Quarterly Report
July - September 2002

National Radio
Astronomy
Observatory

A facility of the National
Science Foundation operated
under cooperative agreement
by Associated Universities, Inc.

NRAO

Table of Contents

Quarterly Report July - September 2002

Executive Summary

ALMA

Installation of the components of the VertexRSI Antenna proceeded during this quarter. The backup structure was raised and attached to the pedestal on October 1, 2002. A set of Level Two Milestones is being developed. Other aspects of the ALMA project can be found at http://www.nrao.edu/almamirror/news/.

EVLA

The fiber optic cable that will be buried along the array arms of the VLA was delivered to the site, and installation will begin in November. Construction of prototypes for all EVLA antenna electronic subsystems was begun. Progress in other aspects of the project is reported in the document "EVLA Progress Report, 1 February to 31 July, 2002."

Green Bank Telescope

The GBT was used approximately 30 percent of the time for refereed observing proposals, and it is anticipated that the GBT will approach full scientific operation at frequencies below 26.5 GHz by the end of 2002. The first awards under the new Student Support Program were made, to twelve students.

Commissioning activities focused on the validation of those modes of the Spectrometer which have been requested in approved observing programs. System checkout also involves clearing problems associated with the flatness of spectral baselines and with the incidence of RFI. The latter problem is being addressed in several projects which examine mitigation of RFI from the laser rangefinders, from the GBT feedarm servo systems, and from the shielded rooms in the Jansky Lab addition.

The azimuth track continues to require considerable attention, because of premature wear. Extensive measurements of track stability, grout stability, and the tilting of the wheels as they pass over the joints in the track have been made during this quarter. The measurements will be assessed by both the Green Bank Operations group as well as an external committee of experts in steel structures and track systems which will be convened in late October. The panel will consider short-term and long-term remediation concepts.

The Software Development Division has made good progress in improving the ability of engineers to test and checkout the Spectrometer, and in making the configuration of the observing equipment easier, quicker, and more reliable. There are now regular monthly releases of the Monitor&Control system, providing for example a more capable LO1. The focus of the effort will gradually shift to the development of a production quality Observer's Interface.

The Precision Telescope Control subsystems have begun to produce results relevant to high frequency operation and to the monitoring of the structure. The quadrant detector is studying the nature of the motions of the feed arm. Work continues on the development of the system using the laser rangefinders to survey the GBT structure to higher accuracies than can be had using conventional instruments. The objective for the winter observing season is to demonstrate the capability to correct the GBT pointing to the arc second level.

Very Large Array & Very Long Baseline Array

In September, the sixth azimuth bearing change was made on a VLA antenna. Separation of the antenna took only 3-4 hours, and the two parts of the antenna were rejoined two days after the old bearing was removed. Repainting of several more VLA antennas was completed during the summer, with the 28th (and last!) antenna in the eight-year program due for completion in October 2002. A full maintenance visit was carried out at the Mauna Kea VLBA antenna.

Retrofitting of new VLA 22-GHz feeds to eliminate moisture buildup was completed in August. Tests demonstrated conclusively that the system temperatures remained low during the rainy season, unlike previous summers, and that the condensation problem has been solved.

A new method has been developed to recontour excessively worn headstacks on VLBA tape recorders. Previously, some of those headstacks had to be discarded, and replaced at a cost of approximately $9,000 each. The recontouring, taking less than an hour per headstack, was carried out on ten units during the quarter.

Central Development Laboratory

Progress continues to be made in the development of mixers for two ALMA bands. Three mixers for the 84-166 GHz band are being tested, and the information on the mixer design parameter that is needed to finalize the production wafer design will be obtained. Two programs are being undertaken for mixers in the 211-275 GHz band. An improved single-ended mixer chip has been designed, the corresponding masks have been fabricated, and the first wafer is being processed at UVA. As the final prototype, a two-chip unbalanced sideband-separating mixer integrated with a pair of 4-12 GHz IF preamps, is currently under design.

Several logic card and motherboard designs were completed for the ALMA correlator. Preparations are in progress for the building of cards for the two-antenna prototype system. Two substantial problems were encountered. First, some of the custom ALMA1 chips failed lab tests and were returned to the factory for additional analysis. Second, the system microprocessors do not reset reliably. A fix for the problem has been proposed, but additional testing is required.

A modified 809/240 GHz tripler was assembled and tested. Although one of the DC bias bypass capacitors exhibited a low reverse breakdown voltage, thereby limiting the completeness of the tests, the frequency tripler did show good agreement between the measured and theoretical performance with zero DC bias, validating the use of GaAs-membrane-on-quartz substrates in this application.

Although the progress on the development of the beam-forming array for the GBT has been slowed by the limited manpower available, several steps have been completed. A number of goals have been defined which will enable the group to focus their effort in the most critical areas. A second type of antenna, the crossed sleeve dipole, is being considered. Hardware has been procured for the antenna test range and is being evaluated and installed. Software to support the monitor and control of the new lock-in amplifier and synthesizer for the test range was developed, and completion of the software for Phase 1 is anticipated to occur in the spring of 2003, when it will be required for engineering tests.

Data Management

The second development cycle of the e2e (End-to-End) project began, with the goal of ensuring that by the end of the cycle designs and/or prototypes for all deliverables will be in place to a level of detail sufficient to allow definition of the project scope and schedule. Following the design review in July, an effort is underway to develop the detailed scientific requirements, and the draft report will be available for inclusion into the project at the end of the second development cycle.

The overarching design for e2e is being finalized, and will describe the form and flow of information in e2e from proposal submission to archive access. The most difficult part of the design has been to capture the intentions of the observers during the proposal submission process. Work is also proceeding on the implementation architecture, and is close to being finalized.

The current focus of AIPS++ has been on the enhancement of the basic package, on the collaboration with GBT operations on single-dish problems, and on the completion of end-to-end testing with IRAM collaborators. In the development of the package, particular emphasis is placed on scientific completeness, ease of use, and enhancements in robustness and performance. The goal in Green Bank is to meet the scientific and technical needs of telescope commissioning. The success of the AIPS++-IRAM test has allowed a close partnership to develop between the North American and European ALMA off-line software groups.

The Central Computing Services has concentrated on improving the security environment at NRAO, on the development of mirrored web servers, and on the difficult challenge of having a common computing environment both in UNIX and in Windows applications. The mirroring of the main web address is now complete and operational. The web page is being improved, and a gallery of important images of radio objects has been created.

Education and Public Outreach

Summer is typically the time when the effort in education programs peaks. This year there were courses in association with Chautauqua and The Research Experience for Teachers. There were workshops for teachers in the Hands-On-Universe program. A total of thirty-one students were resident at the NRAO during the summer, primarily under the auspices of the Research Experience for Undergraduates and the Summer Student Research Assistant Program.

The construction of the Green Bank Science Center is proceeding rapidly. Current expectations are that the Center should be open for "advance preview" business in early spring. The presentation video for the VLA Visitor Center has been completed, and that for Green Bank is expected to be finished by the end of the year.

The NRAO on-line Image Gallery has been launched and is available for public use. It features a multi-level format, low-, medium-, and high-resolution images, and a versatile search engine. It is intended to provide both scientists and the general public an easy and well- organized source for radio astronomy images.

Green Bank

The Outer Disks of M31 and M33 - Using the GBT, Thilker et al. have recently completed sensitive, on-the-fly maps of HI in Local Group members M31 and M33. Their study was aimed at probing the faint outer disks and ultra-low column density environment of these spirals. The data are being used for follow-up on the remarkable, but tentative, association of two compact high-velocity clouds (CHVCs) with M31 and M33. Such CHVCs could represent dark companions to our LG neighbors, if convincingly shown to be extragalactic. The GBT maps will also be used to search for signs of interaction between Andromeda and the M31 Cloud (Blitz et al. 1999) plus M33 and Wright's Cloud. The investigators will use the data to determine key properties of the underlying dark matter distribution and indicate whether or not the halo of M31 and M33 overlap. Furthermore, the GBT HI survey is relevant to efforts at understanding the extra-galactic UV radiation field and anticipated photoionization edge of outer atomic disks. Initial results show fascinating new structure in M33's prominent warp, multiple components in the M33 CHVC, and several other new compact clouds found near M31 and M33. Many of the HI detections in the M31 field may be associated with the stellar stream recently discovered by Ibata et al. (2001).

Investigators *D. Thilker (JHU), R. Braun (NFRA), R. Walterbos (NMSU), E. Corbelli (Arcetri), E. Murphy (U. Virginia), F. J. Lockman, and R. Maddalena (NRAO).*

VLA

VLA Shows "Smoking Gun" for Colliding Black Holes - VLA images of "X-type" radio galaxies have been cited as compelling evidence for black-hole collisions in merging galaxy systems. In "X-type" systems, the current axis of the jet is dramatically different from that of larger-scale lobes. A pair of researchers used the VLA images in conjunction with theoretical work to argue that the images result from a change in the jet alignment due to the collision of one galaxy's central black hole with that of another.

Investigators: *D. Merritt (Rutgers) and R. Ekers (ATNF).*

VLBA

VLBA Measures Nine New Pulsar Parallaxes - The VLBA has been used to measure nine new pulsar parallaxes, doubling the number of pulsars with accurate (errors of only 2%) distance measurements. Such measurements allow determination of the absolute luminosities and radiation efficiencies of pulsars, and, for thermally emitting neutron stars, promise the possibility of directly constraining the neutron star radius and thus the nuclear equation of state at high densities. Combined with measurements of proper motion, also completed in this study, this work helps constrain the pulsar velocity distribution and hence the symmetry of supernova explosions.

Investigators: *W. Brisken, J. Benson, W. M. Goss; and S.E. Thorsett (UCSC).*

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

Evaluation of the VertexRSI Antenna continues at the ALMA Test Facility (ATF) located at the VLA site. Completion of the antenna had been delayed due to fabrication difficulties with the machined aluminum panels and problems associated with the installation of insulation and cladding. These problems have been solved and the antenna is scheduled for completion on November 18, 2002. Evaluation tests of the antenna performance will be conducted over the succeeding months. The IPTs, the Executive Project Managers and the Joint ALMA Office are developing a set of Level Two Milestones, consistent with the Level One Milestones established by the ACC. These milestones will be used to conduct a detailed critical path analysis for the project.

