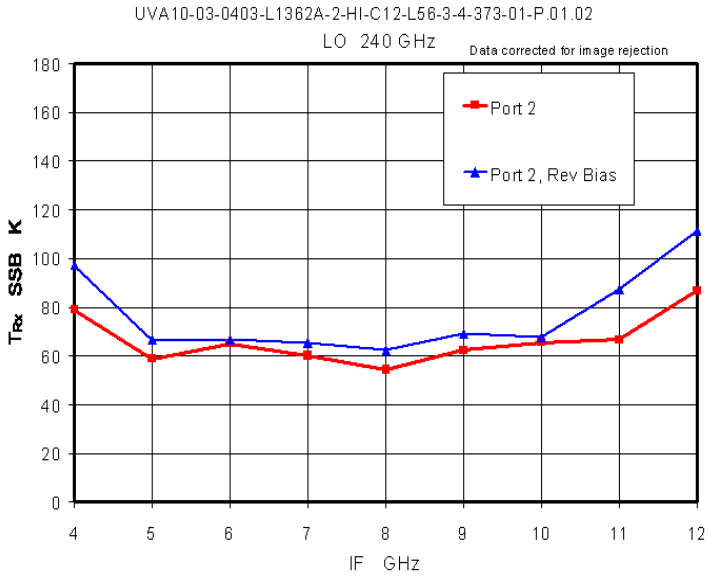
ALMA SIS Mixer Development

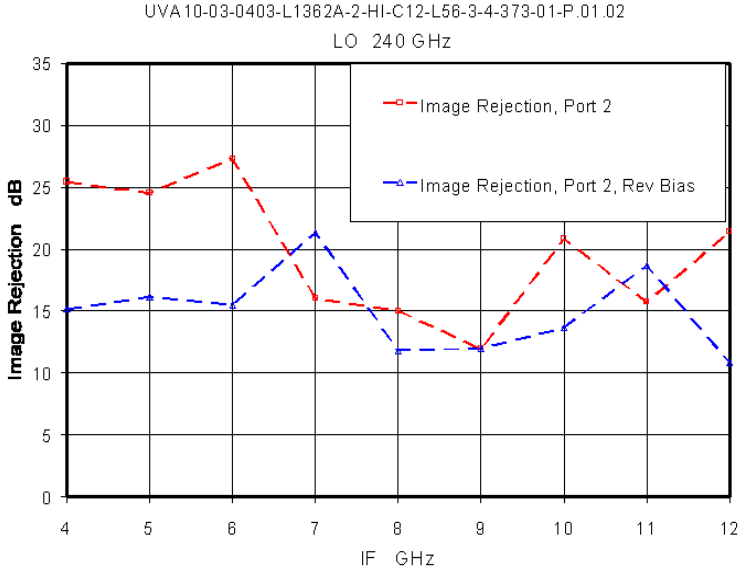
Band 3 (84-116 GHz) SIS mixer-preamp: During this quarter, our mixer simulation program, which is based on the quasi five-frequency approximation to Tucker's theory with non-zero IF, was substantially modified to include the excess shot noise caused by Multiple Andreev Reflection (MAR). Using the measured mixer I(V) curve and the embedding admittances obtained from the original mixer design, the mixer performance was calculated across the full 4-12 GHz IF band. The results agree extremely well with those deduced from the receiver measurements.

Band-6 (211-275 GHz) final ALMA sideband-separating SIS mixer-preamp: This is the final configuration for Band 6. It is essentially the same as the earlier design but uses a physically smaller mixer block and preamplifiers and is designed to mate with the OMT and feed horn in the limited space

of the ALMA cartridge. Typical results are shown in the figures below in which the noise temperatures are SSB quantities for the whole receiver. The sideband-separating receiver was measured using the procedure described in ALMA Memo 357. (Note that the upper and lower sideband responses are measured by reversing the bias on one of the component mixers; this interchanges the sideband output ports).



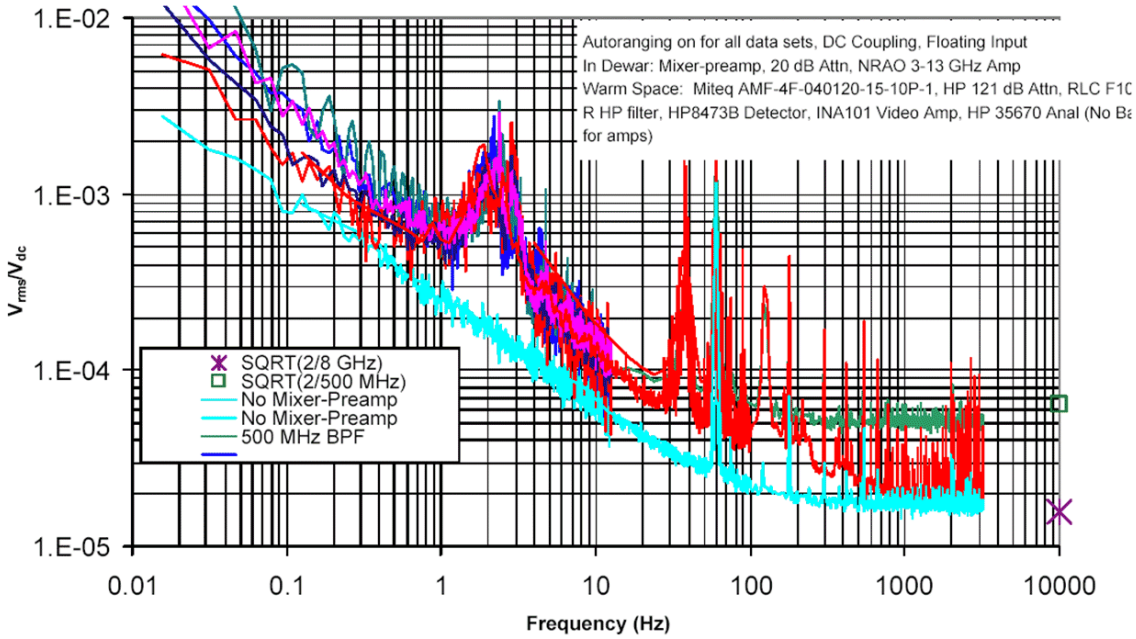




The photograph shows the final version of the Band 6 SIS mixer-preamp, with Type III IF amplifiers attached, at true size. The top graph shows that this unit meets the ALMA specification (< 78K over 80% of the band) for noise temperature. The bottom graph shows that this unit meets the ALMA specification for image rejection (> 10 dB). All measurements shown are with an LO frequency of 240GHz.

Central Development Laboratory

Gain stability measurements on the laboratory ALMA Band 6 receiver: Results are shown in the figure below. These results are typical for SIS mixer receivers, and show that it will be difficult to meet the desired specification of 1×10^{-4} in one second.



Band 6 laboratory receiver gain stability. The broad feature at 2 Hz is due to temperature cycling effects of the refrigerator on mixer gain. The spikes at higher frequencies are predominantly due to 60 Hz and harmonics. The feature at 37 Hz is of unknown origin.

Automated SIS mixer testing: In an attempt to simplify the mixer testing instrumentation and software, we are looking into using a fast Agilent power meter to measure receiver noise powers as the receiver input is switched between hot and cold loads by a rapidly spinning chopper wheel. The software is being designed to synchronize the power meter's measurement period with the chopper wheel. The system is currently being tested.

The merits of unifying the software for all the ALMA front end test systems have been discussed in [1].

Mixer/preamp test system: Construction of the test Dewar in the NRAO Green Bank shop has been completed, and the radiation shields have been sent out for plating. The vacuum window, IR filter, and ellipsoidal mirror are on hand, but the bracket for the mirror still has to be fabricated.

Central Development Laboratory

4-12 GHz IF Preamplifier Development

Reduced-size IF preamplifiers, designated Type III, are required to fit into the limited space in the cartridge (see previous photograph). This required a major change in the layout of components in the amplifier, and replacement of the components of the mixer bias-T (housed inside the preamplifier) with a custom MMIC chip. Also to save space, the MDM power connector was moved to the end of a ribbon cable anchored to the amplifier body. The RF performance of the Type III amplifier appears to be identical to that of the previous design. These amplifiers were successfully used in the Band 6 sideband-separating receiver tests described above.

In ALMA production quantities, the preamplifiers will be assembled commercially. A detailed work package is being prepared for potential contractors, including all drawings, bonding schedules and assembly procedures.

ALMA Band 6 Cartridge

Internal layout: The internal layout of the Band 6 cartridge has been completed. During this quarter, we worked with Tucson and the other cartridge builders to standardize, as far as possible, the components in common between bands — *e.g.*, amplifier and mixer bias electronics, temperature monitors, and cartridge wiring harnesses.

Waveguide vacuum windows: Prototype waveguide vacuum windows have been constructed and tested. The windows are made of a shim of epoxy inside a thin waveguide flange and are simple to manufacture. A pair of these shims, separated by a short waveguide section, is used to reduce the mismatch to acceptable levels.

Cartridge test system: A cartridge test cryostat was received from NAOJ. Initially, the system would not cool below ~20K, and this was traced to incorrect wiring of the crosshead as supplied. Subsequent tests indicated that the system had insufficient capacity to cool a Band 6 cartridge. An incorrectly manufactured thermal link is believed to be the problem, and a new one has been sent from Japan.

Most of the parts ordered for the cartridge test system have now been received, and the instrumentation is about 50% complete.

Central Development Laboratory

Prototype cartridge for Band 6 and precision brackets for mounting SIS mixer-preamps and mirrors.

Travel This Quarter

Members of the CDL SIS group attended the following meetings this quarter:

- The 14th International Symposium on Space Terahertz Technology, Ventana Canyon, AZ, 22-24 April 2003.
- The IEEE International Microwave Symposium, Philadelphia, 9-13 June 2003.
- ALMA Front End Review, SRON, Groningen, 16-18 June 2003.

Publications & Memos this Quarter

[1] J. Effland, "Unified Software Design for ALMA Front End Test Systems," NRAO internal memo, 23 May 2003, (*http://www.cv.nrao.edu/~jeffland/UnifiedStructure1.pdf*).

[2] J. L. Hesler, A. R. Kerr and N. Horner, "A Broadband Waveguide Thermal Isolator," *Proc. 14th International Symp. on Space Terahertz Tech.*, Ventana Canyon, AZ, 22-24 April 2003, see ALMA Memo 469, 30 May 2003.

[3] S.-K. Pan, A. R. Kerr, M. W. Pospieszalski, E. F. Lauria, W. K. Crady, N. Horner, Jr., S. Srikanth, E. Bryerton, C. T. Cunningham, S. M. X. Claude, C-C. Chin, J. Z. Zhang and A. W. Lichtenberger, "An 84-116 GHz Fixed-Tuned Integrated SIS Mixer-Preamplifier with Ultra-Wide-Band IF and Quantum-Limited Sensitivity," submitted to THz 2003, Sendai, Japan, 24-26 September 2003.

[4] G. A. Ediss, "Measurements and Simulations of Overmoded Waveguide Components at 70-118 GHz, 220-330 GHz and 610-720 GHz," *Proc. 14th International Symp. on Space Terahertz Tech.*, Ventana Canyon, AZ, 22-24 April 2003, see ALMA Memo 467, 29 May 2003.

[5] A. R. Kerr, J. Effland, S.-K. Pan, G. Lauria, A. W. Lichtenberger and R. Groves, "Measurement of Gain Compression in SIS Mixer Receivers," *Proc. 14th International Symp. on Space Terahertz Tech*., Ventana Canyon, AZ, 22-24 April 2003, see ALMA Memo 460, 15 May 2003.

Electromagnetic Support

EVLA

The prototype of the L-band feed, scaled to C-band (4-8 GHz), had cross-polarization levels in the range of -15 dB to -23 dB above 7.2 GHz. The mode converter with ring-loaded corrugations was modified, and the feed was remeasured. This improved the cross-polarization sidelobes to below -18 dB. This may be due to the oversized rectangular waveguide that is used only for measurement. The cross-polarization levels in this type of feed should be below -25 dB.

The mode converter of the C-band feed was also redesigned, and new drawings are being made..

GBT

In order to reduce the leakage through the thermal gap in the Ku-band receiver, a photonic crystal structure was designed using Finite Difference Time Domain software. The return loss of the gap with this structure is better than -30 dB, and the leakage into the gap is lower than -25 dB. The illumination beam of the main reflector, derived from far-field maps at 12 GHz and 22 GHz, showed asymmetry in the pattern. Theoretical calculations are being conducted to study this effect.

Spectrometers/Correlators

ALMA Correlator

During the last quarter, the 2-antenna prototype correlator construction was completed. With the installation of the Quadrant Control Card (QCC), the last Charlottesville logic card was in place. Otherwise, system testing continued as did software and firmware development.

The two main areas of testing and software/firmware development concerned setting the bin-to-bin cable timing correctly and performing end-to-end tests of the system.

To verify the cable interface, initial tests were run to insure that all cable interfaces could be run error-free with manual settings of timing. Then software was developed that would automatically adjust the cable timing for the least transmission error. At of the end of the quarter, a few cable interfaces were still not error-free at the $1x10^{-14}$ level and needed additional work.

Central Development Laboratory

A design study was made during the quarter to determine the best DC power system that could be used in the construction of the first quadrant. It was determined that the least expensive system would utilize commercial telecom AC to 48 VDC equipment. Unfortunately, these systems use, as a standard, distributing -48 VDC and not +48 VDC for which the correlator is currently designed. Thus, several printed circuit boards of the ALMA correlator design will have to be modified to accommodate these power supplies.

The design and layout of a fiber optic simulator card was completed. This card has been assembled but has not been installed in the system yet.

Significant work was done on the design of a polyphase filter bank to replace the present filter card. This new design will increase the spectral resolution of the baseline ALMA correlator by factors of up to 32. An architecture for this new filter card was selected and computer-simulated to demonstrate its performance. The simulation has confirmed the design so far, but more work must be done. Paper designs for two of the FPGA chips required for the new filter were done to demonstrate their feasibility.

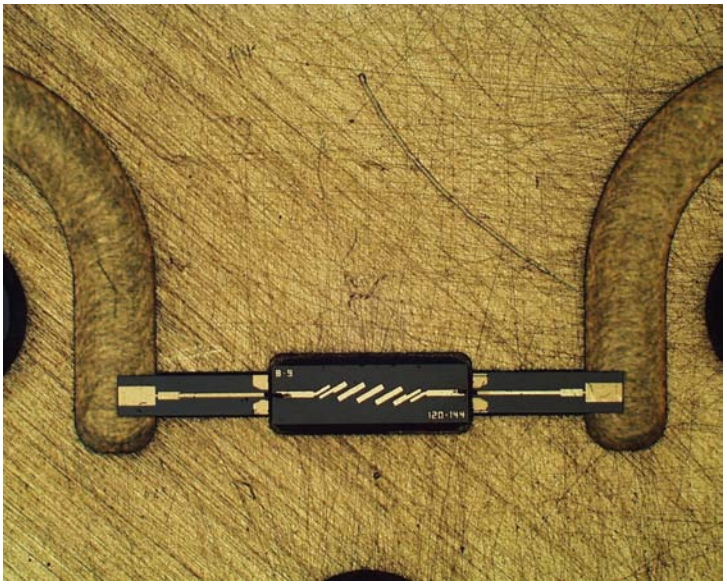
No work on the VLBA data translation project was done during the quarter.

ALMA LO Source

The purpose of this project is to develop a series of electronically-tunable, phase-locked sources operating near 100 GHz. These sources will be used to drive millimeter- and submillimeter-wave frequency multipliers that produce the first-LO signal for the ALMA receivers.

MMIC triplers from UMS for the integrated active multiplier chain have been tested and are within specification. The MMIC mixers for phase-locking require further evaluation. The InP MMIC power amplifier wafer from HRL will be delivered in July.