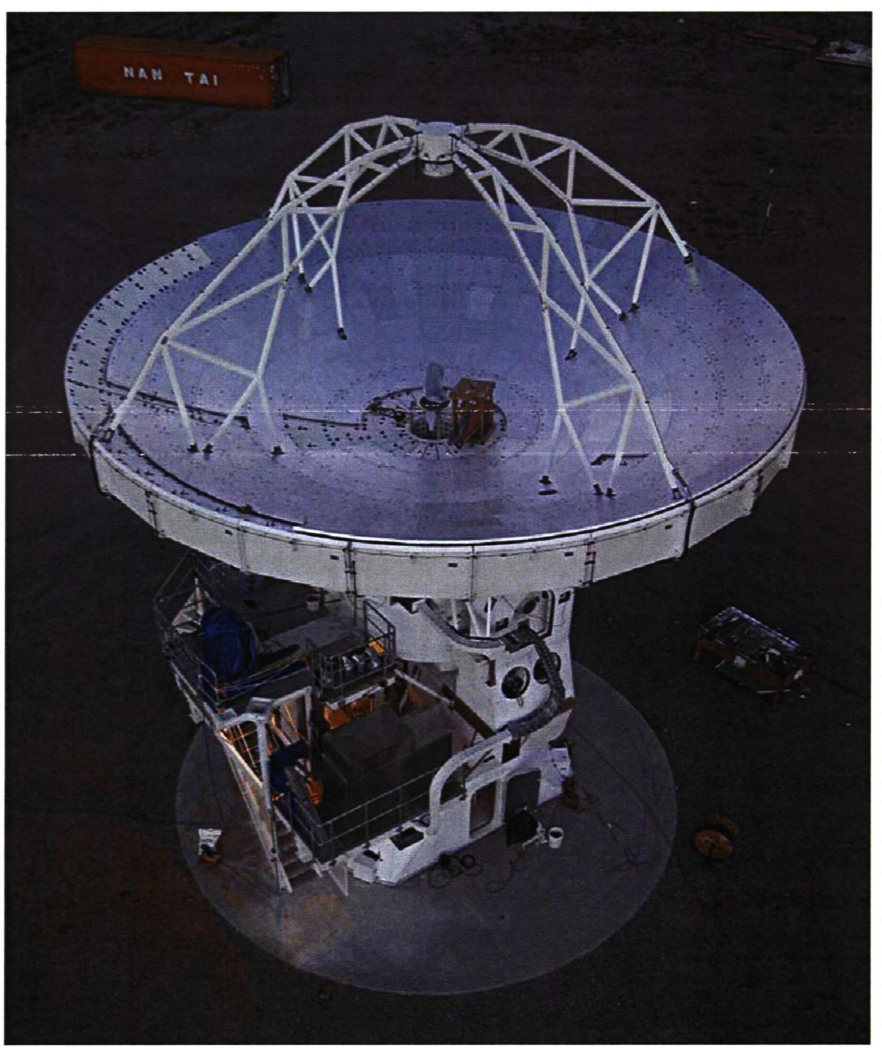

Figure 1 The VertexRSI Antenna at the VLA site. In this view, the installation of the surface panels is nearly complete.

The NRAO Director has convened a panel of experts from inside the NRAO to review the technical details of those portions of the ALMA project assigned to North America. Darrel Emerson chairs the ALMA Technical Advisory Committee (ATAC). The ATAC is currently reviewing existing documentation and conducting interviews with key members of the ALMA North American staff. The committee will submit a report to the NRAO director.

A Progress Review of the EVLA Project was held at the NSF on September 25, 2002. Copies of the presentations from that review were submitted to the NSF. The last of the EVLA Subsystem Preliminary Design Reviews, for the Data Processing Software System, was held on July 18-19.

The fiber optic cable that will be buried along the array arms of the VLA was delivered to the site. The cable cost $338 K, will be installed at the beginning of November 2002. Installation will take approximately two years. Installation of fiber manholes on the array, and a fiber termination room in the Control Building, was begun.

Construction of prototypes for all EVLA electronic subsystems was commenced with a goal of beginning laboratory system integration tests in January 2002. Herzberg Institute for Astrophysics (HIA), the Canadian group responsible for design and construction of the new correlator, proceeded with detailed design of the correlator. HIA's initial request to the Canadian Government for correlator funding was denied but a request to a different funding entity has been made and it is still expected that Canadian funding will be obtained.

In the real-time software area purchases were made for both the hardware and software needed for the module interface board (MIB). The MIB is the device that provides the interface among all pieces of hardware and the EVLA Control Computer via an Ethernet fiber network. In the area of data processing preliminary tests were begun on a prototype data pipeline and a prototype data archive system.

Further details concerning EVLA activities can be found in the document "EVLA Progress Report - 1 February to 31 July, 2002" and in the presentations from the EVLA Progress Review held at the NSF in September.

GBT Student Support Program

The Student Support Program for GBT observers was initiated this quarter. Initial applications for support were made in conjunction with the June 2002 GBT proposal deadline. Both graduate and undergraduate students at U.S. universities are eligible to apply. The program awards support for student stipends, computer hardware purchases, and travel to meetings to present GBT results usually for up to one year. Guidelines for application may be found at http://www.gb.nrao.edu/gbtprops/gbtpropnews/gbt_student_support.htm.

The GBT Student Support Committee met on August 27 to evaluate the June applications. The Committee considered several factors in the evaluation, including the science ranking of the proposal, the student's role in the proposed research, and the importance of the work to the student's professional development. Twelve awards were made, totaling approximately $217,000.

GBT Antenna & Operations

Milestone	Original Deadline	Revised Deadline	Date Completed
Refinement of GBT painting plan	7/1/02	8/1/02	8/1/02
Six-month structural inspection plan for the GBT	7/30/01	10/31/02	
Six-month inspection of GBT welds/structure	6/30/02	11/1/02	
Expansion of Cable Building Complete	7/1/02	10/31/02	
Begin three maintenance days per week	7/1/02	deferred	
Repair bowed GBT BUS member	9/1/02	11/1/02	
Continue site access improvements	12/31/02		
GBT Azimuth Track Review Meeting	10/31/02		

GBT Mechanical Engineering and Central Instrument Shop Work

Milestone	Original Deadline	Revised Deadline	Date Completed
Servo RFI Panel	8/31/02	--	8/15/02
Penn Array Cryostat	8/15/02	--	8/31/02
K band OMT's for VLA (2)	8/30/02	--	8/28/02
EVLA K band Prototype	7/31/02	--	9/11/02
EVLA L band Feed	8/30/02	12/17/02	
K band OMT's for VLA (6)	12/6/02		
Q band feeds for VLA (3)	10/25/02		
Ka band feed for GB	12/2/02		

GBT Software and Computing

Milestone	Original Deadline	Revised Deadline	Date Completed
Configuration through Observer's Interface	3/23/01	9/30/02	9/27/02
LO Phase 0 improvements	7/15/02		7/22/02
LO Phase 1 improvements	8/19/02		8/28/02
Spectrometer Phase 0 improvements	8/19/02		8/28/02
Spectrometer Phase 1 improvements	9/16/02		9/25/02
Antenna Test Range Phase 0 functionality	8/16/02		8/16/02
Prepare for visiting observers	6/30/01	10/1/02	
M&C V3.9: Antenna Improvements Phase 0 Spectrometer Phase II	10/30/02		
M&C V3.10 IF Mgr Improvements Phase 0 LO Phase II Antenna Phase I Spectrometer Phase III Q-band Receiver Checkout	12/11/02		
Project Office Rollout	12/5/02		

Astronomy Education Center Project

Milestone	Original Deadline	Revised Deadline	Date Completed
AEC dormitory bid due date	5/24/02	7/12/02	7/12/01
AEC dormitory start of construction	7/1/02	11/4/02	
AEC main building construction complete	10/15/02	1/31/02	

GBT Commissioning and Observing Activities

The transition from commissioning to regular, scientific operations continues. During the third quarter, about 30% of total time went to refereed observing proposals, and the remainder of the time to commissioning activities and maintenance. The fraction of time available to observations should grow in the fourth quarter. We anticipate that the GBT will approach full scientific operation at frequencies below 26.5 GHz by the end of 2002.

Commissioning activities in the last quarter have concentrated on validation of GBT Spectrometer modes, observing program checkouts, and investigations into special problems and data quality issues. The Spectrometer has more than 200 possible configuration modes, allowing a large range of input bands, sampling, bandwidth, and channel modes, and both autocorrelation and cross-correlation operation. At the end of the third quarter, most of these modes have received initial engineering checkout. The approved proposals presently in the queue request only about 16 of these modes, which are receiving priority attention. In addition to laboratory validation, each mode is subjected to astronomical performance tests, and iteration with the engineering staff is sometimes required. The present focus is on achieving multi-bank operation of the Spectrometer, which allows the full use of all possible input bands and the maximum spectral bandwidths and resolutions.

During the third quarter, all approved observing programs in the proposal queue were carefully reviewed for technical requirements, and those requirements were recorded in a web-accessible data base. For early operation of the GBT, the commissioning staff is previewing each observing program to ensure that the requested capabilities are working properly and that data quality is adequate to meet the scientific objectives of the program. Once this is confirmed, the program is placed on the observing schedule and the investigators carry out the program. As the system matures and the suite of tested capabilities expands, this checkout scheme will be relaxed. A number of data quality problems have been found through these checkouts, mostly with spectral baselines and radio frequency interference problems. A team of commissioning scientists and engineers are investigating the baseline problems and are narrowing down the sources. Some of the problems have been associated with receiver electronics, others with gain saturation caused by external RFI, and others with reflections in the optics. Considerable work remains in this area. Another team is working to reduce RFI. The effects of RFI in the 1.4 GHz band have been noticeably reduced, and there are also apparent improvements in the 300 MHz band. There is much work left to be done in RFI reduction, and this remains an ongoing program.

In the fourth quarter of 2002, work will continue on the checkouts and mode validations described above. In addition, the 18-26.5 GHz (K-band) receiver will be reinstalled and commissioning will continue for that band. 40-50 GHz (Q-band) will begin in the first quarter of 2003.

Azimuth Track

The GBT's azimuth track is experiencing premature wear. After less than a year of regular, although still only part-time use, interior areas of the track assembly are wearing and are affecting wheel motion in a significant way.

The azimuth track is divided into 48 segments around its circumference. In vertical profile, the track consists of three layers: a 2.25-inch thick wear plate of hardened steel, a 9-inch thick base plate of mild steel, and a 5-inch thick splice plate that supports the gap between segments. The steel track is supported by cement-like grout and the concrete ringwall that extends to bedrock.