Microstrip coupled-line bandpass filters were delivered. The first set of filters (up to 48 GHz) covers the required bandwidth with suitable out-of-band rejection. The high-frequency filter set (up to 142 GHz) is shifted 4-6 GHz up in frequency from the target range. This shift has been shown to be caused predominately by the lid. Milling a relief cavity in the lid brings the filters back within specification. Insertion of these filters into the Band 3 LO resulted in elimination of all excess sideband noise over the Gunn LO. Tests with other bands are ongoing.



Detail of a 120-144 GHz filter. The filter section consists of the multiple diagonal strips in the center. The distance from tip to tip of the waveguide probes is 6.5 mm.

Integrated AMCs (Active Multiplier Chains) have been designed for Bands 3 and 6. These are intended to be the final ALMA design as they contain everything from the first multiplier after the YIG-tuned oscillator to the first millimeter-wave driver amplifier after the coupler for the phase-locked loop. This block also contains a programmable bias board for all the MMICs contained in the block, as well as an IF amplifier for the PLL.

The Band 9 lab prototype LO is being upgraded and will be returned shortly to SRON with full frequency coverage, including the new bandpass filters and quintupler.

The Band 7 lab prototype LO was used for stability tests using the GBT spectrometer and is now being prepared for shipment to IRAM for testing with their Band 7 receiver. These stability measurements were performed using a prototype Band 3 receiver driven by both a Gunn and ALMA-type YIG-based LO. Preliminary evaluation of the stability measurements indicates no stability problems with the YIG approach.

Receiver stability measurements: Stability measurements were made on the (conventional) ALMA LO in Green Bank on May 27 through June 9. The YTO-based multiplier chain was compared with a Gunn oscillator LO using the GBT spectrometer and a Band 3 SIS receiver containing the ALMA Band 3 mixer developed in the CDL. Preliminary analysis of the data shows no unusual spectral features that are not obvious RFI.

ALMA Frequency Multipliers

The purpose of this project is to develop millimeter- and submillimeter-wave frequency multipliers for use in laboratory experiments and receiver systems associated with ALMA. A series of multipliers using varactor and varistor circuits operating in the 50 to 950 GHz range is currently being developed and evaluated. The status of the cooled frequency multipliers for the various ALMA frequency bands in the baseline plan is described, followed by an outline of other frequency multiplier development efforts. Although all the aspects of the frequency multiplier effort are included, details are provided only for items that had significant effort expended on them during this quarter. The rest are briefly summarized and the appropriate references provided.

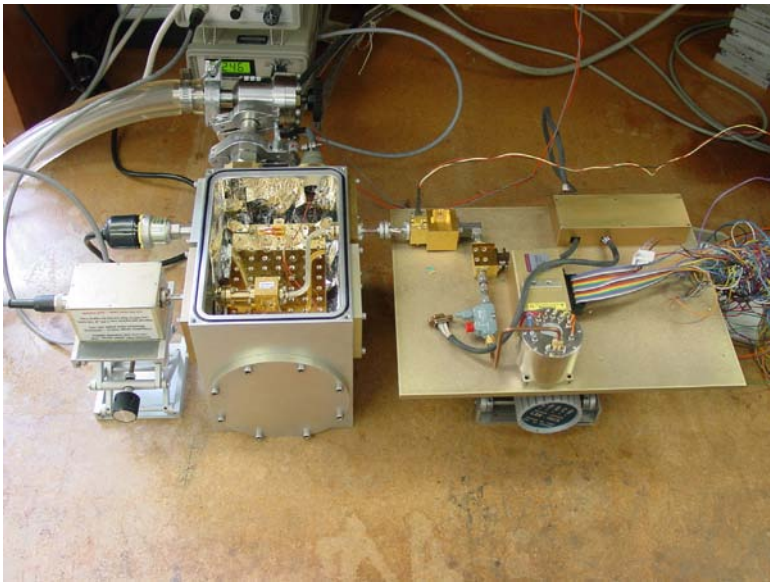
Band 3: No cooled frequency multiplier stage is required for this ALMA band.

Band 6: Two prototype varistor-type frequency multipliers supplied by Virginia Diodes, Inc. (VDI) were evaluated extensively at NRAO. These tests included burn-in and output power performance evaluation, as well as temperature and RF cycling. A report describing the evaluation setup and test procedure, as well as the test results, is available as ALMA EDM document number FEND-40.10.00.00-004A-REP. The two prototypes were different design variations and both are currently in use at NRAO. More of these units can be ordered from VDI.

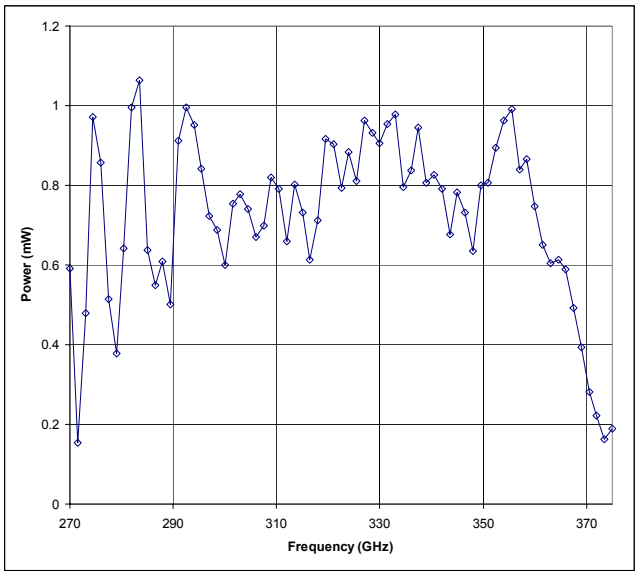
Band 7: Extensive evaluation of the Band 7 cooled frequency tripler prototypes from VDI including burn-in and output power performance evaluation, as well as temperature and RF cycling was performed. The triplers were also mated with the ALMA Band 7 LO driver prototype, and the overall performance was found to meet the project book specification.

Output power leveling by adjusting the drain bias on the final driver amplifier stage was also attempted (see accompanying figure).

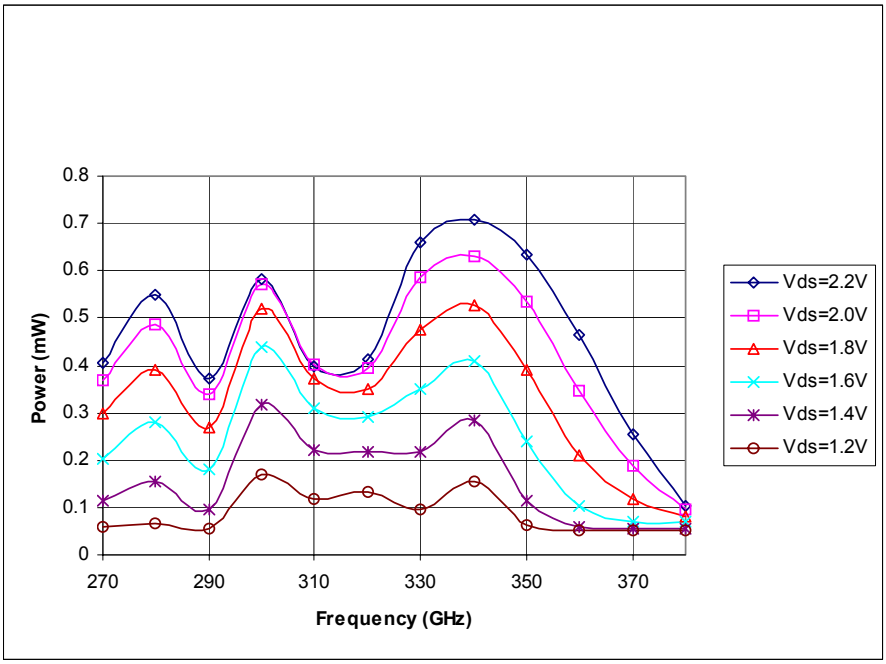
A detailed report describing the evaluation setup and test procedure, as well as the test results, is available as ALMA EDM document number FEND-40.10.00.00-003A-REP. More of these units can be ordered from VDI.



Evaluation of the Band 7 cooled frequency multiplier prototype. Photograph shows the frequency tripler in the 77 K Cryostat with the prototype Band 7 LO driver chain as the input pump source.



Corrected power at the output flange of the Band 6 frequency tripler. The large output power variation in the lower portion of the frequency band was due to the poor input return loss of the frequency tripler. Introducing a 3-dB attenuator at the input of the frequency tripler, immediately following the final driver amplifier stage, significantly alleviated the problem. See AlMA EDM document number FEND-40.10.00.00-003A-REP for details.



Band 7 LO chain power leveling. Plot shows the corrected output power from the frequency tripler (warm operation) as a function of the LO driver amplifier's drain bias. The required power is 0.1 mW.

Band 9: The baseline ALMA Local Oscillator (LO) system requires a frequency multiplier to provide 63 μW of LO signal power in the 614–708 GHz frequency band. Currently, this requirement is proposed to be met using a quintupler design from Virginia Diodes, Inc. (VDI) that is designed to be pumped with 15–20 mW of RF power in the 120–142 GHz frequency range. Five prototype quintupler units were ordered and test data for these frequency multipliers, received recently from VDI, are being evaluated. For details, see ALMA EDM document number FEND-40.10.00.00-002-A-MEM.

None of the designs meet the purchase order specification of 75 μW output (600-720 GHz) with 20 mW input pump power. However, one design holds some promise, referred to as the "best design" in the notes below. There are four units corresponding to this "best design" and the performances are comparable to some degree. They yield around 40-50 μW output over the majority of the band with 20 mW input pump power even though the actual shape of the output curves is not identical for the various units. If we factor in the expected output power increase on cooling the multiplier block, this "best design" has a chance of meeting the specification. When pumped with higher input power in the range of 30-35 mW, the "best design" yields 80-100 μW and is close to saturation. Further evaluation is in progress.

Efforts for a Second Source for the Frequency Multipliers

A small-scale collaboration with the University of Michigan with the objective of developing alternate frequency multiplier designs has not been particularly fruitful. At the same time, JPL has successfully developed similar technology for the FIRST/HIFI receivers, although those designs to date have not had the wider bandwidths required for the ALMA local oscillators. We have initiated a detailed study of a collaboration with JPL to develop wider band frequency multipliers, particularly for the higher ALMA bands, with frequency coverage appropriate for the ALMA receivers. A detailed plan is being generated, with a schedule and budget, on the basis of which we will decide whether to proceed with this effort.

Besides mitigating the risks associated with depending on a single supplier, a collaborative effort with JPL would also yield some other benefits. Some other factors that need to be considered are listed below.

- It will give us access to their substrateless technology which appears to be the only viable route to design devices for around 900 GHz (ALMA Band 10). VDI has had very little success with multiplier designs for 1 THz output.
- There is very little scope for improvement of the existing VDI Band 9 quintupler design. If power-combining of the new InP amplifiers is required to drive them harder to produce higher output power across the entire band, that would call for another amplifier wafer fabrication run at a significant additional cost to the project. Besides, power-combining would result in a larger block with an increased power consumption and heat dissipation.

Further details on this aspect of the developmental effort may be found in ALMA EDM document number FEND-40.10.00.00-005-A-MEM.

Green Bank Solar Radio Burst Spectrometer (GB/SRBS)

In June, the NRAO received an NSF MRI grant to develop a high-performance instrument to receive solar radio emissions with adequate temporal and spectral resolution to probe a wide variety of active solar phenomena from the base of the corona, including energy released from flares, particle acceleration and escape, coronal shocks, and electron beams. The instrument consists of two radio spectrometers that will together provide frequency coverage from 20-3000 MHz. This instrument provides a basic research tool in solar radiophysics for use by the wider community, remedies the lack of an important component of the U.S. Space Weather effort, and provides a platform for research and development work on broadband antennas, feeds, and receivers. A significant portion of the development work will be performed at the NRAO Central Development Laboratory in Charlottesville.

Central Development Laboratory

As part of the grant proposal, the Naval Research Laboratory (NRL) in collaboration with NRAO agreed to supply a copy of the Bruny Island Radio Spectrometer (BIRS) that operates from 10-50 MHz. This instrument will form the foundation for prototyping the lower frequency component of the new spectrometer. The equipment (antenna, active balun, spectrum analyzer, and high-end PC) was received this quarter and work is currently under way to temporarily assemble the instrument in Charlottesville for a detailed evaluation and upgrade prior to its deployment in Green Bank next quarter. Immediate enhancements to the instrument include improving the mechanical stability of the antenna mount to withstand the weather in Green Bank, repackaging of the active balun to reduce the potential for oscillations, and converting the software to operate under the Linux operating system for compatibility with the GB/SRBS instrument platform.

Computing and Information Services

Technology Development

Milestone	Original Deadline	Revised Deadline	Date Completed
NRAO Visiting Committee Presentation	04/14/03		04/15/03
NRAO Computing Re-organization	06/01/03		06/01/03
ALMA Offline Reduction CDR 1	06/26/03		06/26/03
AIPS++ Project Office Deployment	07/30/03		07/10/03
AIPS++ v1.9, Stable 1	08/01/03		
ALMA ASAC	09/04/03		
AIPS++ v1.9 Stable 2/ALMA R1	10/01/03		
AIPS++ v1.9 Stable 5/ALMA R1.1/Prototype Pipeline Delivery	06/01/04		

The Data Management (DM) Technology Development Division has been concerned primarily with management of the AIPS++ project. During this period, both AIPS++ and Data Management underwent large, structural changes. The AIPS++ consortium was ended, with non-NRAO members withdrawing their resources from the project. The code base continues to be developed by NRAO with future collaborations focusing on specific, scientific needs; the code base is covered by the GNU public license, held by AUI, and remains available to all.

Data Management and NRAO computing were also re-organized such that the previous AIPS++ group were removed from Data Management and split between two computing structures, an Interferometric Software Division (ISD) under Socorro Operations and the Single Dish Development Integrated Product Team (IPT) in Green Bank. The ISD now directs the efforts of both the AIPS and the interferometry AIPS++ developers; this effort is led by Jim Ulvestad and Brian Glendenning. Two AIPS++ developers have been moved to the Single Dish Development IPT and work directly under Green Bank management.

Under the new ISD management, a tight focus on NRAO project needs, specifically the ALMA and EVLA projects, drives the computing efforts and the planning reflects the project priorities and timelines. The principle focus in the coming year is in the areas of performance, robustness and increased functionality toward fulfilling the ALMA audit. The major project-based initiatives are in the areas of the ALMA audit, demonstrating convergence on complete fulfillment of the requirements on the project timeline; and a prototype pipeline, which merges AIPS++ functionality into the ALMA Common Software (ACS) environment.

Computing and Information Services

A long-term project plan was developed, with predictable deliverables in line with the project needs and testing. The development plan is divided into two-month stable cycles with specific deliverables, with longer term six month cycles matched to the other ALMA software release dates. The current release of AIPS++ is v1.9. We have suspended mass distribution by CD-ROM; however, the package continues to be available via network download and updates to a current stable version are available via a simple command ('aupdate').

In general, this quarter was focused mainly on management and organizational changes which provide a closer coupling between the telescope initiatives and the software development but also result in a significant loss in resources to the project. The current focus and process changes implemented for the AIPS++ group are in line with the changes recommended by the external technical review.

e2e Project

Milestone	Original Deadline	Revised Deadline	Date Completed
All VLA data online in NRAO archive	05/01/03	05/01/03	06/15/03
Begin internal testing of NRAO data archive	01/15/02	08/15/03	
Announce initial NRAO data archive	06/01/02	10/01/03	
Begin external testing of NRAO data archive	03/15/02	10/15/03	
Initiate prototype pipeline	05/01/03	05/01/03	05/15/03
Prototype pipeline phase A completion	10/01/03	10/15/03	

The prototyping phase of the e2e project (end-to-end data management) continued during this quarter. The main goal of this initial phase of e2e development is to produce designs and/or prototypes sufficient to allow definition of project scope and schedule so that the larger effort to come can be planned. This is being done with an emphasis on producing usable prototypes early on which are responsive to key project drivers, to help ensure close involvement with the scientific staff from the beginning.

In May 2003 the initial e2e project manager (Tim Cornwell) stepped down, and was replaced by Doug Tody as interim project manager, with Dale Frail continuing to serve as the project scientist. Since e2e is already in a period of transition from the initial prototyping phase to planning of the fully integrated data system, it is an opportune time to make such a change. However, due to over-commitment of the remaining DM senior staff, further restructuring of project management may be desirable in the future for the implementation and operations phases. The e2e projects actively worked on this quarter included the following:

- Proposal submission and handling tools. The initial versions of the prototype proposal submission and handling tools were completed in the past quarter. Some initial acceptance and user testing took place this quarter but not enough yet to warrant release of the software. Thus

far testing has only taken place in Socorro and testing by GBT is desirable as well before the software is released to users. Deployment issues still being looked at include switching from the commercial Java Beans server from Borland to the open source alternative JBOSS. Operational issues still to be addressed include who will support the operational software (this is needed for all the e2e tools), and better integration with the existing proposal tools to ease the transition for observers.

- VLA dynamic scheduling tool. This is needed to provide some flexibility in scheduling the current VLA and is a separate project from development of the scheduling tool for the EVLA. An IPT including a subsystem project scientist (Claire Chandler) and a development team has been formed. A preliminary design has been completed and was reviewed internally; implementation is in progress. Deployment of this software for the VLA will be complicated by the need to accustom observers to submitting their scheduling blocks sufficiently in advance of their run.

- NRAO data archive. The NRAO data archive will be used to archive all NRAO data and distribute data to observers. Ultimately it will be extended to hold reference data products from automated pipelines and will support VO (virtual observatory) interfaces to the data. The entire VLA tape archive (2.5 TB) has been loaded onto spinning disk since June 2003. New data is routinely ingested into the archive within several days of acquisition. Loading of existing VLBA data (10 TB total if we load it all) is currently in progress. New GBT data is being loaded daily as it is received from Green Bank. Issues of proprietary data have been investigated and a secure data access policy has been implemented. The proprietary period will probably be 12 months for data taken in 2004 and beyond. Java-based tools for querying the archive and retrieving data have been written and are currently undergoing initial user testing. Assuming all continues to go well, release of the archive to external users for initial testing and data retrieval will occur in October 2003.

- ALMA prototype pipeline. e2e is contracted to provide pipeline processing for ALMA and will need to do the same for EVLA, using AIPS++ as the basis for both online and offline data processing. As the first phase of this project, implementation of a prototype pipeline facility has begun. This will use the CORBA-based ALMA Common Software (ACS) as the computational framework, replacing Glish as the prototype for a new data analysis framework for AIPS++ as well as other systems, while ensuring full integration with ALMA as well as delivery of a prototype Python-based pipeline capability to ALMA in 2004. Development of a more general, scalable, multiwavelength, system independent "common framework" is planned to begin in 2004. The first phase of a three phase implementation plan for the prototype pipeline began in May and will continue through October 2003, with completion of the prototype scheduled in 2004.

- Virtual Observatory (VO) R&D. NRAO is a partner is both the US National Virtual Observatory project (NVO) and in the International Virtual Observatory Alliance (IVOA), with Doug Tody serving as a senior member of both projects, including as chair of the IVOA working group on data access. Activities in the past quarter focused on initiation of the international VO standards effort, with a week-long workshop to define a roadmap for IVOA development being held in Cambridge, UK in May 2003. See *http://www.ivoa.net/twiki/bin/view/IVOA/InterOpMay2003* for further details on this project. As part of the IVOA effort, a "radiovo" subgroup is attempting to define standards for radio astronomy data access, including metadata standards for radio data archives, and open data format standards for visibility data.

Although many elements of e2e are observatory-wide (e.g., proposal preparation, pipeline processing, archive and VO) a major challenge for e2e is to provide the high level observing and data acquisition and quick look software for EVLA. These components, which are required to operate the telescope and take data in the normal science observing mode, include observation preparation, scheduling, real time calibration (shared with EVLA M&C), data capture and formatting, quick look, and queuing of data to the archive. This software is still in the planning stages. High level requirements were covered in the EVLA SSR, the first version of which was delivered to e2e in December. EVLA M&C summarized their requirements in documents sent to e2e during the period May-June 2003. The EVLA post-processing requirements were released in draft form on July 3 and are now undergoing external review. e2e should now have enough information on requirements to proceed to scope the EVLA related effort. There is concern that e2e does not have sufficient resources to fully support EVLA but this is difficult to assess quantitatively until the effort required is better scoped.

A key part of the e2e strategy is to capitalize on the similarities between ALMA and EVLA and coordinate development for the two telescopes where possible. Most of the post-processing software can be similar for the two telescopes: this includes data capture, data formatting, pipeline processing, archiving (some aspects at least), and access to the archive via the VO. For example, the Python-based scalable pipeline being developed for ALMA can be used for EVLA as well (and potentially other NRAO telescopes), although many of the details of calibration will be different for each telescope. AIPS++ will provide the standard post-processing for ALMA and AIPS++ components are what is being used to develop the prototype pipeline.

It should also be possible to develop a common data format which would be the basis for all science data processing as well as what is stored in the archive and delivered to users. The goal is to make this an open format, which is defined independently of any one data reduction package. As a first step in this direction (June 2003), ALMA has produced a draft specification for a formal data model for ALMA data, which is based on the AIPS++ measurement set. The data model consists of a general telescope-independent core plus extensions, which are specific to a particular telescope. Such a data model can be mapped to multiple physical representations, e.g., XML with binary attachments (probably using the VOTable format from VO), or FITS, and could be implemented within different data reduction packages via custom APIs.

Computing and Information Services

Central Computing Services

Milestone	Original Deadline	Revised Deadline	Date Completed
Revise Security Policy	02/05/01	09/30/03	
VPN deployed (Charlottesville)	09/30/01	05/15/03	05/01/03
VPN deployed (NM)	06/30/03	09/30/03	
CCE: core UNIX applications	06/30/03	07/31/03	
CCE: RedHat Linux 9 install configuration	06/30/03		06/20/03
CCE: Linux laptop configuration	07/31/03	08/31/03	
CCE: begin AD domain full testing	06/30/03	07/31/03	
CCE: end AD domain full testing	09/15/03	10/15/03	
CCE: begin AD production client migration	09/30/03	10/31/03	
Issue revised Windows XP policy	09/30/03	07/31/03	

Security

In the past quarter, the NRAO experienced no noteworthy computer security incidents, although the Distributed Denial-of-Service (DDOS) attack which was launched against the Charlottesville FTP server in spring 2002 still continues at a low level, more than a year later. Such attacks use numerous compromised systems as simple-minded automatic agents, unbeknownst to their owners. The measures implemented soon after the attack began, when it was far more intense, remain effective at preserving the availability of this service for legitimate users, but it is an interesting indication of the general state of computer security that so many are still transmitting this traffic after so long.

Virtual Private Networking (VPN) is needed for employees who are required to work frequently or for extended periods of time at non-NRAO locations, and to support telecommuters during construction at Edgemont Road in Charlottesville. VPN testing began in Charlottesville in late 2002, and the service there was made available to users in May. At that time, we purchased identical hardware for Socorro; unfortunately the new equipment was not delivered until the end of June. The Socorro VPN concentrator will be deployed during the coming quarter. The Computing Security Committee has determined system configuration requirements for VPN access, including, for unrestricted access to internal resources, the use of "personal firewall" software to prevent compromise while systems are not on the NRAO network (behind the protection of our filtering routers). Completion of this item overall is awaiting final consensus on concentrator configuration and documentation thereof.

Due to staff commitment to higher-priority tasks, the Computing Security Policy revisions are not yet complete, although a near-final draft of VPN-related modifications has been written. The Policy also needs revisions to accommodate special-purpose Web servers and wireless networking security requirements.

Common Computing Environment (CCE)

The Data Management group has been given a mandate by the NRAO Director to substantially complete the CCE project by the end of 2003. Continued effort will be required after this time to ensure that the sites' environments do not diverge, and to integrate new technology and software; but within the year we intend to have all sites providing standard configuration of operating systems, network services, application software availability, and user interfaces. To meet this goal, we made three significant changes in the way the project is managed, following the face-to-face CCE workshop for all NRAO system administration staff that was held in Socorro March 13-15:

- The use of more formal project management, such as project and technical requirements, assigned targets within a specified overall time line, and regular progress reports;
- Clear, detailed identification of the tasks and resources involved through the end of 2003; and
- Increasing the average fraction of time that the system administration staff commits to the CCE from 10% to 20%.

The target list is used and refined in regular target-review and discussion meetings of the UNIX and Windows CCE groups. As of this report, the major targets in the table above reflect the dates assigned during this "accelerated" phase of the project. Brief weekly reports are submitted by CCE project members, covering the targets for which they are responsible.

During the past quarter, the UNIX group has deployed a "help desk" for problem reporting Observatory-wide, agreed on common file and service locations, developed standard install procedures for the next major upgrade of Linux (which will begin this summer), largely completed procedures to handle the special requirements of laptops, and also significantly improved documentation on major services (printing, mail, etc.) for both users and system staff. The Windows administrators have carried out nearly all of the tasks needed to complete configuration of the Active Directory domain that will be the future environment for Windows systems in the Observatory; on completion of the remainder, a period of intensive testing will begin. During that period, the group will also set up servers to permit automated operating system installation and patching. Without such automation and standardization, new systems can take several days to customize, and patching is almost impossible to keep up with. The group has also done considerable testing on Windows XP and has determined configuration changes necessary to permit lifting the XP moratorium that was imposed in February 2002.

Computing and Information Services

Web Infrastructure

Milestone	Original Deadline	Revised Deadline	Date Completed
Active content demo project using action items	06/11/01	04/03/03	04/01/03
Enhance mail security on web servers	04/03/03	04/03/03	04/03/03
Deploy web server for Library Catalog Queries	04/03/02	04/03/03	04/03/03
Put "Google" search on search.nrao.edu page	04/03/02	05/01/03	05/01/03
Integrate Web statistics from mirrored servers	10/30/02	07/03/03	
Extend web statistics to site specific servers	10/30/02	06/05/03	06/11/03
Purchase web proxy servers for VLA, CDL	06/05/03	09/04/03	
Spare "test" server setup preliminary work	05/01/03	05/15/03	05/15/03
Investigate Apache V2 access control	06/05/03	07/03/03	07/03/03
Design and Populate new VLA web site	05/01/03	06/05/03	06/05/03
Migrate CV proxy server to dedicated system	05/01/03	06/05/03	06/05/03

The retrofit of the NRAO standard look-and-feel for web content continued in this quarter, with the notable redesign and re-organization of the NRAO/VLA web site as a prominent example. In addition, the format of the web pages was enhanced so that internal and staff personal pages may be clearly distinguished from public/official content in the future.

Work continued on installation of automatic "webalizer" statistics schemes, showing the relative popularity of various sections of our content on all web servers. Most site servers are now reporting these statistics routinely. We are investigating the possibility of integrating the statistics from the four mirrored servers that serve the www.nrao.edu content.

A new feature was added to NRAO's search page (search.nrao.edu) that leverages the power of the popular and highly effective "Google" search engine. This allows fast searches of the public content on our web pages, and satisfies the previous requirement of having PostScript and PDF files indexed in a search engine.

Computing and Information Services

The use of active content continues to increase on NRAO's web pages, beyond the highly successful and popular image gallery. A long-neglected pilot project in the use of "PHP" was finally completed and this testbed is now in use as a management tool for the Common Computing Environment action items.

This quarter also saw the increased use of the four main internal web "proxy" servers as described in the previous report. All of these are now upgraded to the latest (and secure) software version, and are in active use at the sites; in addition, the Charlottesville proxy has been migrated off the web server itself and onto a dedicated system. Widespread use of these proxy servers will result in significant inter-site network bandwidth savings in the coming months and years. We hope to purchase and deploy two new small proxy servers to boost web performance for users at the Central Development Lab in Charlottesville, and the VLA site in New Mexico.

Finally, a small server is being prepared to act as a testbed for various tasks, including a trial of the latest version of the Apache web server. It will also act as a general facility for new features and tools being used by the web admin staff, so that testing can be performed without disrupting the service from the production servers.

Information Infrastructure

Milestone	Original Deadline	Revised Deadline	Date Completed
Finish design document	04/15/03	04/15/03	04/15/03
Document Schema	03/06/03	04/15/03	04/15/03
Deploy mirror of OpenLDAP server in NM	07/15/03	07/15/03	
OpenLDAP server with Phone Book info running	08/19/03	04/15/03	

Significant strides were made with the OpenLDAP server setup and the web interface thereto; considerable testing has been performed, and the resulting feedback will enable us to provide a more robust and functional facility.

Charlottesville Computing

All Windows and UNIX based shared file systems have been migrated to the central storage facility (Network Appliance). In addition, routine backup to a tape library of the entire storage on the NetApp is in full operation. The advantages of backups in a centralized paradigm are finally becoming apparent, as this backup regimen is vastly simpler than the failure-prone network-based distributed backup system employed previously.

Computing and Information Services

Much of the effort of the local support staff has been directed towards the support for the building activities in Charlottesville. This includes the movement of computers and servers to the Old Ivy Commons building as well as preparation for the movement of staff within the Edgemont Road building to allow for the new construction. Several laptop computers have been acquired to enable people to take their work into transition areas within the building and to their homes. The use of the VPN concentrator, mentioned above, has facilitated those who now telecommute.

Observatory-wide Communications

Milestones	Original Date	Revised Date	Date Completed
Initial network to support the SCGB	05/31/03		05/31/03
Remove BIMA connection from NRAO intranet	06/15/03		06/15/03
Complete network to support the SCGB	08/31/03		
Upgrade network service to VLBA KP antenna	12/31/02	08/31/03	
Complete Intranet contract migration	08/31/03		

After detailed price comparisons, the new Intranet contract was awarded to the same service provider (AT&T) at the end of February 2003 with a more cost-effective price structure available to us through the Federal Telecommunication Service (FTS2001) of the General Services Administration (GSA). Continuing with the same carrier allowed us the huge advantage of continuing our Intranet operation with no service interruption. Although there has been no disruption of service, the full implementation of the new contract will not go into effect until July 2003. Negotiations to accept the new billing structure will occur after the first full month's invoice is prepared by the service provider.

The NRAO has a long history of assisting other observatories with their network communications. However, the Berkeley-Illinois-Maryland Array (BIMA) project has found other means of communication between Hat Creek, CA and the National Center for Supercomputer Applications (NCSA) at the University of Illinois Urbana-Champaign (UIUC) and its data access ports were removed from the NRAO's network in June.

After an unexpected delay in the delivery of the modems for the upgrade of the network service to the VLBA Kitt Peak antenna, they proved to be defective when installed and tested. Replacement equipment has been shipped to us and successfully tested. However, this effort has been delayed due to the reassignment of the communications staff to the new building projects in Charlottesville.

The basic network to support the Science Center in Green Bank (SCGB) is installed and operational. The more advanced components to support live video casts, streaming video, etc. will be done in the next quarter.

Computing and Information Services

The NRAO video system is now routinely used to relay scientific and technical colloquia throughout the Observatory. The biggest remaining deficiency for interactive multi-site video between the auditoria is the auditorium sound systems. This will be addressed on a best-effort basis over the next few months. However, this project is also likely to be delayed because of the effort being reassigned to the building projects.