As has been described in previous reports, the track has had a series of problems since initial azimuth movement of the telescope began. Significant problems with found with circumferential slippage of the base plate and wear plate and with shearing of the hold-down bolts that attach the wear plate to the base plate. These problems were successfully fixed by the contractor prior to acceptance. However, in December 2001, apparent deterioration of the grout was observed. Furthermore, in late March 2002, it was found that as the azimuth wheels crossed over a joint gap, the wheels tilted first one direction, then the other. The tilting of

the wheels is a potentially serious effect, because the tilts place strain on the flex plates that attach the wheels to the structure above.

The wheel tilts were initially thought to be caused by the deteriorating grout, and a section of grout was replaced in early May as a test. Although the new grout had benefits in some respects, it did not reduce the wheel tilts. Given this result, it was quickly determined that the tilting problem was caused by a cavity that was being created on the interior surface between the wear plate and base plates near the joints. Apparently, this cavity is caused by fretting corrosion, a type of high stress wear. Cavities exist on each side of the joint and reduce the support the track provides to the wheel. Because the joint is a wedge-shaped, 45-degree miter, the wheel tilts one direction, then the other as it passes over the joint. The wear is getting worse with time, and wheel tilts are increasing in a corresponding way. We have twice reduced the maximum allowable wind speed for which we can observe to keep the loading on the flex plates within safe margins. Furthermore, in midsummer, it was discovered that fretting wear is occurring on the interior faces of the wear and base plates around the entire circumference of the track, i.e., not just at the joint areas.

The existing track, which was designed in the early days of the GBT project, is a scaled-up version of the design used on the JPL Deep Space Network 34 m antennas. Although the DSN antennas have experienced some similar problems to those of the GBT on a much smaller scale, no major rebuilds of the 34 m azimuth tracks have been required over their lifetime. The GBT has the largest loading per wheel of any structure in the world, to our knowledge. The next most heavily loaded structure (the retractable roof on Miller Park baseball stadium in Milwaukee) has about half the loading per wheel.

The GBT antenna engineering team has been working intensively on these problems and is studying several remedies. Both short-term and long-term modifications may be required. Experiments are presently underway with shimming and anti-fretting materials that can be used to fill the wear cavities, thereby reduce the wheel tilts, and slow the rate of further fretting wear, both near the joints and at mid–span. A method of strengthening the joint area by welding the base plates using a technique known as narrow-gap, electro-slag welding, is also under active investigation. A consulting contract has been let to pursue this further.

Because the wear is occurring around the entire circumference, it is likely that these approaches will provide only short-term relief. A longer term fix that eliminates the problem entirely will probably be required. This, most likely, will involve replacement of the steel portion of the track. Concepts for this are presently under study. A review panel has been assembled that consists of experts in steel structures, track systems, and antennas. This panel will meet on October 31 and November 1 in Green Bank. The panel will evaluate the present problems, and both the short-term and long-term remediation concepts.

GBT Operations and Maintenance

In the third quarter, GBT Operations supported observing, commissioning, and maintenance activities. The telescope ran many observing programs, while commissioning activities occupied much of the remaining time. Maintenance was performed four days per week. A new Chief Antenna Engineer and Head of Telescope Operations, Robert Anderson, joined the Observatory this quarter.

Operator Activities

The telescope operators continued to support 24-hour per day observing, commissioning, and maintenance activities. The operators assisted with feed changes, servo testing, and other activities, including developing documentation and operating procedures.

Maintenance

Construction continued on the shop and office (Cable Building) expansion for the telescope mechanics. The contractor is scheduled to complete this work by the end of October. This building expansion will allow the mechanics to work from a common area.

Inspections and scheduled maintenance were performed as usual, but much time and effort went into assisting the Antenna Engineering Group with investigations, repairs, and tests on the azimuth track. This work continues to occupy the maintenance staff. Many servo system issues are being addressed in a systematic manner in cooperation with the Electronics Division.

A temporary painting crew was hired as a test run of the yearly painting plan for the GBT. This multi-year plan will enable us to keep the GBT painted to prevent corrosion of the structure.

The contract to develop the structural inspection plan was let this quarter. The contractor delivered the first draft of the plan during the third quarter, and comments on the plan have been made. The final draft of the plan will be completed by the end of October, at which time the inspection work will be planned out and executed as prescribed by the plan.

Work continues on developing spare parts lists for all subsystems on the GBT, and procuring these parts.

GBT Electronics

GBT Spectrometer Hardware

Detailed testing, debugging, and repair of the spectrometer continues. To date, twenty 50 MHz, twenty-seven 12.5 MHz, one 200 MHz, and ten 800 MHz modes have passed engineering checkout.

Modifications to the 1600 MHz phase-locked loops in the high speed samplers were designed and tested more than a year ago. Designing a PC board and implementing these fixes remains as a task to be done. Final measurements and modifications to all High-Speed Samplers remain to be done. All the chip capacitors on the LTAs have been replaced. One Low Speed Sampler has been modified to improve bandpass flatness. The modified sampler has been tested in the system and met with Fisher's approval. Further, Fisher recommended that the other 35 low speed samplers should be modified as well. This will be started shortly.

The Spectrometer Pulsar Spigot card was tested this past quarter, and many of the Spigot card personalities verified. In order to use the spigot card, though, an extensive software development effort is required. This will require the support of electronics personnel to help sort out the requirements.

The Spectrometer system continues to be plagued by intermittent bad connections between a tin-plated pin and gold-plated connector. This galvanically incompatible pairing will be fixed by using tin-plated connectors along with the tin-plated pins. A solvent has been found and ordered to clean the oxide off the tin-plated pins before the installation of the new connectors. Numerous paddle board problems were repaired. Failures of a low speed sampler and long term accumulator have been repaired using spares. The

removed, failed components have yet to be repaired.

The source of 1000 lag pulses in some auto-correlation functions was traced to improper "ground bounce" compensation. This, in turn, was traced to a Long Term Accumulator (LTA) firmware problem which is now fixed, installed and tested on all LTAs.

Front-ends

No new front-ends were installed this past quarter. The Prime Focus, L-band, S-band, C-band, X-band, Ku-band, and K-band receivers all were used, and several problems with them were addressed. The C-band receiver has some instabilities that are being investigated. The K-band receiver was removed from the antenna to allow it to be reworked so that both beams in a pair switch at the same elevation on the sky when beam switching. It will be ready to be reinstalled at the end of October.

The Tipper was taken into the shop for repair of a 48-volt power supply and a motor controller. It was reinstalled outside and is collecting data again. Construction of the new PF2 receiver (920-1230 MHz) nears completion. It should be available for commissioning in the fourth quarter. The Q band receiver is still in storage, and will be installed on the telescope during the first quarter of 2003.

LO/IF Systems

Investigations into a 2.4 MHz ripple in the fiber optic system culminated in the finding that the ripple is an inherent "feature" of the modulators. The vendor is working on another version of the modulator that has this ripple much reduced. Evaluations continue. On several occasions this quarter, a channel of the fiber IF system failed. All of the failures were in supporting components rather than the fiber transmitter/receiver links themselves. Work continues on an MMIC amplifier to replace the unreliable, unobtainable, and expensive commercial units currently used.

Cryogenics

Several GBT receivers had refrigerators replaced, and were re-cooled. Cryogenic support for the CDL was also provided.

Active Surface

The surface was maintained through the summer to allow us to return to high frequency observing immediately in the fall when the weather is suitable. All our spare actuator motors have been used. We are taking motors from complete spare actuators and using them. To date, all the problems with the actuators have been motor, wiring, or electronics problems. A search for a reasonable source for spare motors and motor repairs continues.

Quadrant Detector

The Quadrant Detector and the laser were installed, debugged, and tested. The system is running and collecting data. Several enhancements to the electronics are planned over the next few months to increase the stability and accuracy of the device.

RFI Mitigation

A great deal of time (about five FTEs) was spent this quarter mitigating RFI. We have large projects underway to suppress RFI from the laser rangefinder systems, the GBT feedarm servo systems, and the Jansky Lab Addition shielded rooms.

The engineering package and one prototype of the Laser Rangefinder RFI mitigation project have been completed. Testing is underway, and should be finished this quarter. Work will begin on retrofitting the remaining 19 systems as technician time allows. The GBT feedarm servo RFI pre-work is nearly complete. A two-day telescope shutdown will be required late in October or early November to complete the project.

The shielded control rooms in the Jansky Lab addition were found to have deteriorated to the point where they provide negligible shielding. An investigation turned up severely corroded RFI windows and copper wallpaper corrosion. This was due to galvanic incompatibility between the zinc plated window frames and the copper wallpaper, and was aggravated by the use of an incompatible paste to glue the copper wallpaper to the walls by the original contractor. We repaired and retested four of the windows successfully, and a plan is in place to finish repairing the remainder of the room this winter. We have solved the galvanic incompatibility problems, and so the windows should be trouble-free in the future.

RFI mitigation engineering support to the tune of about 1/2 FTE is being supplied to the AEC construction project, due to a lack of shielding expertise on the part of the architect and the contractor.

NRQZ Management

We continued support of the NRQZ administration through application processing, site visits, and consulting with potential applicants.

GBT Mechanical Engineering Development

During the third quarter in the Mechanical Engineering Division the major portion of engineering and design effort went into azimuth track problems. Several viable alternatives have been generated and are being investigated. In addition the GBT structural inspection plan has been completed and is under review.

Green Bank Software Development and Computing

GBT Software Development

During the third quarter, the Software Development Division (SDD) focused on improving frequency switched observations through LO1 improvement efforts, improving Spectrometer software to aid the

Electronics division in testing and checkout, delivering a configuration tool to help astronomers and commissioners more easily configure the telescope for observations, and developing the infrastructure of the SDD to improve productivity and external communications.

The SDD began regular, monthly releases of its key product (M&C) on July 22, 2002 with the rollout of M&C v3.5. The second regular release was M&C v3.6 on August 28, followed by M&C v3.7 on September 25. A new version of the legacy Observer's Interface (GO) was deployed on September 27, integrating a new Configuration Tool, making configuration ability for the DCR and several modes of the Spectrometer available to users.

The first round of improvements to the LO1 were tested during early Q3 and released in the July and August deployments of M&C on schedule. These included: improved accuracy in Doppler frequency calculations, usability enhancements, synthesizer control optimizations, the addition of two new reference frames, and proper enabling/disabling of interrupts. Although originally scheduled for Q4 2002, the SDD ported the LO1 Counter to Linux ahead of schedule in order to reveal the clues that helped the team resolve the frequency switching issue. Post-release tests have confirmed that frequency switching is now more robust on the GBT; the inversion of peaks in frequency switched spectra has not been reported since the new software was made available, representing a major accomplishment.