Education and Public Outreach

Education and Public Outreach Highlights

Within the span of less than a month, new or upgraded facilities for visitors at both Green Bank and the VLA both opened. At Green Bank the new Science Center opened Memorial Day weekend for the main summer season. New exhibits and furnishings for classroom facilities are still undergoing their final commissioning installations, with hopes and expectations for a dedication near the end of summer. At the VLA, the addition of a gift shop wing in mid-June provides a means of funding EPO staff at the Visitor Center on an ongoing basis. Another construction highlight, of course, was the onset of the expansion and renovation of the Edgemont Road site in Charlottesville in June preceded by a ground breaking ceremony in April.

AUI President Riccardo Giacconi (right) and NRAO Director Fred K. Y. Lo (left) at the NRAO ground breaking ceremony for the expansion of NRAO Headquarters in Charlottesville.

Education and Public Outreach

Informal Education

With the planned opening of the Science Center at Green Bank and the gift shop at the VLA Visitor Center, there has been a significant expansion in staffing. In connection with the Science Center, new hires include a Museum Exhibit Technician, a Sales Clerk, and tour guides. A new custodian, funded by the Science Center operations but supervised by Green Bank Operations, was hired. The Cafe in the Science Center will be operated in a similar fashion; the Food Services Supervisor and a couple of food service handlers will be funded by the Science Center but the supervision will come from the ongoing Green Bank Operations. It is anticipated that the revenue from the Cafe sales will provide a significant contribution to the operations of the Science Center. Finally, a new graphics artist for Green Bank, working half-time for Operations and half-time for EPO, was hired.

The front entrance of the new Science Center in Green Bank with construction almost complete.

Exhibits already present in the Science Center, but with finishing touches still to complete, include interactive displays on pulsar rotation, three dimensional geometry of the constellation of Orion, spectrum of basic atoms, and how reflectors focus energy. Numerous other exhibits still to come include an animated model of the GBT that will tip in elevation and rotate about its track.

In exchange for having the Science Center also serve as a Pocahontas County Visitor Center site, the Pocahontas County Convention & Visitor Bureau provides a receptionist at the Science Center. The dorm building to accompany the Science Center to house visiting student groups is now under construction with expected completion in late summer or early autumn. Green Bank public attendance estimates, which became more of an actual head count after the Memorial Day opening, were 160 for April, 1,815 for May, and 4,145 for June.

Education and Public Outreach

In New Mexico, a Senior Sales Clerk has been hired to provide staffing at the VLA Visitor Center and we are still recruiting for part-time help so that the gift shop will be staffed every day of the week. At the VLA we are also working with a videographer to produce a video on what occurs in the VLA control room. In addition to the recruiting and hiring of new staff a good deal of time also goes into training, including learning new Point of Sales (POS) hardware and software systems. All staff members at both centers who may encounter the public are given information about the NRAO, what we do, and how to interact with the public. The VLA Visitor Center guestbook sign-in numbers were 974 for April, 541 for May, and 1,441 for June

The just completed but still unstocked interior of the new gift shop addition of the Visitor Center at the VLA.

Formal Education

School visitors from GW Community School, Mountain Institute on Astronomy, North High School, Newburg High School, Tygarts Valley High School, Concord College, Gettysburg College, Towson University, and Marshall University all came for overnight/in-depth tours and observing with the 40 Foot Telescope at Green Bank. The group from Concord College used GPS receivers to map the Green Bank site and we are expecting the site maps from them that not only will show the GBT and the new Science Center, but also the scale model planets that are spread on the grounds from the Sun at the

east end of the Jansky Lab out to Pluto near the GBT. In Green Bank, two Chautauqua sessions were held in late May followed in June by Hands-on-Universe data handling and processing training for teachers.

June also saw the start of the summer programs for teachers (NSF Research Experience for Teachers) and students. The student program includes co-ops, NSF Research Experience for Undergraduates, NRAO Undergraduate Research Program, and NRAO Graduate Research Program. There are twelve students and one teacher in Socorro, seven students and two teachers in Green Bank, two students in Tucson, and eight students in Charlottesville.

Community Relations

In Charlottesville, as part of the effort to increase awareness of the presence of the NRAO headquarters in Albemarle County, there were two NRAO sponsored evening observing sessions at a local public school. One session was preceded by a talk on the NRAO as part of the school's science night activities. A more extensive public observing session planned for the May lunar eclipse was cancelled due to weather conditions. Riccardo Giaconni gave a reprise of his Nobel Lecture on the development of X-ray astronomy at the University of Virginia's historic Rotund. The lecture was presented to a full house and was very well received.

AUI President Riccardo Giacconi in the Rotunda of the University of Virginia presenting a reprise of his Nobel Prize lecture.

Education and Public Outreach

Green Bank hosted a small group of leaders from the area Math Science Consortium. In addition to high tech tours and Starlab presentations, Green Bank has started hosting free film nights in the new Science Center auditorium with astronomy related films tied to an educational discussion of different aspects of astronomy. In New Mexico, the Socorro EPO staff participated in a Rural Economic Development through Tourism meeting for the county.

Astronomy Community

In May, the NRAO made a strong appearance at the AAS meeting in Nashville. The NRAO presented a new, more compact display featuring all of our telescopes and sites in a unified display that attracted favorable comment from visitors. The NRAO research results were featured in two press conferences at the meeting (VLBA Reveals Dust-Enshrouded "Supernova Factory" & Closest Gamma Ray Burst Providing Scientists with Crucial Test for Burst Physics). Both stories made the New York Times and other news media. The NRAO also had the only display at the Cooling Flows in Galaxies and Clusters of Galaxies conference in Charlottesville in early June. The NRAO was host in June to a five day, 160 research paper conference in Socorro in celebration of the 10th anniversary of the VLBA's dedication.

In earlier stages of developing the Image Gallery, the issue of an NRAO Image Use Policy was raised and an official Image Use Policy was created from those various discussions and specified both on the NRAO web site and in the NRAO Newsletter.

Planning continues for the Conference on Communicating Astronomy to the public to be held in Washington, D.C. Most panelists for the half dozen panel discussions over three days at the beginning of October are set and we are at about the half way mark for attendance registration. Current plans also call for a tour of the NRAO Green Bank facilities on the Saturday following the meeting by attendees. A request for NSF support for this conference has received favorable comment and with some changes seems to be moving forward for approval.

To meet the continuing needs of the Observatory, significant EPO staff effort was provided for producing the new AUI Management Proposal, the 2002 Observing Summary, the July Newsletter, various NRAO brochures, plus images and mats for retirement and award ceremonies. Socorro EPO also participated in a SCOPE (Southwestern Consortium of Observatories for Public Education) in Tucson this April.

Media Relations

As a means of improving awareness of the NRAO in Albemarle County, a prominent educational display in the baggage claim area of the Charlottesville Airport was unveiled in April. Feedback from visitors who pass by that area, indicate its presence cannot be missed. In New Mexico, the NRAO joined the Albuquerque Convention and Visitors Bureau (ACVB), which entitles us to distribute VLA tourist brochures at the airport and at several major Albuquerque hotels. In addition, the VLA Visitor Center is

now listed as an attraction at their ACVB web site, the ACVB visitor kiosks, and in their annual visitor's guide, which is distributed throughout the metropolitan area. Following the VLBA 10th Anniversary Conference, Socorro EPO and EVLA staff spent a day hosting a writer from a computer magazine. It is expected that this will yield a story in a couple of months devoted entirely to the EVLA and all the special technical features of that project.

In June, an NRAO Public Information Officer (PIO) presented an invited talk on constructing effective press releases to a NASA workshop for science public affairs officers, held at Port Canaveral, FL. The workshop included NASA PIOs from various NASA centers as well as NASA Headquarters, and also included science reporters from CBS, CNN, Reuters, MSNBC, and Space.com, who spoke on what works for them and what does not regarding media relations.

Environment, Safety and Security

ALMA Test Facility

During this quarter, the NM safety officer made daily visits to all three antenna sites at the ALMA Test Facility (ATF) at the VLA Site. ES&S provided safety oversight for the arrival of the EIE/Alacatel dish and receiver cabin at the ATF and the subsequent movement of the assembled dish to and from the VLA Transporter Maintenance facility. On two separate dates, ES&S provided preliminary mechanical and electrical inspections on the NAOJ/Mitsubishi antenna.

NRAO-New Mexico

The NM ES&S conducted two safety inspections. On the 5/15 a safety inspection was completed at the AOC Building and on 5/21 a safety inspection was completed at the Pie Town VLBA Station. ES&S worked with the EVLA Fiber Optic Group and the Cryogenics Group to develop a revised Waveguide Manhole, Confined Space Entry Procedure for installation of the EVLA fiber optic cables at each VLA antenna foundation. During this quarter, ES&S conducted 25 Safety training sessions and trained 225 employees on numerous, safety related subjects. A high level of new employee safety orientations was required. Also, the NM Emergency Services group had two meetings with a total of 21 members in attendance. One issue to be resolved in NM is the maser shipment planned for HI VLBA station. This shipment falls under the DOT Dangerous Goods Shipping Regulation.

NRAO-Green Bank

The NRAO GB site specific safety manual was updated. Access is available on the NRAO web page for internal use only. The GB high angle rescue team held practice sessions to improve rescue skills in event of a rescue requirement. Multiple training sessions were held to provide new employee orientation, lifeguard training, fire extinguisher use, respiratory protection training, and GBT specific sessions. Additional progress was made on the testing of the security equipment with respect to RFI related issues. The use of video surveillance and card access was reviewed.

NRAO-Charlottesville

The Charlottesville Edgemont Road and Old Ivy Commons were inspected for the annual safety inspection. All identified items at the Old Ivy Commons have been completed at this time. ES&S reviewed the new Edgemont Road design for safety and security surveillance. Also, ES&S visited the planned space for the ALMA technical group to consider environmental concerns as well as potential safety and security issues.

Environment, Safety and Security

General

During this period, the ES&S division was moved to a direct report to the Directors office, through the Deputy Director for Operations. NRAO-wide, a specific emphasis was placed on the update of the corporate safety manual. In addition, progress was made on the development of the NRAO Business Continuity Plan. This plan is being developed to address emergency type scenarios that could have a negative impact on the business functions of the Observatory. The approach is a three pronged device that consists of Safety preparedness and response actions, Business Continuity and restoration, and data management. The ES&S is involved in addressing the first two items. ES&S participated in the annual Business Managers Meeting, the ALMA week presentations, and met with the new NSF contact, Andrew Clegg, to provide an overview of ES&S at the Observatory.

Telescope Usage

The NRAO telescopes were scheduled for research and maintenance during the second quarter of 2003 in the following manner. Note that time lost and actual observing for the arrays are computed as fractions of the total antenna arrays. For example, losing 27 VLA antennas for one hour counts as 1.0 hour of time lost, while losing one out of ten VLBA antennas for one hour counts as 0.1 hours of time lost.

	VLA	VLBA	GBT
Scheduled Observing (hrs)	1643.1	1167.5	1182.0
Scheduled Maintenance and Equipment Changes	238.1	218.0	490.0
Scheduled Tests and Calibration	309.0	371.4	501.0
Time Lost	88.1	41.9	165.0
Actual Observing	1555.0	1125.6	1017.0

GBT Observing Programs

The following research programs were conducted with the GBT during this quarter:

No.	Observer(s)	Programs
BB155	Ball, G. H. (CfA) Moran, J. M. (CfA) Greenhill, L. J. (CfA)	H_2O Maser in M51 - Phased reference observations of M51 AGN. 1.3 cm
BB169	Bartel, N. (York U.) Bietenholz, M. F. (York U.) Rupen, M.	SN 1986J - the search for a pulsar nebula for grad students. 2 cm
BC132	Carilli, C. Petric, A. (Columbia)	Testing the AGN vs. GN+starburst hypotheses in the highest redshift FIR luminous QSOs. 21 cm
BM186	Momjian, E. Romney, J. D. Carilli, C. L. Troland, T. H. (Kentucky)	OH megamaser emission and low frequency continuum observations of IRAS 17208-0014. 21 cm
BP103	Perez-Torres, M. (IRA) Mantovani, F. (IRA) Marcaide, J. (Valencia) Guirado, J. (Valencia) Alberdi, A. (IAA, Spain) Lara, L. (IAA, Spain) Ros, E. (MPIfR) Panagia, N. (STScI) Shapiro, I. (CfA) Sramek, R. Stockdale, C. (Oklahoma) Weiler, K. (NRL) Van Dyk, S. (IPAC/Caltech) Lundqvist, P. (Stockhom U.)	sn2001gd in NGC5033. 3.5 cm
BR085	Reid, M. (CfA) Carilli, C. Menten, K. M. (MPIfR) Wilner, D. (CfA)	Measuring the temperature of the microwave background radiation field at z = 0.9. 2 cm

GBT Observing Programs

No.	Observer(s)	Programs
BT069	Taylor, G. Berger, E. (Caltech) Kulkarni, S. R. (Caltech) Frail, D. A.	VLBA observations of GRB 030329. 1.3 cm
GB046	Bartel, N. (York U.) Rupen, M. Bietenholz, M. (York U.) Beasley, A. (OVRO) Graham, D. (MPIfR) Altunin, V. (JPL) Venturi, T. (Instituto di Radioastronomia) Umana, G. (Istituto di Radioastronomia, C) Cannon, W. (York U.) Conway, J. E. (Onsala Space Obs.)	SN1993J and the center of M81 (two for one: Morphological and spectral evolution). 6 cm
GBT01A-014	Braatz, J. Greenhill, L. J. (CfA)	Detecting high-velocity masers to reveal nuclear disks in nearby AGNs, 1.3 cm
GBT02A-012	Minter, A. Balser, D.	Probing HI structure on sub-A.U. - A.U. Scales: hydrodynamical or MHD turbulence? 21 cm
GBT02A-014	Fisher, R. Tully, R. (Institute for Astronomy)	Squelched galaxies and dark halos. 21 cm
GBT02A-015	Fisher, R. Tully, R.(Institute for Astronomy)	Comparison of SNIa and luminosity-linewidth distance scale zero-points. 21 cm
GBT02A-028	Braatz, J. Langston, G. McMullin, J. Garwood, R.	Exploring the radio spectrum of Orion A and W51. 2, 3.5, 6, 11, 21, 38 cm
GBT02A-030	Nord, (NRL) Lazio, T. J. W.(NRL) Kassim, N. E. (NRL)	Imaging the Galactic center at 330 MHz. 90 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT02A-031	Lockman, F. J.	Galactic HI mapping of X-ray, UV, and optical deep fields. 21 cm
GBT02A-038	Thilker, D. (Johns Hopkins) Braun, R. (NFRA) Walterbos, R. (NMSU) Corbelli, E. (Osservatorio Astrofisico Arcet) Lockman, F. J. Murphy, E. M. (Virginia)	Probing the ultra-low neutral hydrogen environment and outer disks of M31 and M33. 21 cm
GBT02A-046	Braatz, J. Henkel, C. (MPIfR) Wilson, A. S. (Maryland)	Monitoring a maser disk in Mrk 1419. 1.3 cm
GBT02A-062	Camilo, F. (Columbia) Halpern, J. P. (Columbia) Stairs, I. (U. of British Columbia) Backer, D. C. (UC, Berkeley) Arzoumanian, Z. (NASA/GSFC)	Studying PSR J2229+6114: an energetic gamma-ray emitting young pulsar. 21 cm
GBT02A-063	Claussen, M. Wootten, H. A. Marvel, K. (AAS) Wilking, B. (Missouri)	Water maser monitoring of low and Intermediate Mass Young Stellar Objects. 1.3 cm
GBT02A-069	Fisher, R.	Galaxy survey of HI emission 21 cm
GBT02B-002	Curran, (U. of New South Wales) Pihlstroem, Y. Murphy, M. (U. of New South Wales) Webb, J. (U. of New South Wales)	A search for highly redshifted molecular lines in damped Lyman-α absorbers (HCO). 1.3 cm
GBT02B-003	Sahai, R. (JPL) Claussen, M.	A water maser survey in planetary and proto-planetary nebulae (H_2O). 1.3 cm
GBT02B-006	Yusef-Zadeh, F. (Northwestern) Roberts, D. (Northwestern) Maddalena, R.	A survey of supernova remnant masers of OH (1720, 1665/67 MHz) 21cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT02B-010	Henkel, C. (MPIfR) Braatz, J. A. Carilli, C. L. Lubowich, D. (AIP) Millar, T. (UMIST)	The kinetic temperature of a molecular cloud at z=0.9 (NH_3) 2 cm
GBT02B-018	Braatz, J. Henkel, C. (MPIfR) Greenhill, L. (CfA) Moran, J. (CfA) Wilson, A. S. (Maryland)	Using high-velocity masers to trace AGN accretion disks (H_2O) 1.3 cm
GBT02B-019	Stairs, I. (U. of British Columbia) Ransom, S. (McGill) Kaspi, V. (McGill) Hessels, J. (McGill) Backer, D. C. (UC, Berkeley Lorimer, D. (U. of Manchester)	Timing of newly discovered globular cluster pulsars. 38, 21 cm
GBT02B-021	Chandler, A. (Caltech) Jacoby, B. (Caltech) Anderson, (Caltech) Kulkarni, S. R. (Caltech) Prince, T. A. (Caltech) Backer, D. C. (UC, Berkeley)	Timing the six millisecond pulsars in M62. 21 cm
GBT02C-005	Liszt, H. Holdaway, M.	L-band continuum mapping of the Galactic Center. 21 cm
GBT02C-007	Dickey, J. M. (Minnesota) Kavars, D. (Minnesota) Lockman, F. J. Martin, P.G. (Toronto) McClure-Griffiths, N. (CSIRO) Rothwell, T. (Toronto) Stil, (Calgary) Taylor, R. (Calgary)	A quick GBT HI survey of the inner galactic plane. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT02C-019	Yusef-Zadeh, F. (Northwestern) Cotton, W. D. Maddalena, R. Roberts, D.A. (Northwestern) Law, C. (Northwestern)	Multi-frequency radio continuum observations of the Galactic Center Region. 90 cm
GBT02C-023	Lockman, F. J.	A study of the HI clouds in the Galactic halo. 21 cm
GBT02C-033	Liszt, H. (NRAO-CV) Gerin, M. (Ecole Normale Superieure) Lucas, R. (IRAM (Grenoble))	Search for C4H absorption in diffuse clouds at 19 GHz 1.3 cm
GBT02C-034	Camilo, F. (CAL) Stairs, I. (U. of British Columbia) Lorimer, D. (U. of Manchester) Backer, D. (UC, Berkeley) Ransom, S. (McGill)	Timing observations of the young pulsar in supernova remnant 3C58. 38, 21 cm
GBT02C-059	Wannier, P. (JPL) Vastel, C. (Caltech) Brogan, C.	HI spin temperature determination toward W49N and W31C. 21 cm
GBT02C-061	Bourke, T. (CfA) Myers, P. C. (CfA) Tafalla, M. (OAN, Spain) Wilner, D. (CfA) Lee, C.W. (Korea Astronomy Obs.)	Discriminating models of infall-asymmetry in starless contracting cores (NH3). 1.3 cm
GBT02C-062	Modjaz, M. (Harvard) Moran, J. M. (CfA) Greenhill, L. J. (CfA) Kondratko, P.T. (Harvard)	Probing the magnetic field on sub-parsec scales in the accretion disk of NGC 4258 (H_2O Zeeman). 1.3 cm
GBT02C-063	Fuller, G. (UMIST) Edris, K. (UMIST) Cohen, J. (NRAL)	A search for OH maser emission from high mass protostellar objects. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT02C-065	Braatz, J. Henkel, C. (MPIfR) Wilson, A. (Maryland)	A search for cosmologically interesting H_2O megamasers. 1.3 cm
GBT03A-001	Petrie, P (Australian National U.) Turner, B. Dunbar, (Case Western)	A search for MgNC in TMC. 1.3 cm
GBT03A-002	Kardashev, N. (Lebedev Physical Inst.) Soglasnov, V. (Astro Space Center) Kovalev, Jr., Y. Langston, G	Search for extreme Faraday rotation in AGN. 3.5, 21 cm
GBT03A-013	Hunter, D. A. (Lowell Observatory) Wilcots, E. (U. of Wisconsin)	The HI Edges of Irregular Galaxies. 21 cm
GBT03A-016	Stairs, I. (U. of British Columbia) Manchester, R. (Australia Telescope) Lyne, A. G. (NRAL)	The physics of a massive pulsar system. 21 cm
GBT03A-019	Swift, J (UC, Berkeley) Welch, W. J. (UC, Berkeley) Di Francesco, J. (NRC)	Possible pre-stellar core in L1551. 1.3 cm
GBT03A-020	Martin, J (Virginia) Hibbard, J. Hogg, D. O'Connell, R. W. (Virginia)	HI in early type galaxies with anomalous light profiles. 21 cm
GBT03A-021	Ransom, S. (McGill) Kaspi, V. (McGill) Roberts, M. (McGill) Backer, D. (UC, Berkeley)	A Search for radio pulsations from the nearby isolated neutron star RX J1856.5-3754. 38 cm
GBT03A-023	Stairs, I. (U. of British Columbia) Thorsett, S. (UC, Santa Cruz) Arzoumanian, Z. (NASA/GSFC)	Timing binary pulsars at the GBT. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT03B-007	Giovanelli, R. (Cornell) Magnani, L. (U. of Georgia) Maddalena, R. Springob, C. (Cornell) Spekkens, K. (Cornell) Masters, K. (Cornell) Haynes, M. (Cornell)	A drift scan HI survey of the Virgo cluster region and its foreground. 21 cm
GBT03B-009	Stairs, I. (U. of British Columbia) Backer, D. (UC, Berkeley) Rajagopalan, R. (UC Berkeley)	A Drift-scan Pulsar Survey 38 cm
GBT03B-015	Ransom, S. (McGill) Stairs, I. (U. of British Columbia) Kaspi, V. (McGill U.) Hessels, J. (McGill U.) Backer, D. (UC, Berkeley)	Timing the pulsars in the globular cluster M30. 11, 21, 38 cm
GBT03B-023	Margot, J. (Caltech) Peale, S. (UC, Santa Barbara) Slade, M. (JPL)	Measurements of Mercury spin dynamics to characterize interior properties. 3.5 cm
GBT03B-034	Langston, G.. Walter, F.	Dwarf galaxies and high velocity clouds. 21 cm
GBT03B-035	Camilo, F. (Columbia) Halpern, J. (Columbia) Gotthelf, E.V. (Columbia) Lorimer, D. (Manchester)	Searching for the pulsar in the crab-like SNR G74.9+1.2. 21 cm
GBT03B-037	Ransom, S. (McGill.) Ray, P.S. (NRL) Kaspi, V. (McGill) Dib, R. (McGill)	XTE J1807-294 Target of Opportunity. 11 cm
GBT03B-038	Beaulieu, S. (Universite Laval) Freeman, K. (Australian National U.) Lockman, F. J.	Observations of HI in two dwarf spheroidal galaxies. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT03B-039	Magnani, L. (Georgia)	HI emission from region around molecular cloud MBM40. 21 cm
GBT03B-040	O'Neil, K. Bothun, G. (Oregon)	A new member of the local group? 21 cm
GBT03B-041	Dyer, K. Lockman, F. J.	Observations of HI toward SN 1006. 21 cm
GBT03B-042	Dyer, K.	Continuum reobservations of galactic SNRs . 6, 21 cm
GP036	Paragi, Z. (Geodetic Observ) Wardle, J. F. C. (Brandeis) Homan, D. Vermeulen, R. (Stichting ASTRON) Schilizzi, R. (JIVE) Fejes, I. (Geodetic Observatory) Spencer, R. E. (NRAL) Stirling, A. (NRAL)	Testing the low-energy content of SS433 jets: CP observations at 1.6 GHz using a global VLBI array. 21 cm

VLA Observing Programs

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

No.	Observer(s)	Programs
AA278	Anderson, J. (NMIMT) Ulvestad, J.	Estimating LLAGN sizes using intraday variability. 3.6 cm
AA280	Araya, E. (Puerto Rico) Hofner, P. (Puerto Rico) Churchwell, E. (Wisconsin) Sewilo, M. (Wisconsin) Watson, C. (Wisconsin) Linz, H. (Puerto Rico) Kurtz, S. (Mexico/UNAM)	Formaldehyde 6 cm emission toward IRAS 18566+0804. 2 cm
AA282	Anglada, G. (IAA, Andalucia) Rodriguez, L. (Mexico/UNAM) Torrelles, J. (IAA, Andalucia) Ho, P. (CfA)	Formation of disks and jets in young binaries: SVS 13. 1.3 cm
AB1038	Bolatto, A. (UC, Berkeley) Leroy, A. (UC, Berkeley) Simon, J. (UC, Berkeley) Blitz, L. (UC, Berkeley)	Atomic hydrogen in dwarf galaxies. 20 cm
AB1054	Braine, J. (Bordeaux) Vallejo, O. (Bordeaux)	Dark matter content of NGC 4414. 20 cm
AB1059	Bastian, T. Gary, D. (NJIT) Lee, J. (Arizona) Benz, A. (SFIT, ETH) Vilmer, N. (Paris Obs) Klein, K. (Paris Obs)	Joint microwave and hard X-ray imaging of impulsive solar flares. 0.7, 1.3, 2 cm

VLA Observing Programs

No.	Observer(s)	Programs
AB1068	Butt, Y. (CfA) Dame, T. (CfA) Yusef-Zadeh, F. (Northwestern)	Tracing cosmic ray sources with OH masers. 18 cm
AB1069	Beswick, R. (Manchester) Pedlar, A. (Manchester) Muxlow, T. (Manchester) Wills, K. (Sheffield) Gallimore, J. (Bucknell) Strong, M. (Manchester)	HI emission and absorption in starburst galaxies. 20 cm
AB1073	Bontemps, S. (Bordeaux) Motte, F. (Caltech) Schneider, N. (Bordeaux) Herpin, F. (Bordeaux) Minier, V. (New South Wales)	Massive star formation sites in Cyg X. 3.6, 6 cm
AB1075	Butt, Y. (CfA) Rupen, M. Benaglia, P. (LaPlata)	VLA Mosaic of Cyg OB2 and unidentified source TeV J2032+4130. 6, 20 cm
AB1088	Boboltz, D. (USNO) Hollis, J. (NASA/GSFC) Diamond, P. (Manchester) Johnston, K. (USNO) Fey, A. (USNO)	43-GHz SiO maser emission toward late-type stars. 0.7 cm
AB1090	Braatz, J. Greenhill, L. (CfA) Moran, J. (CfA)	Continuum and maser-line emission in nearby AGNs. 1.3 cm

VLA Observing Programs

No.	Observer(s)	Programs
AB1091	Beelen, A. (IAP, Paris) Cox, P. (IAP, Paris) Carilli, C. Mohan, N. (Raman Institute) Omont, A. (IAP, Paris) Bertoldi, F. (MPIR, Bonn) Petric, A. (Columbia)	Imaging host galaxies of $1.5 < z < 5$ QSOs. 20 cm
AB1094	Bik, A. (Amsterdam) Kurtz, S. (Mexico/UNAM) Kaper, L. (Amsterdam) Waters, R. (Amsterdam) Lenorzer, A. (Amsterdam)	Emission line objects in massive starforming regions. 3.6, 6 cm
AC616	Colina, L. (Cantabria) Alberdi, A. (IAA, Andalucia) Torrelles, J. (IAA, Andalucia) Panagia, N. (STScI) Wilson, A. (Maryland)	Search for new radio supernovae in NGC 7469. 3.6 cm
AC664	Crapsi, A. (Firenze) Caselli, P. (Firenze) Tafalla, M. (OAN) Walmsley, M. (Firenze)	Unveiling the temperature structure of a protostellar core. 1.3 cm
AC665	Chyzy, K. (Jagellonian) Bomans, D. (Ruhr U.) Klein, U. (Bonn U.) Urbanik, M. (Jagellonian)	Magnetic fields in blue compact galaxy IC10. 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AC671	Carilli, C. Walter, F. Fan, X. (Princeton) Bertoldi, F. (MPIR, Bonn) Cox, P. (IAP, Paris) Beelen, A. (IAP, Paris) Strauss, M. (Princeton) Petric, A. (Columbia)	CO(3-2) in QSO J1148+5251 at z=6.37. 0.7 cm
AC676	Capetti, A. (Torino) Santantoni, L. (Torino)	Radio structure of galaxies with type Ia supernovae. 20 cm
AD474	Disney, M. (Wales) de Blok, W. (CSIRO) Minchin, R. (Wales) Boyce, P. (Bristol, UK) Dalcanton, J. (Washington) Ekers, R. (CSIRO) Garcia, D. (Wales) Grossi, M. (Wales) Kilborn, V. (Manchester) Knezek, P. (Johns Hopkins) Linder, S. (Wales) Stavely-Smith, L. (ATNF) West, A. (Washington)	HI sources without optical counterparts, from HIPASS. 20 cm
AF398	Fanti, C. (Bologna) Rossetti, A. (Bologna) Fanti, R. (Bologna) Dallacasa, D. (Bologna) Stanghellini, C. (Bologna) Gregorini, L. (Bologna) Vigotti, M. (Bologna)	Cores and hotspots CSS/GPS sources. 2 cm

VLA Observing Programs

No.	Observer(s)	Programs
AF399	Fey, A. (USNO) Boboltz, D. (USNO) Johnston, K. (USNO) Claussen, M. Gaume, R. (USNO)	Radio star observations for a radio/optical frame tie. 3.6 cm
AF402	Falcke, H. (MPIR, Bonn) Huttemeister, S. (Bochum) Leipski, C. (Bochum)	Imaging radio-quiet quasars. 6 cm
AG640	Gomez, J. (IAA, Andalucia) deGregorio-Monsalvo, I. Kuiper, T. (JPL) Torrelles, J. (IAA, Andalucia) Anglada, G. (IAA, Andalucia)	CCS observations of class O protostars. 1.3 cm
AG648	Giroletti, M. (Bologna) Giovannini, G. (Bologna) Taylor, G.	Low-power compact radio galaxies. 1.3, 3.6 cm
AH785	Hofner, P. (Puerto Rico) Araya, E. (Puerto Rico) Linz, H. (Puerto Rico) Olmi, L. (Puerto Rico) Kurtz, S. (Mexico/UNAM) Cesaroni, R. (Arcetri)	Interior structure of the hot-molecular core G31.41+0.31. 1.3, 3.6 cm
AH811	Helfand, D. (Columbia) Becker, R. (Calif., Davis) White, R. (STScI) Warwick, R. (Leicester)	A multi-wavelength image of Milky Way. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AH816	Hofner, P. (Puerto Rico) Araya, E. (Puerto Rico) Olmi, L. (Puerto Rico) Linz, H. (UNAM) Kurtz, S. (Mexico/UNAM) Cesaroni, R. (Arcetri)	Massive proto-binary in G31.41+0.31 hot molecular core. 0.7 cm
AH817	Higdon, J. (Cornell) Higdon, S. (Cornell) Weedman, D. (Cornell) Jannuzi, B. (Princeton) Dey, A. (KPNO-NOAO) Rieke, M. (Arizona) Soifer, B. (Caltech)	Star formation history of the high-z universe: Bootes field. 20 cm
AH819	Hoare, M. (Leeds) Busfield, A. (Leeds)	Stellar winds from massive young stellar objects. 3.6 cm
AH822	Harris, D. (CfA) Biretta, J. (STScI) Junor, W. (New Mexico)	Inner jet of M87: tests of a synchrotron model. 1.3, 2, 3.6 cm
AH827	Hota, A. (TIFR) Saikia, D. (TIFR)	Two starburst galaxies with outflows: NGC1482 and NGC6764. 3.6, 6 cm
AI106	Imai, H. (NFRA) Diamond, P. (Manchester) Deguchi, S. (NAO, Japan) Nakashima, J. (NAO, Japan) Miyazaki, A. (Ibaraki U.)	Central object and circumstellar envelope of AGB star W43A. 0.7 cm