Spectrometer improvements debuted in the August release of M&C, and were geared toward items that would help Electronics more effectively check out hardware modes. Improvements included: sampler assignment to more than one bank, enhanced message generation, identifying and constraining integration times to prevent software faults, easing on/off recovery, and improving balancing and initialization. Additional work will be required at the onset of Q4 to complete the improvements for balancing; these are scheduled for the October release of M&C.

Software for the new PF2 Receiver was designed and developed during Q3 2002, and released with M&C v3.7 in September. An MCB simulator was developed to aid in testing and will be integrated into the unit tests for the PF2, and perhaps other devices, during the upcoming quarter.

Through Q3 2002, the SDD completed a prototyping exercise for a telescope Configuration Tool, to serve as the foundation for a new Observer's Interface. This served as the continuation of efforts started in Q2, in which the primary focus was configuring the telescope in a simplified manner, to reduce the time it takes for pre-observation setup. SDD met its goal of unveiling a Configuration Tool at the end of Q3 2002, and chose to integrate this ability into GO for immediate use by observers and commissioners. Although the team's goal was to deliver three configuration scenarios (one for the DCR and two spectrometer modes), testing during the last week of the quarter indicated that one DCR scenario and 12 spectrometer modes for four receivers were already available using the new tool - a total of 52 combinations.

The team will use the Active Checkout process as a guide for which additional scenarios are to be supported in subsequent Configuration Tool releases. It is estimated that the new tool will save up to 45 minutes per observing session; metrics will be collected as observers and commissioners "test drive" the new tool during Q4 to refine this claim. As a result of the prototyping exercise, the SDD has established competencies in Java, XML, XML-RPC and SOAP, modern technologies that will help the group adapt its products to emerging industry standards.

However, much work is still required to yield a production quality Observer's Interface. The SDD acknowledges that a formal design exercise is now necessary and plans to devote a portion of Q4 2002 to this effort. By the end of 2002, the group intends to provide the following: a) use cases/scenario descriptions for key issues surrounding the Observer's Interface, b) class diagrams for existing components and components that will be adapted from other sources, c) screen shots for the top-level application plus observing,

configuring, status and monitor panels, and d) a roadmap that identifies goals for the delivery of functionality during 2003.

In addition to improved release management, the SDD also took steps to improving software quality and team effectiveness: software engineers initiated a process for developing and running unit tests, identified ways to track the results from code refactoring, and built a cross-compiler to reduce the amount of time required to build new software. The net result of these activities is a more productive staff that releases higher quality software; efforts will continue toward this end throughout 2003.

Additional progress was made in support of the Precision Telescope Control System, the Beam Forming Array, the Caltech Continuum Back-end, and the Pulsar Spigot Card. These efforts are detailed in the project-specific sections that follow.

Precision Telescope Control System. Contributions from the SDD were chiefly incremental development to support R&D for the PTCS architecture. Functionality delivered included: expanding the number of temperature probes available on the laser range finders, providing enhanced TCP data streams and data capture mechanisms, and expanding the pointing synchronization message to provide additional data. A key accomplishment was the delivery of additional parameters in the phase measurement system for the laser range finders to assess the quality of measurements from those devices.

Beam Forming Array. Under the direct supervision of Amy Shelton, summer student Michael Lacasse successfully completed Phase 0 of an upgrade to the Antenna Test Range, to enable testing of the Beam Forming Array and other upcoming GBT development projects. He successfully established a technical vision for the Antenna Test Range, and designed and developed software based on the Labview package to support monitor and control of a new lock-in amplifier and synthesizer, with some data visualization capabilities. With the helpful addition of user-facing as well as programmer-facing documentation, the SDD is now well positioned to complete Phase 1 of the Antenna Test Range project in the spring of 2003 for deployment by summer, when it is required by the receiver engineers.

Caltech Continuum Back-end. The SDD participated in the Preliminary Design Review for the Caltech Continuum Back-end during the first week of September. The groups were able to negotiate distinct boundaries for work packages, and determine a path for moving prototype software developed by Caltech into the production environment at Green Bank. Caltech will deliver device simulator software, interface code, and an interface specification document to the SDD at the Critical Design Review scheduled in December, after which the SDD can develop production quality software for commissioning of the device onto the GBT.

Pulsar Spigot Card. Caltech completed C code to enable testing of the Pulsar Spigot Card, and visited Green Bank at the end of the quarter for exercises. During this time, the SDD met with Caltech to discuss integrating the code into the production environment according to SDD development standards. Although this activity has not yet been scheduled, the SDD now has all of the information it needs to develop the production-quality software that will support this device.

Green Bank Computing

The main focus this quarter has been on expanding and reorganizing the way data are stored and backed up. A new 2 Terabyte RAID array has been purchased and after some initial problems, is in the process of being deployed. This will give us the extra storage required to move all users home directories to one machine, simplifying our backup strategy enormously.

A 20-slot LTO tape unit has also been brought into operation and is working well. With this unit we can

back up 3-4 Terabytes in one go. In normal operation we will be able to backup all necessary data on a daily basis. Using network backup software in conjunction with this tape library will shortly allow us to perform all routine backups with no daily operator intervention required.

The new web server at Green Bank was brought into active service on July 22, providing a much more reliable service. At the same time much of the web content was reorganized and old material cleaned out. An effort was made at the same time to remove world readable email addresses from the pages to help reduce the amount of spam email we receive. The new web server mirrors all the individual sites as well as the main NRAO web site, which boosts reliability as well as reducing network traffic.

During this quarter there have been several machines upgraded and in the process three more Solaris boxes have been retired. New hardware has been purchased for scanning mail and a separate Citrix server has also been bought. The mail scanner will be deployed shortly following a testing period at Charlottesville. The scanning software will detect and eliminate virtually every known virus arriving at or leaving the server, replacing any infected attachments with an explanatory message. Along with this valuable feature it is capable of tagging spam email allowing users to deal with it as they see fit.

The Citrix server will come into operation with the advent of the Windows 2000 domain. Preparations for this are continuing. Dynamic DNS was activated recently, with the activation of updated DHCP service to follow shortly. These two steps when completed will allow the domain controllers to be brought up.

Number crunching capacity has been greatly increased with the addition of two high-end dual processor machines. Both these machines have substantial local storage, which should help those running AIPS++.

The network bandwidth problems at Green Bank will soon be alleviated by the addition of another T1 line, doubling the available bandwidth. The possibility of integrating DSL, which is now available in Green Bank, into our network strategy is also being investigated.

During this quarter we have experienced a couple of hardware problems. The first was caused by a concatenation of failures and led to a server being unavailable for most of one day with some loss of productivity. The second was more serious and led to Green Bank losing network connectivity for a short while. By reconfiguring the remaining equipment and patching in some obsolete hardware Ed Childers saved the day and had most people on site reconnected before the replacement hardware arrived, which had been errantly delivered to Pittsburgh.

GBT Development Projects

Precision Telescope Control System (PTCS) - PTCS metrology systems have started to produce results relevant to high frequency operation of the GBT and GBT structural monitoring. Our objective for the winter observing season is to demonstrate the capability to correct GBT pointing to the arc second level, and possibly observe with a prototype implementation of a pointing correction subsystem. Experiments using half-power tracks of astronomical sources, quadrant detector signals, servo monitor data, and weather stations have demonstrated the following:

Structural vibration perturbations to pointing are mainly due to feed arm motions. These motions are measurable with the quadrant detector to accuracies as good as 50 microns and typically better than 200 microns. These deflection measurements correspond to angles on the sky of 0.15 to 0.60 arc seconds.

We have demonstrated the ability to predict short-term pointing changes due to servo disturbances and structural vibrations to about 0.4 arc seconds. The forward prediction interval is 0.1 second, more than adequate to generate error signals for subreflector or azimuth and elevation servo control loops.

Wind induced structural vibrations of the feed arm are much smaller than the longer-term (60-90 second)

sway of the feed arm due to stagnation pressure forces on the structure. The ratio of vibration to sway is approximately 0.1 to 0.2. An experiment demonstrated approximately 6 millimeter feed arm motions in a 10 to 20 mile-per-hour gusty wind that was accompanied by approximately 500-micron amplitude vibrations of the feed arm. Hence, there is good reason to believe that the vibratory component of wind perturbations may not need to be compensated for when winds are less than 10 mile per hour, even up to 115 GHz operation. Note that pointing contributions due to stagnation head or lift of the primary are a separate issue, and cannot be predicted by the quadrant detector signals.

A series of ongoing experiments is measuring structural resonances and feed arm deflections in order to develop semi-automated structural health monitoring. Baseline structural performance is being measured for later comparisons and trend discovery. These experiments are also developing feed arm flexure models that will be used to assess our ability to correct pointing for temperature and wind sway. One experiment has shown that we can repeatedly measure feed arm position over time scales of 35 minutes and accuracies better than 250 microns. This result strongly suggests that metrology correction for feed arm flexures is possible over time scales 35 minutes with accuracies equivalent to better than one arcsecond—which is our ultimate pointing stability goal.

Work continues on the development of the Engineering Measurement System which utilizes laser rangefinders and a real-time data processing and analysis system to survey the GBT structure to higher accuracies than can be had using conventional instruments. This will also be the algorithm prototyping environment for the follow-on Precision Measurement System that provides real-time laser metrology data for corrections to GBT pointing and primary figure. The current status is that an architecture has been designed and interfaces to existing laser rangefinder and M&C system data streams are being implemented.

At the same time, work continues on investigating differential laser measurements between ZY102 and ZY103. Discrepancies between the differential distance and the distances between ZY103 and a hollow retro reflector on ZY102, and ZY103->ZY102 were detected. A careful repeat of the experiment revealed a subtle, but critical, software error on ZY-to-ZY measurements only, which has now been fixed.

After further review of the ZY102->ZY103 data some additional errors were found and corrected. The differential, and ZY103-> hollow retro reflector data now agree to 0.017 mm, but there are problems of <0.5 mm between the differential and ZY-to-ZY results. The problems are probably due to calibration errors. A field calibration procedure will be devised to check the calibrations. Don Wells' software was independently checked, as far as the phase-to-distance calculation, by a Mathematica program with 100% agreement.

In August the first all night rangefinder runs, of all 12 ground instruments, were conducted with very good results. The two nights' data is archived and awaits processing.

Work has commenced on the procurement of rangefinder shelters. Conceptual designs have been prepared, and a contract placed with a commercial vendor to perform the detailed design, deliver a prototype and, assuming successful acceptance, perform the production run of 20 covers.