VLA Observing Programs

No.	Observer(s)	Programs
AJ297	Johnston, K. (USNO) Fey, A. (USNO) Boboltz, D. (USNO) Gaume, R. (USNO) Claussen, M.	Astrometry and polarimetry of the T Tau System. 0.7, 1.3, 2, 3.6, 6 cm
AJ299	Johnson, K. Plante, S. (Laval)	Star cluster formation at low metallicities: SBS0335-052. 3.6, 6 cm
AJ300	Jackson, N. (Manchester) Browne, I. (Manchester) Wilkinson, P. (Manchester) Mao, S. (Manchester)	Wide-separation lenses in the CLASS survey. 2 cm
AJ302	Jonker, P. (Cambridge) Fender, R. (Amsterdam) Dubus, G. (IAP) Dhawan, V. Rupen, M.	X-ray transient XTE J1908+094. 3.6 cm
AK509	Kulkarni, S. (Caltech) Frail, D. Galama, T. (Caltech) Bloom, J. (Caltech) Berger, E. (Caltech) Harrison, F. (Caltech)	Radio afterglows from gamma ray bursts.
AK550	Kulkarni, S. (Caltech) Berger, E. (Caltech) Soderberg, A. (Caltech) Chevalier, R. (Virginia)	Type Ibc supernovae. 1.3, 3.6, 6, 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AK557	Kothes, R. (DRAO) Landecker, T. (DRAO)	HI absorption in four supernova remnants for kinematic distances. 20 cm
AK558	Kumar, M. (CAUP) Shepherd, D. Tafalla, M. (CfA)	A dark core inside a compact young star cluster. 1.3 cm
AK559	Kurtz, S. (Mexico/UNAM) Fields, D. (Roane State) Thinniam, R. (INAOE) Ayala, S. (UNAM)	Extended emission around UC HII regions. 3.6 cm
AK562	Krause, O. (MPIA, Heidelberg) Bally, J. (Colorado/JILA) Toth, L. (MPIA, Heidelberg)	Ammonia (1,1) and (2,2) in massive star forming region IRAS04186+5143. 1.3 cm
AK565	Kardeshev, N. (Lebedev) Rupen, M. Slee, O. (CSIRO) Tsarevsky, G. (CSIRO) de Freitas Pacheco, J. (Obs. Nice)	Search for new microquasars among ROSAT sources. 6, 20 cm
AK566	Kunert, M. (Copernicus/Torun) Marecki, A. (Copernicus/Torun) Spencer, R. (Manchester)	MSO objects without cores or hot spots. 6 cm
AK571	Kording, E. (MPIR, Bonn) Colbert, E. (Johns Hopkins) Falcke, H. (MPIR, Bonn)	Radio loud IXOs? 3.6 cm
AL586	Lockman, F.J. Rupen, M. Liszt, H.	Structure and shape of newly discovered halo HI clouds. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AL587	Lang, C. (Iowa) Lazio, J. (NRL)	Higher frequency mosaic of the Galactic center. 6 cm
AL592	Loinard, L. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Wilner, D. (CfA) Ho, P. (CfA) D'Alessio, P. (Mexico/UNAM)	Isolated accretion disks in IRAS16293-2422. 0.7 cm
AM707	Murgia, M. (Bologna) Parma, P. (Bologna) Fanti, R. (Bologna) deRuiter, H. (Bologna) Bondi, M. (Bologna) Ekers, R. (CSIRO) Fomalont, E.	Low frequency observations of the radio galaxy NGC 326. 90 cm
AM744	Mirabel, I. (CNRS, France) Ribo, M. (Barcelona) Marti, J. (U. Jaen)	Simultaneous observations with the INTEGRAL galactic plane survey. 2, 3.6, 6, 20 cm
AM748	Menten, K. (MPIR, Bonn) Reid, M. (CfA) Beuther, H. (MPIR, Bonn)	Sensitive search for SiO masers in star-forming regions. 0.7 cm
AM750	Mayo, E. (Kentucky) Troland, T. (Kentucky) Crutcher, R. (Illinois)	Zeeman effect in Cygnus X. 20 cm
AM755	Matthews, B. (UC, Berkeley) Heiles, C. (UC, Berkeley)	OH in the Orion A integral filament. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AM756	Mundy, L. (Maryland) Henning, T. (MPIA, Heidelberg) Wilner, D. (CfA) Chandler, C.	Dust properties in T Tauri systems: VLA 7mm observations. 0.7, 1.3 cm
AM759	Miller, N. (NASA/GSFC) Oegerle, W. (NASA/GSFC)	Continuum imaging of Butcher-Oemler cluster A2111. 20 cm
AM763	Martin, S. (UC, Berkeley) dePater, I. (UC, Berkeley) Gibbard, S. (LLNL)	Lower tropospheric motions in Neptune. 2, 3.6, 6 cm
AM766	Monnier, J. (CfA) Greenhill, L. (CfA) Ribo, M (Barcelona) Tuthill, P. (Sydney) Danchi, W. (NASA/GSFC)	Monitoring colliding wind binary WR112. 3.6 cm
AM771	Mohan, R. (IIA, Bangalore) Beelen, A. (IAP, Paris) Omont, A. (IAP, Paris) Carilli, C. Cox, P. (IAP, Paris) Bertoldi, F. (MPIR, Bonn) Petric, A. (Columbia)	Mapping starbursts in host galaxies of z~1 QSOs. 20 cm
AM773	Mirabel, I. (CNRS, France) Ribo, M. (Barcelona) Marti, J. (U. Jaen)	Simultaneous observations with INTEGRAL GPS. 2, 3.6, 6, 20 cm
AM775	Mirabel, I. (CNRS, France) Ribo, M. (Barcelona) Marti, J. (U. Jaen)	GRS 1915+105 observation with INTEGRAL.

VLA Observing Programs

No.	Observer(s)	Programs
AM776	Mirabel, F. (CNRS, France) Ribo, M. (Barcelona)	4U1755-33 in D configuration. 20 cm
AN114	Nagar, N. (Arcetri)	Search for multiple AGN in merger systems. 2 cm
AO170	O'Dea, C. (STScI) Guerra, E. (Rowan) Daly, R. (Penn State) Donahue, M. (STScI)	Propagation of powerful radio galaxies. 6 cm
AO172	Osten, R. Brown, A. (Colorado/JILA) Bastian, T.	Coherent emission from active binary systems. 20, 90 cm
AO173	Owen, F. Dwarakanath, K. (Raman Institute) Ledlow, M. (KPNO-NOAO)	HI in FR I radio galaxy B2 1108+27. 20 cm
AP454	Pedlar, A. (Manchester) Muxlow, T. (Manchester) Beswick, R. (Manchester) Wills, K. (Sheffield) Aalto, S. (Chalmers, Onsala) Booth, R. (Chalmers, Onsala) Thrall, H. (Manchester) Smith, R. (AAO)	Mainline OH masers in the M82 starburst. 20 cm
AP456	Peck, A. (CfA) Henkel, C. (MPIR, Bonn) Gallimore, J.	Molecular cloud in the core of Mrk348. 6, 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AP457	Perlman, E. (Maryland) Jones, L. (Birmingham) Ebeling, H. (Hawaii) Scharf, C. (STScI) Horner, D. (NASA/GSFC)	Evolution of cluster radio galaxies at the highest redshifts. 20 cm
AP460	Pihlstrom, Y. Murphy, M. (New South Wales)	Quasar flux densities. 1.3 cm
AR503	Rodriguez, L. (Mexico/UNAM) Garay, G. (Chile)	Search for circumstellar disks around massive O-type protostars. 0.7 cm
AR505	Ratay, D. (Florida) Gottesman, S. (Florida)	HI Observations of barred, flocculent galaxies. 20 cm
AR508	Rupen, M. Mioduszewski, A. Dhawan, V. Ribo, M. (Barcelona)	Galactic x-ray binaries. 20 cm
AR510	Robishaw, T. (UC, Berkeley) Simon, J. (UC, Berkeley) Blitz, L. (UC, Berkeley)	A possible interaction between LGC 3 and neighboring HVC. 20 cm
AR511	Rector, T. Londish, D. (Sydney)	Radio quiet BL lac objects? 6 cm
AR513	Rodriguez, L. (Mexico/UNAM) Reipurth, B. (Hawaii)	Study of the exciting source of the HH92 jet. 3.6 cm
AR514	Romani, R. (Stanford) Brisken, W.	In-beam calibrator survey for astrometry of PSR J0538+2817. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AR518	Rawlings, S. (Oxford) Brand, K. (Oxford) Hill, G. (Texas) Tufts, J. (Texas)	Jet alignments in forming super-structures. 3.6 cm
AR520	Rudnick, L. (Minnesota) Slee, O. (CSIRO)	New type of radio galaxy/cluster relic? 3.6, 20 cm
AR523	Rupen, M. Dhawan, V. Mioduszewski, A. Ribo, M. (Barcelona)	X-ray binaries, transients and related sources. 0.7, 1.3, 2, 3.6, 6, 20 cm
AR524	Rusin, D. (CfA) Winn, J. (CfA) Kochanek, C. (CfA)	Possible third image of gravitational lens PMN J1632-0033. 0.7, 2 cm
AR525	Rupen, M. Mioduszewski, A. Blundell, K. (Oxford)	Unraveling the precessing jet in SS433. 0.7, 1.3, 2, 3.6, 6, 20 cm
AR526	Ribo, M. (Barcelona) Negueruela, I. (Strasbourg) Mirabel, F. (CNRS, France)	HMXB 4U2206+54. 3.6 cm
AS745	Solomon, P. (SUNY) Vanden Bout, P. Carilli, C.	Dense molecular gas and star formation in high redshift galaxies. 1.3 cm
AS749	Sollins, P. (CfA) Ho, P. (CfA) Zhang, Q. (CfA) Keto, E. (CfA)	Searching for infall in hot molecular cores. 1.3 cm

VLA Observing Programs

No.	Observer(s)	Programs
AS750	Schinnerer, E. Mundell, C. (Liverpool JMU) Garcia-Burillo, S. (Liverpool JMU) Combes, F. (Paris Obs) Ulvestad, J.	HI in a CO selected galaxy sample. 20 cm
AS751	Shirley, Y. Wootten, H.A.	Ammonia thermometry of low mass star forming cores. 1.3 cm
AS754	Stocke, J. (Colorado/JILA) Rosenberg, J. (Colorado/JILA) Shull, J. (Colorado/JILA) Keeney, B. (Colorado/JILA)	HI mapping of galaxies near bright AGNs. 20 cm
AS758	Shepherd, D. Claussen, M. Kurtz, S. (Mexico/UNAM)	Tracing a circumbinary disk around massive protostar G192.16-3.82. 1.3 cm
AS760	Smith, J. (Hertfordshire) Robinson, A. (Hertfordshire) Gallimore, J. (Bucknell) Axon, D. (Hertfordshire) Corbett, E. (Mt. Stromlo)	Radio axes and the optical polarization of Seyfert 1s. 3.6, 20 cm
AS761	Sjouwerman, L. Dickel, J. (Illinois) Kong, A. (CfA) Johnson, K. Williams, B. (Delaware) Dyer, K. (North Carolina)	Polarization measurements of the center of M31. 6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AS762	Sokoloski, J. (Southampton) Mioduszewski, A. Brocksopp, C. (MSSL) Rupen, M.	Monitoring symbiotic binaries during outburst. 3.6, 6, 20 cm
AS765	Surdej, J. (Belgium) Coleman, P. (Groningen/Kapteyn) Sluse, D. (Belgium) Jean, C. (Belgium) Claeskens, J-F. (Liege) Smette, A. (NASA/GSFC) Warren, S. (Imperial College) Dye, S. (Imperial College)	Observations of the nearest gravitationally lensed quasar. 3.6, 6, 20 cm
AS770	Strasser, S. (Minnesota) Dickey, J. (Minnesota) Taylor, A. (Calgary)	Study of very cold neutral hydrogen clouds. 20 cm
AS771	Sollins, P. (CfA) Ho, P. (CfA) Zhang, Q. (CfA) Keto, E. (CfA)	Searching for infall in hot molecular cores. 1.3 cm
AT285	Thornley, M. (Bucknell University) Kennicutt, R. (Arizona) Kewley, L. (CfA) Regan, M. (DTM/Carnegie) Walter, F.	HI in galaxies in the SIRTF Nearby Galaxies Survey. 20 cm
AT286	Thornley, M. (Bucknell University) Kennicutt, R. (Arizona) Kewley, L. (CfA) Helou, G. (IPAC)	Radio-FIR relation on kpc scales in SIRTF Nearby Galaxy Survey. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AT292	Tyson, J. (Bell Labs) Fassnacht, C. (Calif., Davis) Becker, A. (Bell Labs) Comerford, J. (UC, Berkeley) Dell'Antonio, I. (Brown University) Hennawi, J. (Princeton) Margoniner, V. (Bell Labs) Turner, E. (Princeton)	Q2345+007AB: wide separation lens or accidental QSO pair? 6 cm
AT293	Testi, L. (Arcetri) Shepherd, D.	Dust in HD163296. 0.7 cm
AV261	VanTrung, D. (SA/IAA, Taiwan) Lim, J. (SA/IAA, Taiwan)	Cyanopolyynes in carbon-rich envelopes. 0.7, 1.3 cm
AV265	Vogt, C. (MPIfA) Clarke, T. (Virginia) Ensslin, T. (MPIfEP, Garching)	Faraday rotation measure of extended radio sources. 6 cm
AV266	Vlemmings, W. (Cornell) van Langevelde, H. (NFRA) Diamond, P. (Manchester) Chatterjee, S. (Cornell)	Survey for in-beam calibrators for OH maser astrometry. 3.6 cm
AV267	Van Dyk, S. (IPAC)	Search for radio supernovae in Wolf-Rayet galaxies. 20 cm
AV268	deVries, W. (LLNL) van Breugel, W. (LLNL) Kassim, N. (NRL) Cohen, A. (NRL) Dawson, S. (UC, Berkeley) Lacy, M. (Calif., Davis) Rottgering, H. (Leiden)	90cm observations of SIRTF First-Look field. 90 cm

VLA Observing Programs

No.	Observer(s)	Programs
AW593	Weiler, K. (NRL) Stockdale, C. (NRL) Sramek, R. Van Dyk, S. (IPAC) Panagia, N. (STScI) Marcaide, J. (Valencia) Lewin, W. (MIT) Pooley, D. (MIT) Immler, S. (Massachusetts)	ToO observations of Supernovae. 1.3, 2, 3.6, 6, 20, 90 cm
AW599	Whysong, D. (Calif., Santa Barbara) Antonucci, R. (Calif., Santa Barbara) Geller, R. (Calif., Santa Barbara)	Search for Thompson scattering in the intergalactic medium. 20 cm
AW601	Wilcots, E. (Wisconsin) Pisano, D. (CSIRO) Freeland, E. (Wisconsin)	The dynamical evolution of galaxy groups. 20 cm
AW602	Wilkin, F. (UNAM/Mexico) Loinard, L. (UNAM/Mexico)	SiO in the NGC 1333 IRAS 2A protostellar outflow. 0.7 cm
AW603	Walsh, A. (CfA) Zhang, Q. (CfA) Myers, P. (CfA) Di Francesco, J. (CfA) Bourke, T. (CfA) Wilner, D. (CfA)	Cluster formation in NGC 1333. 1.3 cm
AW606	Wucknitz, O. (Hamburg U.) Browne, I. (Manchester) Biggs, A. (Manchester) Jackson, N. (Manchester) York, T. (Manchester)	LensCLEANing B0218+357 to derive H0. 2 cm

VLA Observing Programs

No.	Observer(s)	Programs
AW607	Winn, J. (CfA) Rusin, D. (CfA) Kochanek, C. (CfA) Lovell, J. (CSIRO) Fassnacht, C. (Calif., Davis) Fassnacht, C. (Calif., Davis) Koopmans, L. (Caltech)	Gravitational lens monitoring. 3.6 cm
AW608	Weiler, K. (NRL) Stockdale, C. (NRL) Sramek, R. Van Dyk, S. (IPAC) Panagia, N. (STScI) Marcaide, J. (Valencia) Lewin, W. (MIT) Pooley, D. (MIT) Immler, S. (Massachusetts)	ToO observations of supernovae. 1.3, 2, 3.6, 6, 20, 90 cm
AW609	Weiler, K. (NRL) Stockdale, C. (NRL) Sramek, R. Van Dyk, S. (IPAC) Panagia, N. (STScI) Marcaide, J. (Valencia) Lewin, W. (MIT) Pooley, D. (MIT) Immler, S. (Massachusetts)	Long term monitoring of radio supernovae. 1.3, 2, 3.6, 6, 20, 90 cm
AX008	Xu, Y. (Nanjing) Greenhill, L. (CfA) Menten, K. (MPIR, Bonn) Moscadelli, L. (Cagliari) Reid, M. (CfA) Zheng, X. (Nanjing)	Search for calibrators near W3OH. 6, 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AZ143	Zhao, J. (CfA) Herrnstein, R. (CfA) Goss, W.M. Bower, G. (UC, Berkeley) Pegg, J. (CfA)	Monitoring quasi-periodic oscillations of SgrA*. 0.7, 1.3, 2 cm
AZ144	Zhao, J.H. (CfA) Roy, S. (NCRA, India) Goss, W.M. Rao, P. (NCRA, India)	Low frequency spectral shape of SgrA*. 3.6, 6, 20, 90 cm
BC139	Claussen, M. Goss, W.M. Moellenbrock, G. Beasley, A. (Caltech)	Tests of water maser phase referencing. 1.3 cm
BD087	Dhawan, V. Fomalont, E. Lestrade, J-F. (Paris Obs) Rupen, M. Mioduszewski, A.	VLB Astrometry of X-ray binaries. 2, 3.6 cm

VLBA Observing Programs

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

No.	Observer(s)	Programs
BB152	Bach, U. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Greve, A. (IRAM) Krichbaum, T. (MPIR, Bonn) Terasranta, H. (Metsahovi) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Precessing or helical jet in NRAO 150? 0.7 ,1.3, 4, cm
BB153	Bach, U. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Middelberg, E. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Measuring the core shift in Cygnus A. 0.3, 0.7, 2 cm
BB155	Ball, G. (CfA) Moran, J. (CfA) Greenhill, L. (CfA)	H_2O maser in M51. 1.3 cm
BB156	Budding, E. (Carter Obs.) Slee, O. (CSIRO) Beasley, A.J. (OVRO) Willes, A. (Univ. of Sydney)	Comparison between radio emission of two Algol-type binaries at high resolution. 2 cm
BB159	Bachiller, R. (Yebes Obs) Codella, C. (Arcetri) Desmurs, J. (Yebes Obs) Marvel, K. (AAS) Rioja, M. (Yebes Obs) Santiago-Garcia, J. (Yebes Obs)	Precession and outbursts in protostellar outflows: NGC 1333 region. 1 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BB161	Britzen, S. (Heidelberg Obs) Wagner, S. (Heidelberg Obs) Bach, U. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Fuhrmann, L. (MPIR, Bonn) Cimo, G. (MPIR, Bonn) Kraus, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn) Greve, A. (IRAM) Bremer, M. (Bristol, UK) Grewing, M. (IRAM) Booth, R. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala)	Jet of IDV source S5 0716+714. 0.3 cm
BB162	Bach, U. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Middelberg, E. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn) Greve, A. (IRAM) Bremer, M. (Bristol, UK) Grewing, M. (IRAM) Booth, R. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala)	Cygnus A at 3mm. 0.3 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BB163	Bach, U. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn) Greve, A. (IRAM) Bremer, M. (Bristol, UK) Grewing, M. (IRAM) Booth, R. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala) Terasranta, H. (Helsinki)	Jet in NRAO 150. 0.3 cm
BB169	Bartel, N. (York U.) Bietenholz, M. (York U.) Rupen, M.	SN 1986J - search for a pulsar nebula. 2, 4 cm
BC120	Chatterjee, S. (Cornell) Backer, D. (UC, Berkeley) Benson, J. Brisken, W. Cordes, J. (Cambridge) Ellis, R. (UC, Santa Cruz) Fomalont, E. Golden, A. (Ireland) Goss, W.M. Kramer, M. (Manchester) Lazio, T. (NRL) Lyne, A. (Manchester) McKinnon, M. Thorsett, S. (UC, Santa Cruz) Wong, D. (Cornell)	Pulsar astrometry with the VLBA. 20 cm
BC126	Cotton, W.D. Saslaw, W. (Virginia)	Likely gravitational lensing of 3C435B. 3.6 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BC128	Claussen, M. Marvel, K. (AAS) Wilking, B. (UMSL) Wootten, H.A.	VLBA Monitoring of water masers around low and intermediate young stellar objects. 1 cm
BC132	Carilli, C. Petric, A. (Columbia)	Separating AGN and starburst activity in two FIR luminous QSOs. 18 cm
BC135	Cotton, W.D. Bakker, E. (Leiden) Chagnon, G. (Obs. de Paris) Coude du Foresto, V. (Obs. de Paris) Diamond, P. (Manchester) Kononen, P. (Helsinki) McAllister, H. (Georgia State Univ.) Mennesson, B. (JPL) Perrin, G. (Obs. de Paris) Ragland, S. (CfA) Ridway, S. (NOAO) Traub, W. (CfA) van Langevelde, H. (JIVE) Vlemmings, W. (Leiden) Waters, R. (Amsterdam)	VLBA Observations of bright O-rich Mira stars. 0.7 cm
BD089	Doeleman, S. (Haystack)	Multi transition VLBI observations of SiO masers. 0.3, 0.7 cm
BE025	Engels, D. (Sternwarte) Brand, J. (Bologna) Perez-Torres, M. (Bologna)	Imaging the putative disk of the transvestite star V778 Cyg. 1 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BE026	Engels, D. (Sternwarte) Brand, J. (Bologna) Perez-Torres, M. (Bologna)	Search for bipolar outflows in young proto-planetary nebulae. 1 cm
BE028	Edwards, P. (ISAS) Kataoka, J. (Tokyo Inst.)	Constraining the predicted motion in 3C303. 6 cm
BE030	Edwards, P. (ISAS) Holder, J. (Leeds) Piner, B. (Whittier)	Puzzling parsec-scale structure of the TeV gamma ray source 1ES1956+650. 1,.3, 2 cm
BG116	Geldzahler, B. (George Mason) Bradshaw, C. (George Mason) Fomalont, E.	Astrometric observations of the compact radio source G127.11+0.54. 4 cm
BG129	Chandler, C. Greenhill, L. (CfA) Reid, M. (CfA) Moran, J. (CfA) Diamond, P. (Manchester)	SiO proper motions in Orion KL. 0.7 cm
BG134	Greenhill, L. (CfA) Jauncey, D. (CSIRO) Kondratko, P. (CfA) Kuiper, T. (JPL) Lovell, J. (CSIRO) Moran, J. (CfA)	Follow-up imaging of water megamasers detected with the DSN. 1 cm
BH102	Hoffman, I. (New Mexico) Goss, W.M. Brogan, C. Claussen, M.	Full Stokes observations of the W44 OH(1720 MHz) masers. 18 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BH105	Hough, D. (Trinity) Aars, C. (Texas Christian University)	Variability in the nuclei of lobe-dominated quasars, Part II. 2, 4 cm
BH108	Hong, X. (Shanghai) An, T. (Shanghai) Wang, W. (Shanghai) Zhao, J.-H. (CfA)	Millimeter VLBA observations of the core structure on a sub-parsec scale in the gamma ray AGN 1156+295 at z=0.729. 0.3, 0.7, 2 cm
BH114	Hoffman, I. (New Mexico) Goss, W.M. Palmer, P. (Chicago)	The 6 cm formaldehyde masers in Sgr B2. 6 cm
BI027	Imai, H. (JIVE) Diamond, P. (Manchester)	Evolution of a molecular jet from the AGB star W43A. 1 cm
BK086	Krichbaum, T. (MPIR, Bonn) Fuhrmann, L. (MPIR, Bonn) Beckert, T. (MPIR, Bonn) Cimo, G. (MPIR, Bonn) Kraus, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn)	Intermittently IDV source 0917+62. 1.3, 2 cm
BK092	Krichbaum, T. (MPIR, Bonn) Bach, U. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Polatidis, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn) Ungerechts, H. (Massachusetts) Terasranta, H. (Helsinki) Aller, H. (Michigan) Aller, M. (Michigan)	VLBA Monitoring of 1633+382 during a major millimeter-flare. 0.3, 0.7 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BK097	Krichbaum, T. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Lobanov, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn) Greve, A. (IRAM) Bremer, M. (Bristol, UK) Grewing, M. (IRAM) Booth, R. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala) Gomez, J. (IAA, Andalucia) Alberdi, A. (IAA, Andalucia)	Interior structure of relativistic jets at 86 GHz. 0.3 cm
BL104	Lobanov, A. (MPIR, Bonn) Roland, J. (IAP, Paris) Ros, E. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn)	Cross-band monitoring of a flare in the VLBI core of 3C345. 0.7, 1, 2, cm
BL111	Lister, M. Aller, H. (Michigan) Aller, M. (Michigan) Cohen, M. (Caltech) Homan, D. Kadler, M. (MPIR, Bonn) Kellermann, K. Kovalev, Y. (Lebedev) Lobanov, A. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Vermeulen, R. (NFRA) Zensus, J.A. (MPIR, Bonn)	MOJAVE Program. 2 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BL115	Lanyi, G. (JPL) Boboltz, D. (USNO) Charlot, P. (Bordeaux) Fey, A. (USNO) Fomalont, E. Gordon, D. (NASA) Ma, C. (NASA) Sovers, J. (Remote Sensing) Taylor, G. Ulvestad, J.	High precision K/Q-band astrometry. 1 cm
BM161	Marecki, A. (Torun) Barthel, P. (Kapteyn) Falcke, H. (MPIR, Bonn) Owsianik, I. (MPIR, Bonn) Polatidis, A. (Onsala)	Testing spectral age derivation assumptions for CSO 1245+676. 1 cm
BM171	Marscher, A. (Boston Univ.) Aller, M. (Michigan) Gomez, J. (IAA, Spain) Jorstad, S. (Boston Univ.) Marscher, A. (Boston Univ.) McHardy, I. (Southampton)	Relationship between X-ray events and superluminal ejections in blazars. ,0.7, 1 cm
BM175	Middelberg, E. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Roy, A. (MPIR, Bonn) Walker, R.	Beating the sensitivity limits: 3mm imaging of NGC 4261. 0.3, 0.7, 2 cm
BM176	Momjian, E. (Kentucky) Romney, J. Carilli, C. Troland, T. (Kentucky)	VLBA continuum and HI absorption observations of LIG UGC 2369. 18 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BM178	Marvel, K. (AAS) Alcolea, J. (OAN) Boboltz, D. (USNO) Bujarrabal, V. (OAN) Colomer, F. (OAN) Desmurs, J. (OAN) Diamond, P. (Manchester) Kemball, A. Soria, R. (OAN)	Relative spatial distribution of SiO masers in AGB stars at 43 and 86 GHz. 0.3, 0.7 cm
BM182	Ma, C. (NASA/GSFC) Johnston, K. (USNO) Fey, A. (USNO) Boboltz, D. (USNO) Gordon, D. (NASA/GSFC) Gaume, R. (USNO) Kingham, K. (USNO) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) MacMillan, D. (Interferometrics) Petrov, L. (NASA/GSFC) Fomalont, E. Walker, C.	VLBA Geodesy/Astrometry observations for 2003. 3.6 cm
BM184	Moscadelli, L. (Cagliari) Claussen, M. Furuya, R. (Arcetri) Kitamura, Y. (ISAS) Testi, L. (Arcetri) Wootten, H.A.	Low-mass YSOs explored by H_20 masers. 1 cm
BM185	Murgia, M. (Bologna) Dallacasa, D. (Bologna) Stanghellini, C. (Bologna) Fanti, R. (Bologna)	Spectral versus kinematic age in CSOs. 2, 3.6, 6, 18 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BM186	Momjian, E. (Kentucky) Romney, J. Carilli, C. Troland, T. (Kentucky)	OH and continuum in ULIRG 17208-0014. 20, 90 cm
BM191	Marscher, A. (Boston) Aller, M. (Michigan) Gomez, J. (IAA, Granada) Jorstad, S. (Boston) McHardy, I. (Southampton)	Relationship between X-ray events and superluminal ejections in blazars. 0.7, 1 cm
BM192	Macquart, J-P. (Groningen/Kapteyn) deBruyn, A. (NFRA) Gabuzda, D. (Copernicus/Torun) Gurvits, L. (NFRA) Dennett-Thorpe, J. (Groningen/Kapteyn)	Imaging the IDV quasar J1819+3845 at 22 GHz. 1.3 cm
BM196	Mioduszewski, A. Blundell, K. (Oxford) Rupen, M. Walker, C. Taylor, G.	Movie of precessing jet and equatorial outflow in SS433. 20 cm
BM197	Mioduszewski, A. Dhawan, V. Rupen, M.	The Black hole X-ray transient, IGR J1746-321. 0.7, 2, 4 cm
BP089	Piner, B.G. (Whittier) Edwards, P. (ISAS) Jones, D. (JPL)	Monitoring of Ultra-fast blazars. 0.7, 1, 2 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BP103	Perez-Torres, M. (Bologna) Mantovani, F. (Bologna) Marcaide, J. (Valencia) Guirado, J. (Valencia) Alberdi, A. (IAA, Andalucia) Lara, L. (IAA, Granada) Ros, E. (MPIR, Bonn) Panagia, N. (STScI) Shapiro, I. (CfA) Sramek, R. Stockdale, C. (NRL) Weiler, K. (NRL) Van Dyk, S. (IPAC) Lundqvist, P. (Stockholm)	SN 2001 gd in NGC 5033. 3.6 cm
BP106	Petric, A. (Columbia) Carilli, C.	Study of the highest redshift compact steep spectrum sources, and a search for sub-arcsecond scale gravitational lensing. 20 cm
BR084	Reid, M. (CfA) Brunthaler, A. (MPIR, Bonn)	Proper motion of Sgr A*. 7 cm
BR085	Reid, M. (CfA) Carilli, C. Menten, K. (MPIR, Bonn) Wilner, D. (CfA)	HC_3N temperature in the z=0.89 molecular cloud in 1830-211. 1, 2 cm
BR086	Ribo, M. (Barcelona) Dhawan, V. Marti, J. (Jaen) Mirabel, I. (Saclay)	ToO observations of galactic gamma ray sources with INTEGRAL. 2,4 cm
BR087	Rector, T. Gabuzda, D. (Cork University) Peterson, K. (Yale University)	Third epoch observations of high energy peaked BL Lac objects. 6 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BR088	Ratner, M. (CfA) Bartel, N. (York U.) Bietenholz, M. (York U.) Lebach, D. (CfA) Lestrade, J-F. (Paris Obs) Ransom, R. (York U.) Shapiro, I. (CfA)	Astrometry of HR 8703 in 2003 for gravity probe-B mission. 4 cm
BS094	Sudou, H. (Tohoku University) Iguchi, S. (NAO) Kameno, S. (NAO) Murata, Y. (ISAS) Taniguchi, Y. (Tohoku University)	Search for an accretion disk and a dusty tours in NGC 4261. 0.7, 1, 2 cm
BS116	Slysh, S. (Lebedev) Salter, C. (NAIC) Ghosh, T. (NAIC) Nolan, M. (NAIC) Perillat, P. (NAIC)	VLBI Holography of the Arecibo 305-m telescope. 6 cm
BS121	Savolainen, T. (Tuorla Obs) Courvoisier, T. (INTEGRAL) Valtaoja, E. (Tuorla Obs) Wiik, K. (Tuorla Obs)	Physics of AGN, a Deep understanding of the quasar 3C 273. 0.3, 0.7, 1, 2, 4, 6 cm
BT068	Teng, S. (NASA) Neff, S. (NASA) Ulvestad, J.	Radio supernova in NGC 3690. 2, 4, 6, 13 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BT069	Taylor, G. Berger, E. (Caltech) Frail, D. Kulkarni, S. (Caltech)	VLBA Observations of GRB 030329. 1,2,4,6 cm
BV044	Vlemmings, W. (Cornell) Diamond, P. (Manchester) van Langevelde, H. (JIVE)	Polarization of circumstellar H_20 masers. 1 cm
BV049	Vlemmings, W. (Cornell) Mellema, G. (Leiden) van Langevelde, H. (JIVE)	Circular polarization of the H_20 masers of proto-planetary nebulae. 1 cm
BW066	Wiik, K. (Tuorla Obs) Collmar, W. (MPIfEP) Savolainen, T. (Tuorla Obs) Valtaoja, E. (Tuorla Obs)	Hard X-ray and multi-frequency properties of the blazar 3C 279. 0.3, 0.7, 1, 2, 4, 6 cm
BW067	Walker, R. Hardee, P. (University of Alabama)	Patterns in 3C120 jet from 0.5 to 6 arcseconds. 90 cm
BW068	Wiik, K. (Tuorla Obs) Baath, L. (Halmstad Univ.) Rantakyro, F. (ESO) Savolainen, T. (Tuorla Obs) Tornikoski, M. (Metsahovi) Valtaoja, E. (Tuorla Obs)	High frequency monitoring of two flaring AGN. 0.3, 0.7, 1 cm