1 cm and 3 mm Receivers - Design and construction of the 1 cm (26-40 GHz) and 3 mm (68-92 GHz) psuedo-correlation front-ends continued. Most of the major components have been ordered (and many received), or are being designed and fabricated in-house. These include the feedhorns, OMTs, Magic-Tees, 180 degree phase switches, and down-converters. Progress has been made on the dewar layouts. A frequency converter which will convert the receiver IFs to the 4-8 GHz range for transmission on the GBT fiber IF system was also designed, and major components ordered. Current plans estimate the 1 cm front-end will be completed in the second quarter of 2003, and the 3 mm receiver in the fourth quarter of 2003.

Mechanical Engineering and the NRAO Central Instrument Shop

In August, the Central Instrument Shop successfully completed the fabrication of the cryostat for the Penn Array and delivered it to UPenn. The shop also fabricated mandrels for an electroformed S-band OMT and then completed the external machining on the electroformed part. In support of the ongoing RFI mitigation projects the shop has fabricated various special purpose RFI boxes and feed-throughs. Also completed this quarter was a prototype K band feed for the EVLA which improved the tuning performance. The shop also continues work on Green Bank W (3 mm) and Ka (1 cm) receivers and OMT's as well as parts for the GBT PF2.

Next quarter, work will continue on the K and L band OMT's and receivers for the VLA.

Management and Scientific Services

Milestones	Original Date	Revised Date	Date Completed
VLBA Calibration Pipeline Released Publicly	8/30/02	10/1/02	10/1/02
VLA/VLBA Proposal Deadline	10/1/02		10/1/02
VLA Public Tour	10/6/02		
Debut New VLA Visitor Center Film	10/31/02	10/6/02	
Automated Monitoring of AIPS Software Downloads	6/30/02	10/15/02	
Update Astronomer Information on Web	9/30/02	10/30/02	
EVLA Completion Plan Science Case-Version 1	10/31/02		
18th Annual New Mexico Symposium	11/1/02		
Jobserve Cookbook Revision	11/23/02		
First Fringes on Mark 5 Recorder Prototypes	11/30/02		
43 GHz JVAS Survey Complete	12/1/02		
VLBA Large Proposal Review Complete	12/20/02		
AIPS++ VLA Data Reduction Cookbook-Version 2	12/20/02		
Release frozen 31DEC02 AIPS version; begin 31DEC03	1/2/03		
VLA Public Tour	2/1/03		
VLA/VLBA Proposal Deadline	2/3/03		
EVLA Completion Plan Finished	2/28/03		
VLA Visitor Center Gift Shop Opening	2/28/03		
VLBA 10th Anniversary Symposium	6/30/03	6/12/03	
Synthesis Imaging Summer School	6/30/04		

Electronics

Milestones	Original Deadline	Revised Deadline	Date Completed
VLA/VLBA Pie Town Link (LO/IF)			
Complete construction & checkout of spares	1/31/01	5/30/03	
Receivers (FE)			
Identify and correct moisture buildup problem in new VLA 22 GHz feeds	12/31/01	9/30/02	8/2/02
Build and install three more 86 GHz receivers	10/31/01	11/15/02	
Build and install one more 86 GHz receiver for a total of nine	12/30/02	11/15/02	
Extend bandwidth of two 86 GHz receivers	Pending funding		
Build 10th 86 GHz receiver for spare	Pending funding		
Install new 1.4 GHz receiver windows as the old ones fail	Open ended		
VLBA Improvements			
Head pre-amp boards	As needed		
LPS Improvements	5/30/03		
Develop recontouring capability for head stacks	7/19/02		7/19/02
VLA Improvements			
Install Iridium Filters at 1.6 GHz	12/31/01	11/30/02	

86 GHz receivers

Construction of nine receivers is essentially complete and seven receivers are currently installed on the VLBA. Final checkout and installation of the eighth and ninth receivers have been slowed by a gold-plating problem with the Y-coupler. Recent tests show that the gold-plating is not necessary so that the eighth receiver will be released for installation early in the next quarter and the 9th receiver will be kept as a spare until the subreflector surface at VLBA Brewster is corrected.

Two new 86 GHz receiver goals are added (both of which depend on funding):

1) extend the bandwidth of all nine available receivers to 96 GHz from 90 GHz; currently only seven receivers are "wideband";
2) Construct a 10th receiver as a spare or for testing on the EVLA.

1.4 GHz Receiver Windows

We have not yet identified a satisfactory window material.

Head Pre amp Boards

No drives in use have been modified. Funding originally intended for this project was used to rebuild capstan motors.

LPS (Lightning Protection System)

Recurrence of lightning damage at VLBA Pie Town this summer led to a plan to improve the LPS at all susceptible VLBA sites.

Head Stacks

Surplus equipment obtained from Spin Physics has been used successfully to perform contour recovery of 10 failed head stacks. Before, recovery required tape shuttling for weeks; the new procedure takes less than one hour. As well, the new procedure has a higher success rate.

Iridium Filters

Though only five filters remain to be installed, the deadline is extended to allow time for observational testing. Use of the filters for observing is not expected until "A" configuration starting May '03.

Engineering Services

Milestones	Original Date	Revised Date	Date Completed
Complete CnB reconfiguration	9/13/02		9/13/02
Complete C array reconfiguration	10/11/02		
Mechanical Group			
Paint Kitt Peak VLBA	7/22/02		6/10/02
Paint Antenna #24	7/15/02		6/14/02
Fabricated EVLA cable wrap simulator	7/10/02		7/10/02
Overhaul Antenna #27	7/18/02		7/18/02
Paint Antenna #21	6/15/02	7/15/02	7/23/02
Concrete poured in VLBA Shop	8/9/02		8/9/02
Paint Antenna #27	8/26/02		8/26/02

Milestones	Original Date	Revised Date	Date Completed
Complete installation of Apex hand rails on VLBA Antennas	8/26/02		8/26/02
Maintenance visit to Mauna Kea VLBA	8/26/02		8/26/02
Team to Los Alamos VLBA to repair grout	8/26/02		8/26/02
Fabricated fiber optic cable reel mounts	9/1/02		9/1/02
Overhaul Antenna #28	9/3/02		9/3/02
Antenna #7 Azimuth Bearing change	7/15/02	9/15/02	9/17/02
Repaired press brake	9/18/02		9/18/02
Paint Antenna #26	10/8/02		
Install Hasps in all antennas Az & EL cabinets	12/31/02		
Electrical Group			
Radio upgrade	12/28/01	6/30/02	7/3/02
HURCO Milling Machine installation	7/10/02		7/10/02
Prototype VLBA ACU Power Supply	8/25/02		8/25/02
Prototype VLBA Tachometer	12/31/02		
Site & Wye Group			
Complete Track repairs between BN6-AN5	12/31/02		
ES Engineering Group			
Feed cone prototype complete	6/30/02		9/25/02
VLBA Subreflector re-work	12/31/02		

Computing Division

Milestones	Original Date	Revised Date	Date Completed
NRAO DNS/DDNS implementation	5/30/02	7/15/02	7/20/02
Establish NRAO-NM laptop policy	2/28/02	7/31/02	Deferred*
True replacement boards Modcomps	9/2/02		7/30/02
Convert Mainsaver to Oracle	8/13/02		8/13/02
Finalize AOC rewire proposal	8/15/02		8/15/02
Correlator Controller in Continuum	5/1/01	8/31/02	8/31/02
Upgrade Web/ftp servers	8/31/01	9/1/02	9/1/02
Foreign Monitor Data Loading	9/30/02	On Hold**	
Migrate Solaris Servers to Linux	10/31/02		
Install Sophos Antivirus Gateway	10/31/02		
VLBA Recorder Test Software	1/31/02	11/1/02	
Upgrade Ftp Server	8/31/02	11/1/02	
Radio Telescope at Visitors Center	11/1/02		
Transcribe VLA Observe/System Files	11/30/02		
Configure/Build Filehost Replacement	11/30/02		
Ingres Conversion to Oracle	8/13/02	12/1/02	
Correlator Controller Support Line Mode	12/31/02		
Streamline VLA observe file submission	12/31/01	On Hold**	
Alternative to 9 track tape at VLA Site	3/31/02	12/31/02	
Master Address Database	2/15/03		
Correlator Controller Bug Fixes	3/31/03		
Phase 1 AOC Rewire	3/31/03		
Correlator Controller Integrate line/continuum	6/30/03		

* We have decided to defer the establishment of an NRAO-NM laptop policy until hardware and software developments have stabilized further. This is an area in which changes are frequent and we feel that a stringent policy is premature at this time.

** On hold pending completion of the conversion of Ingres based database applications to Oracle.

AIPS

Distribution and Versions

The 31DEC02 version of AIPS now has been in routine operation for nine months, under the new CVS configuration for the midnight jobs. Counts of midnight-job fetches were resurrected in the third quarter, and show approximately 50 sites running the new midnight job. This is considerably more sites than were active under the old "secure-shell" midnight job, indicating that the CVS configuration has made life easier for the remote users. Monitoring of remote downloads of the frozen 31DEC01 version, by ftp, is expected to be completed in the fourth quarter of 2002.

Key Developments

1. A new task, WIPER, was added to provide interactive editing of data using a plot of the (u,v) data on a TV screen. Various options, for flagging data or for removing flags for data previously flagged with WIPER, are available.
2. The VLA data-filling task, FILLM, has been changed to allow the reading of disk files. This will be important for use with the upcoming on-line VLA data archive. Minor bugs in file counts and the handling of channel 0 data also were fixed in FILLM.
3. The UVCON task that is used to simulate (u,v) data, particularly for configuration studies for ALMA, SKA, and EVLA, has been modified to improve its mosaicing capabilities. The various mosaicing imaging tasks (e.g., VTESS) and AIPS "include" files have been changed to permit up to 4096 fields (pointings) to be imaged.
4. QUACK was given an option ("TAIL") to flag all sources for a user-specified time after the end of a scan. This deals with a minor VLBA feature in which a few antennas are not recorded as being off-source until a second or two after a scan actually ends.
5. The task FRPLT, which plots fringe-rate spectra, has been rewritten completely to expand the plot options.
6. The multi-source fitting task, SAD, was fixed to correct mistakes in the reports of errors of source sizes in major and minor axes.
7. FITLD had an error in computing the apparent positions of sources, because general relativistic corrections had not been included. This has been fixed.
8. IMAGR has been modified so that it will avoid remaking all images in the middle of cleaning the images, if at all possible.
9. More friendly/flexible naming of output text files has been made available within AIPS.
10. The AIPS Cookbook was modified to include all the above changes, and more.
11. The guide to low-frequency imaging is dependent on observers who are postdoctoral fellows, and has been delayed by their other activities.

Goals for Fourth Quarter 2002

1. Continue user support and bug fixes, as the major portion of AIPS effort.
2. Freeze 31DEC02 version of AIPS, and begin new daily-updated 31DEC03 version.
3. Add monitoring of ftp downloads of frozen AIPS version.
4. Add new task for fitting antenna positions, needed by the data analysts after VLA reconfigurations.
5. Add low-frequency/wide-field imaging appendix to AIPS Cookbook.
6. Incorporate VLBA calibration pipeline into AIPS midnight job release.

Major Developments

Milestone	Original Date	Revised Date	Date Completed
Study use of overmoded w/g in LO transmission	03-16-01	02-28-03	
Demonstrate 211-275 GHz balanced sideband-separating SIS mixer with integrated 4-12 GHz IF preamps.	07-31-01	09-30-02	09-30-02
Construct second test receiver	12-31-01	09-30-02	09-30-02
G/T optimization of feed taper at 10 GHz	03-31-02	09-30-02	09-30-02
G/T optimization of feed taper at 30 GHz	03-31-02	01-31-03	
Feed pointing optimization of the VLA antenna	06-30-02	03-31-03	
Testing of EVLA L-band and C-band prototype feeds	03-31-03		
Testing of GBT Ka-band and W-band feeds	03-31-03		
ALMA Correlator:			
1) Start and complete PCB layout of station interface board.	09-30-02		08-15-02
2) Start and complete PCB layout of correlator interface board.	09-30-02	10-31-02	
3) Develop FPGA designs for and test interface boards.	09-30-02	12-01-02	
4) Start PCB layout of station motherboard.	09-30-02		09-15-02
5) Order parts for 2-antenna prototype correlator.	09-30-02		09-15-02
6) Assemble station and correlator bins in prototype correlator rack.	09-30-02		09-06-02
7) Start design of rack plenum.	09-30-02		09-15-02
8) Complete design of quadrant control card.	09-30-02	12-01-02	
9) Start PCB layout of quadrant control card.	09-30-02	12-01-02	
10) Start minor layout changes for all 2-antenna prototype correlator PCB cards.	09-30-02	11-01-02	
1) Start testing of prototype interface cards.	12-31-02		
2) Complete design and start PCB layout of the quadrant control card.	12–01-02		
3) Start PCB layout of the front panel data port logic card.	12-31-02		
4) Complete design and start PCB layout of the correlator motherboard.	12-31-02		
5) Complete all mechanical design of the 2-antenna prototype correlator.	12-31-02		
6) Complete GBT spigot card project.	12-31-02		
7) Complete VLBA data recoding project.	12-31-02		
Initial test of prototype ALMA correlator.	12-21-02		
Cold multiplier performance vertified	12-16-02		

Amplifier Design and Development

Development work within the amplifier group has included: design, packaging, and testing of commercial "flat pack" hybrid couplers for use in balanced amplifier designs, design of single-stage test amplifiers for evaluation of Cryo-3 devices and packaging of MMIC devices for high power LO use by ALMA. Work continued with substitution of Cryo-3 devices into existing designs to investigate upgrade opportunities and to help prioritize design efforts as the Cryo-3 devices become routinely available.

Amplifier Production

Production of standard LNA designs during the third quarter included three K-band, three Ka-band, and four W-band units for a total of 10 completions. A large build (33 pieces) of the similar 3-18/8-18 GHz LNAs was begun, with completions due in the third quarter of 2002 and first quarter of 2003. Production of standard amplifiers has been at about 40% of capacity as the amplifier group has directed much of its time to development activities.

Other Projects

The amplifier group supports the plating lab which has been running at near capacity during the quarter. The electroform tank has been in continuous operation, with production meeting scheduled demands for VLA/VLBA production, various GBT projects, and waveguide components for various development activities. Gold-plating of amplifier bodies, waveguide components, and test fixtures for development work has been meeting both scheduled and unplanned demands.

The amplifier group continues to support the miscellaneous maintenance needs of the CDL. Recent activities have included several technician days in the installation of the industrial air compressor for the machine shop, restoration of surplus test equipment, ongoing support of computer instrumentation, and production of bias cards/cables for the LNAs.

Superconducting (SIS) Millimeter-Wave Mixer Development

ALMA SIS Mixer Development

Band 3 (84-116 GHz) SIS mixer: Last year we completed the design of a tunerless DSB SIS mixer for Band 3 capable of operation with a 4-12 GHz IF. Recently, funding for wafer fabrication at UVA was provided by the Herzberg Institute as part of the Canadian contribution to ALMA. As reported last quarter, two mixers were successfully tested at the CDL and sent to HIA. This quarter, we continued testing mixers with different on-chip tuning from the same wafer. One had performance not as good as the two previously tested, but is still within the ALMA specifications. The next has been assembled and will be tested shortly. These tests should provide useful information on the mixer design parameters needed in finalizing the ALMA production wafer design.

Band 6 (211-275 GHz) Building Block SIS Mixer: A new single-ended mixer chip has been designed with several improvements: (i) The RF tuning and matching circuits have been re-optimized for the correct dielectric constant of the thin film SiO_x dielectric. In the original design, this was taken as 5.7, the usual value

for bulk SiO. Measurements of mixers from many wafers produced convincing evidence that the dielectric constant was considerably lower, and a capacitance test circuit gave a value of 4.2. When the thickness of the dielectric layer was reduced to correct (partially) for this, the RF characteristics confirmed the lower value. (ii) The new mixer chips have a shorter RF choke circuit. This will improve operation with the wideband 4-12 GHz IF, and the shorter chip size results in more mixers per wafer. (iii) The new mixer is optimized for the actual ALMA frequency band, which had not been decided at the time of the earlier design. The new design will be compatible with the new sputtered SiO_x process being developed at UVA which has been shown to have a much lower density of pinhole defects (allowing short-circuits between layers) than the older SiO_2 process. Masks have been designed and fabricated, and the first wafer is being processed at UVA. A single-ended mixer test block for evaluating the new design is being fabricated in the CDL shop.

Band-6 (211-275 GHz) Single-Ended Sideband-Separating SIS mixer: This two-chip unbalanced sideband-separating design, integrated with a pair of 4-12 GHz IF preamps, is expected to be the final pre-prototype for Band 6. The mixer design is of the split-block type, using the waveguide quadrature hybrid described in ALMA Memo 343 and other waveguide elements described in ALMA Memo 381. The integral LO coupler (required in unbalanced mixers) is described in ALMA Memo 432. If this design is successful, it will remain only to make mechanical changes and reduce the outer dimensions to allow a pair of mixer-preamps to mate with the OMT and feed horn in the limited space of the ALMA cartridge.

Non-ALMA SIS Mixer Development

800-880 GHz Distributed SIS Mixer: EM simulations were performed for Edward Tong (CfA) on the tuning circuit of an 800-880 GHz distributed SIS mixer. Sonnet *em* was used to simulate the superconducting Nb circuit close to the gap frequency. It was found that the coplanar inductor-loaded microstrip transformer does not provide optimum coupling between the waveguide probe and the distributed SIS junction and is the main cause of the poor performance of the CfA mixer. This work is reported in [1]. A new design is being developed.

ALMA 4-12 GHz IF Preamplifier Development

4-12 GHz Preamp Development

A general shift has occurred in focus from preamp development to production. We are refining the mechanical design so it can be integrated into the cartridge and be produced in (relatively) large quantities. Mini-Systems, Inc. claims to be able to put the DC components of the mixer bias-T network onto a single chip. LHe dip tests will have to be done to determine how much the resistance of the TaN resistors used in the network change when cooled to 4.2 K.

Collaboration with SRON

4-12 GHz Isolator Evaluation: SRON still has not received the second 4-12 GHz Pamtech isolator. To date, Pamtech has been unable to deliver a second broadband cryogenic isolator.

Band 9 SIS Mixer-IF Integration: It appears that the high parasitic reactance associated with the RF choke circuit in the Band 9 SIS mixer are causing a resonance within the IF band. IF simulations of the mixer/amplifier interface have been performed at the CDL, and Andrey Baryshev is confident he will be able to redesign the choke structure to alleviate the problem.

Band 9 SIS Mixer-IF Mechanical Interface: We have also been working with SRON on the mechanical interface between the mixer block and NRAO IF preamp.

ALMA Band-6 Cartridge Development

Once again this quarter, much time was spent on budget revisions and de-scoping. New cost estimates were generated for the Band 6 mixer and cartridge construction, initially assuming six prototype cartridges would be required, and later eight.

Work continued on magnetic circuit design for the SIS mixers in an effort to reduce hysteresis and heating in the leads to the superconducting coils. Test samples of several magnetic alloys have been sent out for annealing (in a hydrogen atmosphere), which is expected to reduce the hysteresis considerably in some of the materials.

After we determined that the official ALMA cartridge optics design had inappropriate edge taper at the subreflector, a new optics design was received from IRAM. The new design is being analyzed at Cambridge using a physical optics program — to date a single frequency point at the band center has been analyzed and the edge taper there appears to be as intended.

Because the ALMA receiver dewar allows very limited cooling capacity per cartridge on the 20 K and 4 K stages, it is difficult to design LO transmission circuits with sufficient thermal resistance between stages even if stainless steel waveguides are used. Waveguides sufficiently long to provide acceptably low thermal loading have too much attenuation (whether or not internally plated with gold or copper). A gapped waveguide thermal isolator has been designed for Band 6 in an attempt to overcome this problem. Measurements on WR-10 scale models indicate it is free of resonances across the waveguide band and tolerant of moderate misalignment between waveguides. This will be reported in a memo when the work is complete.

Automatic SIS Mixer Testing

The database schema to support both mixer and cartridge measurement data has been designed during the quarter, and a memo is in preparation to document the design.

Mixer Saturation Measurements: Mixer saturation could be a major source of ALMA calibration error, especially if a room-temperature load is used in the calibration procedure. Measurements are being made to confirm the mixer saturation predictions given in ALMA Memo 401. A weak CW signal is injected into the receiver input while the receiver is alternately switched between hot and cold loads. IF power measurements accurate to a few tenths of a percent are required. The automated LO and a phase-locked Gunn oscillator are used as the stable LO and source, and we are at present trying to eliminate a noise problem at the 0.5% level.

Publications & Memos this Quarter

[1] H. Mazzawa, C.-Y. E. Tong, T. Noguchi, T, Matsunaga, R. Blundell, and S.-K. Pan, "An Nb-based waveguide SIS distributed mixer employing coplanar inductor loaded microstrip transformer for the 800 GHz frequency band," *Proc. of the 2002 Applied Superconductivity Conference*, Houston, Texas, August 4-9, 2002.