VLBA Observing Programs

No.	Observer(s)	Programs
GB046	Bartel, N. (York U.) Rupen, M. Bietenholz, M. (York U.) Beasley, A. (Caltech) Graham, D. (MPIR, Bonn) Altunin, V. (JPL) Venturi, T. (Bologna) Umana, G. (Bologna) Cannon, W. (York U.) Conway, J. (Chalmers, Onsala)	SN 1993J and center of M81: morphological and spectral evolution. 6 cm
GJ010	Jackson, N. (Manchester) Wilkinson, P. (Manchester) Browne, I. (Manchester) York, T. (Manchester) Mao, S. (Manchester) Biggs, A. (Manchester) Koopmans, L. (Caltech) deBruyn, A. (NFRA)	Substructure in CLASS lensing galaxies. 6 cm
GM049	Macquart, J-P. (Groningen/Kapteyn) deBruyn, A. (NFRA) Gabuzda, D. (Copernicus/Torun) Gurvits, L. (NFRA) Dennett-Thorpe, J. (Groningen/Kapteyn)	Brightness temperature from polarimetry of IDV quasar J1819+3845. 6 cm
GP036	Paragi, Z. (NFRA) Wardle, J. (Brandeis) Homan, D. Vermeulen, R. (NFRA) Schilizzi, R. (NFRA) Fejes, I. (FOMISGO) Spencer, R. (Manchester) Stirling, A. (Lancashire)	1.6 GHz circular polarization in SS 433. 20 cm

Personnel

NEW HIRES

Amestica Valenzuela, Rodrigo	Software Engineer II	05/19/2003
Caviggia, Kurt	Engineering Associate, Junior	05/27/2003
Choudhary, Sunita	Engineering Associate, Junior	05/19/2003
Ervine, Patricia	Accountant	05/05/2003
Gerrard, Douglas	Electronics Engineer II	04/15/2003
Monsalvo, Itziar	Research Assistant	05/29/2003
Ramey, Kenneth	Software Engineer II	05/30/2003
Robertson, Ann "Kathy"	Observatory Librarian	06/06/2003
Ye, Jason	Research Assistant	06/09/2003
*Lacasse, Michael	Engineering Associate, Junior	05/21/2003

TERMINATIONS

Brown, Robert	Deputy Director	05/02/2003
Desmond, James	Special Assistant	06/30/2003
Dwarakanath, Koratekere	Visiting Scientist	05/20/2003
Fakes, Troy	Engineering Associate, Junior	05/09/2003
Ravichandran, Satish	Engineering Associate, Junior	05/02/2003
Tapia, Reydelle	Engineering Associate, Junior	05/14/2003

PROMOTIONS AND APPOINTMENTS

Emerson, Darrel	To Assistant Director	06/01/2003
Hogg, David	To Interim Deputy Director	06/01/2003
Hunt, Gareth	To Interim Associate Director	05/23/2003
Morris, Gregory	To Electronics Engineer III	05/01/2003

*Rehire

Publications

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

PREPRINTS RECEIVED, APRIL - JUNE 2003

ARGON, A.L.; REID, M.J.; MENTEN, K.M. A Class of Interstellar OH Masers Associated with Protostellar Outflows.

BLOOM, J.S.; FRAIL, D.A.; KULKARNI, S.R. GRB Energetics and the GRB Hubble Diagram: Promises and Limitations.

BLUNDELL, K.M.; BEASLEY, A.J.; BICKNELL, G.V. A Relativistic Jet in the Radio-Quiet Quasar PG 1407+263.

BOBOLTZ, D.A.; FEY, A.L.; JOHNSTON, K.J.; CLAUSSEN, M.J.; DE VEGT, C.; ZACHARIAS, N.; GAUME, R.A. Astrometric Positions and Proper Motions of 19 Radio Stars.

BOKER, T.; LISENFELD, U.; SCHINNERER, E. Molecular Gas in the Central Regions of the Latest-Type Spiral Galaxies.

BOND, J.R.; CONTALDI, C.R.; PEN, U.-L.; POGOSYAN, D.; PRUNET, S.; RUETALO, M.I.; WADSLEY, J.W.; ZHANG, P.; MASON, B.S.; MYERS, S.T.; PEARSON, T.J.; READHEAD, A.C.S.; SIEVERS, J.L.; UDOMPRASERT, P.S. The Sunyaev-Zeldovich Effect in CMB-Calibrated Theories Applied to the Cosmic Background Imager Anisotropy Power at $l > 2000$.

BRADSHAW, C.F.; GELDZAHLER, B.J.; FOMALONT, E.B. The X-ray Spectral Changes of Scorpius X-1.

HARDCASTLE, M.J.; WORRALL, D.M.; KRAFT, R.P.; FORMAN, W.R.; JONES, C.; MURRAY, S.S. Radio and X-ray Observations of the Jet in Centaurus A.

HOMAN, D.C.; LISTER, M.L.; KELLERMANN, K.I.; COHEN, M.H.; ROS, E.; ZENSUS, J.A.; KADLER, M.; VERMEULEN, R.C. Jet Collimation in Action: Realignment on Kiloparsec Scales in 3C 279.

LOCKMAN, F.J. High Velocity Cloud Complex H: A Satellite of the Milky Way in a Retrograde Orbit?

LONSDALE, C.J.; LONSDALE, C.J.; SMITH, H.E.; DIAMOND, P.J. VLBI Imaging of Luminous Infrared Galaxies: AGN Cores in Mrk231, UGC 5101, and NGC 7469.

LONSDALE, C.J.; SMITH, H.E.; ROWAN-ROBINSON, M.; SURACE, J.; SHUPE, D.; XU, C.; OLIVER, S.; PADGETT, D.; FANG, F.; CONROW, T.; FRANCESCHINI, A.; GAUTIER, N.; GRIFFIN, M.; HACKING, P.; MASCI, F.; MORRISON, G.; O'LINGER, J.; OWEN, F.; PEREZ-FOURNON, I.; PIERRE, M.; PUETTER, R.; STACEY, G.; CASTRO, S.; POLLETTA, M.D.C.; FARRAH, D.; JARRETT, T.; FRAYER, D.; SIANA, B.; BABBEDGE, T.; DYE, S.; FOX, M.; GONZALEZ-SOLARES, E.; SALAMAN, M.; BERTA, S.; CONDON, J.J.; DOLE, H.; SERJEANT, S. SWIRE: The SIRTF Wide-Area Infrared Extragalactic Survey.

MASON, B.S.; PEARSON, T.J.; READHEAD, A.C.S.; SHEPHERD, M.C.; SIEVERS, J.; UDOMPRASERT, P.S.; CARTWRIGHT, J.K.; FARMER, A.J.; PADIN, S.; MYERS, S.T.; BOND, J.R.; CONTALDI, C.R.; PEN, U.; PRUNET, S.; POGOSYAN, D.; CARLSTROM, J.E.; KOVAC, J.; LEITCH, E.M.; PRYKE, C.; HALVERSON, N.W.; HOLZAPFEL, W.L.; ALTAMIRANO, P.; BRONFMAN, L.; CASASSUS, S.; MAY, J.; JOY, M. The Anisotropy of the Microwave Background to $l = 3500$: Deep Field Observations with the Cosmic Background Imager.

MCKINNON, M.M. Three-Dimensional Statistics of Radio Polarimetry.

MIYOSHI, M.; IMAI, H.; NAKASHIMA, J.; DEGUCHI, S.; SHEN, Z.-Q. VLBA Observation of a Radio Intraday Flare of Srg A.

MUNOZ, J.A.; FALCO, E.E.; KOCHANEK, C.S.; LEHAR, J.; MEDIAVILLA, E. The Redshift Distribution of Flat-Spectrum Radio Sources.

MYERS, S.T.; CONTALDI, C.R.; BOND, J.R.; PEN, U.-L.; POGOSYAN, D.; PRUNET, S.; SIEVERS, J.L.; MASON, B.S.; PEARSON, T.J.; READHEAD, A.C.S.; SHEPHERD, M.C. A Fast Gridded Method for the Estimation of the Power Spectrum of the CMB from Interferometer Data with Application to the Cosmic Background Imager.

OTT, J.; MARTIN, C.L.; WALTER, F. Chandra Observations of Expanding Shells in the Dwarf Starburst Galaxy NGC 3077.

PREPRINTS RECEIVED, APRIL - JUNE 2003

PEARSON, T.J.; MASON, B.S.; READHEAD, A.C.S.; SHEPHERD, M.C.; SIEVERS, J.; UDOMPRASERT, P.S.; CARTWRIGHT, J.K.; FARMER, A.J.; PADIN, S.; MYERS, S.T.; BOND, J.R.; CONTALDI, C.R.; PEN, U.; PRUNET, S.; POGOSYAN, D.; CARLSTROM, J.E.; KOVAC, J.; LEITCH, E.M.; PRYKE, C.; HALVERSON, N.W.; HOLZAPFEL, W.L.; ALTAMIRANO, P.; BRONFMAN, L.; CASASSUS, S.; MAY, J.; JOY, M. The Anisotropy of the Microwave Background to l = 3500: Mosaic Observations with the Cosmic Background Imager.

PETRIC, A.O.; CARILLI, C.L.; BERTOLDI, F.; FAN, X.; COX, P.; STRAUSS, M.A.; OMONT, A.; SCHNEIDER, D.P. Sensitive Observations at 1.4 and 250 GHZ of z > 5 QSOs.

PHILLIPS, R.B.; STRAUGHN, A.H.; DOELEMAN, S.S.; LONSDALE, C.J. R Cassiopeiae: Relative Strengths of SiO Masers at 43 and 86 GHz.

RIZZA, E.; MORRISON, G.E.; OWEN, F.N.; LEDLOW, M.J.; BURNS, J.O.; HILL, J. Sensitive Radio and Optical Observations of z Approximately = 0.2 Rich Abell Clusters.

ROUSSEL, H.; HELOU, G.; BECK, R.; CONDON, J.J.; BOSMA, A.; MATTHEWS, K.; JARRET, T.H. Nascent Starbursts in Synchrotron-Deficient Galaxies with Hot Dust.

SCHINNERER, E.; BOKER, T.; MEIER, D.S. Molecular Gas and the Nuclear Star Cluster in IC342: Sufficient Inflow for Recurring Star Formation Events?

SCHMITT, H.R.; DONLEY, J.L.; ANTONUCCI, R.R.J.; HUTCHINGS, J.B.; KINNEY, A.L. A Hubble Space Telescope Survey of Extended [OIII] lambda 5007 A Emission in a Far-Infrared Selected Sample of Seyfert Galaxies: Observations.

SHORE, S.N.; MAGNANI, L.; LAROSA, T.N.; MCCARTHY, M.N. Mechanisms for the Origin of Turbulence in Non-Star-Forming Clouds: The Translucent Cloud MBM 40.

SIEMIGINOWSKA, A.; STANGHELLINI, C.; BRUNETTI, G.; FIORE, F.; ALDCROFT, T.L.; BECHTOLD, J.; ELVIS, M.; MURRAY, S.S.; ANTONELLI, L.A.; COLAFRANCESCO, S. Chandra Discovery of an X-ray Jet and Extended X-ray Structure in Z=0.63 Quasar, B2 0738+313.

SIEVERS, J.L.; BOND, J.R.; CARTWRIGHT, J.K.; CONTALDI, C.R.; MASON, B.S.; MYERS, S.T.; PADIN, S.; PEARSON, T.J.; PEN, U.-L.; POGOSYAN, D.; PRUNET, S.; READHEAD, A.C.S.; SHEPHERD, M.C.; UDOMPRASERT, P.S.; BRONFMAN, L.; HOLZAPFEL, W.L.; MAY, J. Cosmological Parameters from Cosmic Background Imager Observations and Comparisons with BOOMERANG, DASI, and MAXIMA.

STOCKDALE, C.J.; WEILER, K.W.; VAN DYK, S.D.; MONTES, M.J.; PANAGIA, N.; SRAMEK, R.A.; PEREZ-TORRES, M.A.; MARCAIDE, J.M. Radio Emission from SN 2001gd in NGC 5033.

WALTER, F.; BERTOLDI, F.; CARILLI, C.; COX, P.; LO, K.Y.; NERI, R.; FAN, X.; OMONT, A.; STRAUSS, M.A.; MENTEN, K.M. Detection of Molecular Gas in a Quasar at the End of Cosmic Reionization.

XU, C.K.; LU, N.; CONDON, J.J.; DOPITA, M.; TUFFS, R.J. Physical Conditions and Star Formation Activity in the Intragroup Medium of Stephan's Quintet.

YOUNG, L.M.; VAN ZEE, L.; LO, K.Y.; DOHM-PALMER, R.C.; BEIERLE, M.E. Star Formation and the ISM in Four Dwarf Irregular Galaxies.

YUSEF-ZADEH, F.; NORD, M.; WARDLE, M.; LAW, C.; LANG, C.; LAZIO, T.J.W. Nonthermal Emission from the Arches Cluster (G0.121+0.017) and the Origin of Gamma-ray Emission from 3EG J1746-2851.

ZAVALA, R.T.; TAYLOR, G.B. Faraday Rotation as a Probe of the Physical Conditions near Relativistic Jets.