[2] A. R. Kerr and N. Horner, "A Split-Block Waveguide Directional Coupler," ALMA Memo 432, 26 August 2002.

Electromagnetic Support

EVLA

An analysis of Gain/System temperature (G/T_{sys}) as a function of the feed taper at the edge of the subreflector at 10 GHz was started this quarter. This analysis is critical to the design of the 8-12 GHz and 12-18 GHz feed horns.

A detailed design of the L-band feed (1 to 2 GHz) was completed. Drafting of mechanical drawings is in progress.

Two K-band feeds with redesigned ring-loaded corrugation sections were measured. The return loss was better than -23 dB in the 18 to 26.5 GHz range. This mechanical redesign does not require any type of adjustment and will be adopted for all the EVLA feeds where ring-loaded corrugations are used.

A number of K-band phase shifters were measured this quarter and found to have good performance.

Spectrometers/Correlators

ALMA Correlator

During the last quarter, several logic card and motherboard designs were completed. Prototype cards for the station interface design were received. The correlator interface card design and PCB layout were completed and are awaiting final layout review before being sent out for prototype build. The station motherboard design was completed, and an initial PCB layout fully routed.

Design changes were made to most of the logic cards for the correlator in anticipation of having cards built for the two-antenna prototype system. Cards that required very minor changes include the filter card, the station card, both power supply cards, the correlator card, and the correlator mezzanine card. More substantial design changes were made to the LTA. All of these cards are awaiting PCB layout modification and card manufacturing for the prototype system.

Parts were ordered for the prototype correlator during September.

The prototype correlator card was sent out for installation of the remaining 62 ALMA1 chips. This fully populated card was successfully tested and subsequently used for software and FPGA firmware testing.

Software support was added in the LTA C167 processor to provide a set of comprehensive tests for the fully populated card. While refining these tests, subtle sources of errors were detected in the fast dump (1 msec) mode and in the 125 MHz clock distribution. These errors were easily eliminated with changes in FPGA personalities and a resistor value change.

Prototype correlator bin hardware was assembled in the two-antenna rack, and mechanical design of air plenum was started.

Design of the quadrant control card continued and is about 80% completed.

Preliminary ICDs were written for both the correlator-to-backend interface and the correlator-to-ALMA site interface.

Two substantial problems were encountered during the quarter. First, some of the custom ALMA1 correlator chips that passed factory test failed our lab tests. These chips were sent back for additional manufacturer testing and re-tested good there. The problem at present seems to be inadequate test vectors for the chips, but more study is needed.

A second problem was the inability to reset the system Infineon microprocessors reliably. This problem seems to have been fixed with the addition of active state control of the microprocessor's data bus during

hardware reset. More work must be done to insure that this fix is completely acceptable.

Other Projects

More testing was done on the GBT pulsar spigot card, and mode firmware was written and tested.

The printed circuit board for the project to stream VLBA recorder data onto a RAID disk was assembled and testing begun.

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 designs for the multipliers and mixers that make up the warm multiplier assemblies are finished and have been sent to the foundry (United Monolithic Semiconductor). The MMIC power amplfiier designs will be completed this month. The YIG-tuned oscillators for the pre-prototype LOs have arrived. These LOs should still be delivered by the end of the year. A preliminary set of specifications and interfaces for the ALMA first LO has been drafted and distributed for comment.

Amplitude noise measurements of a Band 6 pre-prototype LO were performed. Measurements from 220-270 GHz LO frequency show the excess sideband noise introduced by the LO to be within ALMA specification. More measurements will be done to investigate how much power leveling is required and the effect of this leveling on the LO amplitude noise and phase stability. Results are published in ALMA Memo #436.

Sideband noise measurements of the hybrid photonic LO approach were made at the NAOJ in Mitaka, Japan. This approach uses the output of the photomixer to drive the W-band power amplifier and cold multipliers, eliminating the YIG-tuned oscillators and active multiplier chain. Preliminary measurements at 500 GHz were encouraging, but equipment problems prevented a full set of measurements. Regardless, a thorough comparison of the LO approach is recommended, using measurements with ALMA-type mixers and multipliers.

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 being developed.

80/240 GHz Frequency Tripler: The modified 80/240 GHz frequency tripler was assembled and tested during this quarter. Figures 1 and 2 show the details of the mounting block and the frequency tripler

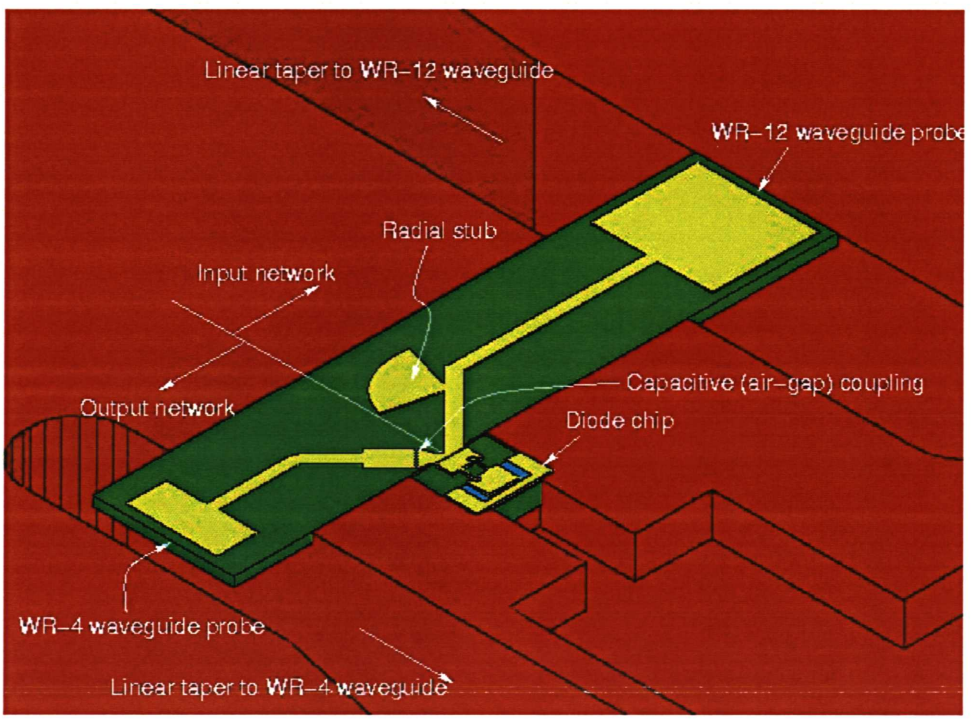

Figure 1

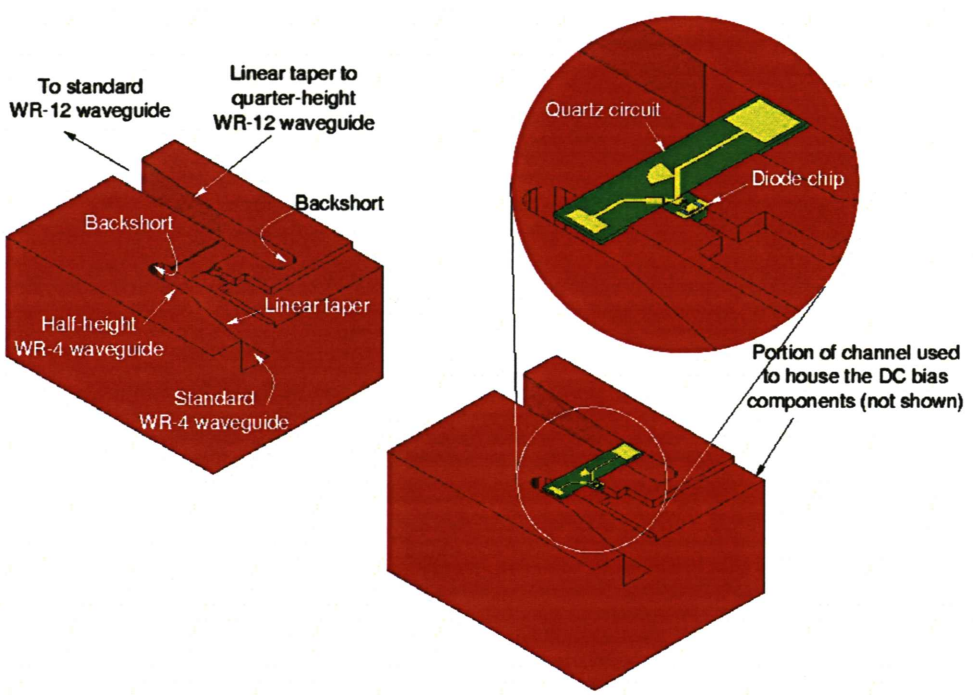

Figure 2

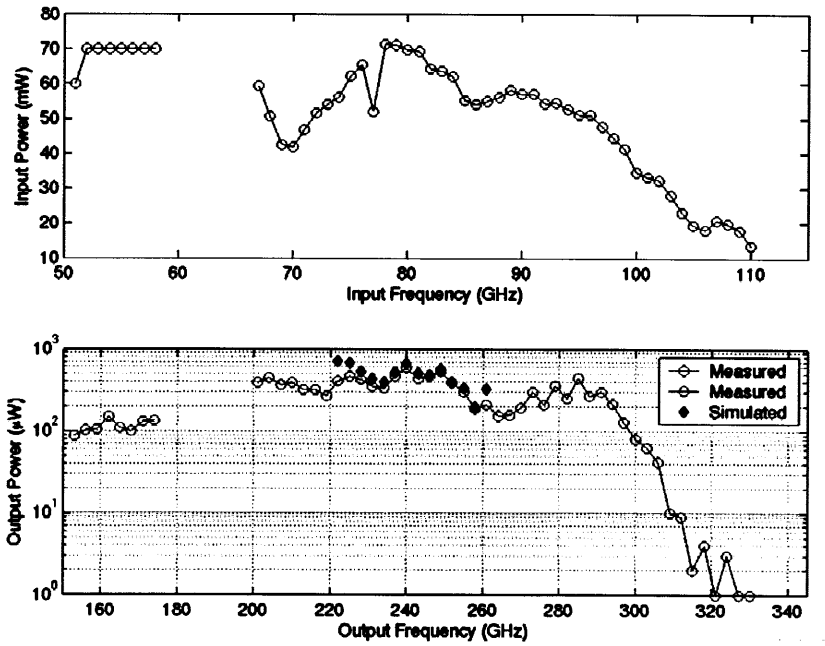

Figure 3

circuitry. The DC bias bypass capacitors exhibited a low reverse breakdown voltage of around 6-8 V, rendering the optimal operation of the frequency tripler in varactor mode impossible. For the purpose of this evaluation, the frequency tripler was modified by shorting out the bias bypass capacitor to the ground pad using silver epoxy. This allowed for the operation of the frequency tripler with the offending circuit element bypassed and under the conditions of zero applied DC bias voltage on the Schottky diodes. To allow for a comparison between the measured and theoretical performance under these conditions, swept harmonic balance simulations were performed (with the DC bias voltage set to zero) in MDS to estimate the predicted output power of the frequency tripler. Calculated output power levels obtained as a result of these simulations are shown plotted along with the measured data in Figure 3 above.

Notwithstanding the inability to measure its optimum varactor-mode performance, the good agreement between the measured and theoretical performance of the 80/240 GHz frequency tripler under zero applied DC bias validates the use of GaAs-membrane-on-quartz substrates for the design of monolithic frequency multipliers.

Virginia Diodes, Inc. Frequency Multiplier Evaluation: Currently, preparations are under way to evaluate the operation and reliability of frequency multipliers obtained from Virginia Diodes, Inc. A test setup is being readied to evaluate both room temperature and cryogenic (77 K) performance of these frequency multipliers. In the next quarter, the Band-6 varistor tripler will be evaluated, followed by the Band-7 tripler and the Band-9 quintupler when they are delivered.

JPL/University of Michigan Collaboration: The corrected wafer for fabricating the test diode arrays for the 110/220 GHz doubler has been received by Michigan, and trial fabrication runs are currently under way. Wafer thinning techniques to thin down GaAs wafers to 2 mils have been demonstrated, and the possibility of designing an integrated frequency multiplier for fabrication at the University of Michigan is being investigated.

Beam-Forming Array

The purpose of this long-term project is to develop a 21-cm imaging spectrometer for the Green Bank Telescope (GBT) within a period of five years. The physical size of conventional 21-cm feeds on the GBT makes it impossible to support a system with more than three beams if they are formed in the traditional manner. A beam-forming array is the most natural, efficient, and logical way to gain the advantage and would represent a major breakthrough in technology applicable to all radio telescopes.

Progress has been slowed this quarter as a result of project personnel attending to high priority GBT commissioning activities. These activities have created significant scheduling uncertainties within the beam-forming array project, thus making it nearly impossible to follow a predetermined timetable. It was agreed that during the GBT commissioning period, the project schedule would be abandoned and that the currently available project team would focus their efforts on achieving a number of specific goals which are very well-defined even in the absence of the overall system design. These comprise:

1. A very low-noise array element.
2. The antenna range upgrade for array measurements (required for other projects in addition to the array).
3. A fast, clean, low-distortion A/D module.
4. FPGA digital bandpass filter module.
   (Items 3 and 4 can be immediately applied to the RFI research effort.)
5. Antenna optics calculations to determine the array size and signal processing requirements.

Work continues with the low-noise element design. A second type of antenna, the crossed sleeve dipole, is being considered for use in the array since its feed impedance is a close match to that required by the low-noise amplifiers. Various vacuum sealing techniques have been investigated, and a suitable configuration involving the use of a polyurethane foam plug is currently being characterized.

Progress was made on the antenna test range project. A turret, obtained from surplus, was found to exceed specifications and will be used to replace the older unit. Slip rings, an absolute optical encoder, and a stepping motor for the turret were specified and ordered. The stepping motor has been installed. Two synthesizers were evaluated and it was determined that the units had large phase drifts when externally phase-locked, so the units were returned to the manufacturer for repair and calibration. One unit has been returned and appears to be locking externally with no appreciable drift. Work has begun on the RF switching manifold.

Under the direct supervision of the Green Bank Software Development Division (SDD), an REU student successfully completed Phase 0 of an upgrade to the antenna test range to enable testing of the beam-forming array and other upcoming GBT development projects. A technical vision for the new antenna test range was established, and the student designed and developed software based on the Labview package to support monitor and control of a new lock-in amplifier and synthesizer with some data visualization capabilities. With the helpful addition of user-facing as well as programmer-facing documentation, the SDD is now well positioned to complete Phase 1 of the antenna test range project in the spring of 2003 for deployment by summer, when it is required by the receiver engineers.

e2e Project

Milestone	Original Deadline	Revised Deadline	Date Completed
Internal tests of VLA interim archive	1/15/02	11/1/02	
External tests of VLA interim archive	3/15/02	1/1/03	
Announce VLA interim archive server	6/1/02	3/1/03	
Purchase GBT archive hardware	9/15/01	12/1/02	
Initial EVLA scientific requirements	11/1/02		
Initial tests of proposal toolkit	12/1/02		
Deploy GBT server	1/15/03		
End of second development cycle	4/15/03		
e2e Advisory Group meeting	5/15/03		

The second development cycle of the e2e (End-to-End) project started on 15 August 2002. The main goal of this development cycle is to ensure that by the end we have designs and/or prototypes for all deliverables to a level of detail sufficient to allow definition of project scope and schedule. Thus we are devoting two cycles of our spiral model to design and development. This amounts to about 15% of our total project effort. This fraction is generally believed to strike a suitable balance between D&D costs and low-term risk.

The EVLA Data Processing PDR was held in July 2002. The main result was a call from the reviewers for the EVLA Project to develop detailed scientific requirements similar to those developed by the ALMA Science Software Requirements group. This is now proceeding and will produce a draft report by early November. This report will be used during the costing process at the end of the second development cycle.

The details of our work in the second cycle follow:

- We continue to load the VLA tape archive to our server. We purchased an additional 4TB of disk storage for the server. This should enable us to hold all the existing VLA archive on disk. Our loaded data now searches back to August 2001. Our rate of loading has increased substantially with the hire of a person dedicated to this work.
- The archive interface has been used successfully by the AOC data analysts to retrieve data from recent observations. In addition, a group of scientists led by the DM Project Scientist, Dale Frail, is testing the interface.

- We are beginning to test the archive system with GBT data. A number of large projects are being loaded into the system, and the standard facilities will then be tested.
- The Calibrator Source Toolkit is now finished in the sense that we believe it meets the original scientific requirements as captured in the e2e Project Book. An acceptance procedure is being followed whereby a group of NRAO and non-NRAO scientists will judge whether or not it meets the scientific requirements. If so, then it will be made available for use by all NRAO observers. This is our first trial of this acceptance procedure. If successful, it will be adopted for use for all e2e deliverables.
- Work on a prototype proposal submission and management toolkit is proceeding well, using the design developed in the first cycle.
- An overarching design for e2e is being finalized. This describes the form and flow of information in e2e from proposal submission to archive access. The most difficult part of this design has been to capture the intentions of observers during the proposal submission process. This information must be drawn from the observer and propagated through the rest of the e2e to allow construction of observing scripts and pipeline reduction of the resulting observations. The conclusion of this overarching design will then enable us to develop designs for the remaining toolkits such as the Observation Evaluation Toolkit and Observation Simulation Toolkit. In addition, we will be able to move onto the second prototype of the Pipeline Toolkit.
- The implementation architecture for e2e is also close to finalization. We expect to use Java/Oracle for business processes (such as proposal submission and handling), and AIPS++ for scientific processes such as pipeline reduction. This architecture makes optimum use of commercially available tools such as Java and Oracle, and NRAO-developed tools in AIPS++.

Technology Development

Milestone	Original Deadline	Revised Deadline	Date Completed
ALMA AIPS++ tests	8/15/01	8/30/02	9/1/02
AIPS++ WBS for v2.0	6/15/02	7/30/02	10/1/02
AIPS++ booth and demo at ADASS '02 Baltimore, MD	10/16/02		
AIPS++ booth and demo at AAS, Seattle, WA	1/6/03		
AIPS++ external users' workshop	1/15/03		
AIPS++ release v2.0	4/1/03		

The DM Technology Development division is concerned primarily with management of the AIPS++ project. This package is developed by a consortium of participating observatories, and is the next-generation data reduction package for a wide range of radio telescopes. The package is currently in an active integration phase, with increasing use at many sites. The current focus reflects the overall project status, and is concerned primarily with scientific completeness, ease of use and enhancements in robustness and performance. The project planning is based closely on these priorities. The current release of AIPS++ is v1.7, and is available on CD-ROM or by network download. The next release of AIPS++ will be named v2.0, and will be issued in April 2003.

In addition to the overall priorities listed above, AIPS++ has retained a continuing focus this quarter on addressing time-critical needs for both ALMA and the GBT.

AIPS++ single-dish staff have continued a close collaboration with GBT Operations, aimed at meeting the scientific and technical needs of telescope commissioning. This includes frequent meetings and close liaison on planning priorities and single-dish development. In addition, the on-site AIPS++ developers in Greenbank assist directly in user support and telescope commissioning activities. These activities have continued during this quarter. In addition, Joe McMullin, who heads single-dish development in AIPS++, spent six weeks at Greenbank to assist in this process. A number of user tutorials on single-dish capabilities were conducted during this period.

AIPS++ has also retained a focus on meeting ALMA needs during this quarter. This has primarily concerned completion of phases I and II(a) of the AIPS++-IRAM end-to-end test. The test report was presented by Athol Kemball (NRAO) and Robert Lucas (IRAM) to the ALMA Science Advisory Council (ASAC), at their meeting in early September 2002. This test was a success, and has allowed to a close partnership to develop between the North American and European ALMA off-line software groups. Athol Kemball visited IRAM twice during this quarter to advance this test, accompanied by Kumar Golap and George Moellenbrock respectively. Tutorials on AIPS++ use were conducted at IRAM during these visits, with a primary focus on synthesis development and reduction.

In general, this quarter has seen continued improvement in scientific completeness, usability and performance of the AIPS++ package. Our collaboration with in-house testers has continued at NRAO. In addition, a new user group has been constituted at the Australia Telescope National Facility (ATNF), in order to provide similar feedback on scientific priorities to the ATNF AIPS++ personnel. These user outreach and training initiatives will continue as a strong priority in the coming quarters.

Central Computing Services

Milestone	Original Deadline	Revised Deadline	Date Completed
Revise Security Policy	2/15/01	12/31/02	
VPN (Charlottesville)	9/30/01	12/31/02	
Anti-virus email gateway purchases	12/31/01	8/15/02	8/31/02
Anti-virus email gateway deployment completed	9/30/02	11/30/02	
Complete CCE-compliant UNIX upgrades (CV)	10/15/01	08/31/02	9/30/02
CCE design (to infrastructure level)	10/31/01	7/31/02	7/31/02
CCE design (application co-ordination processes)	12/31/02		
CCE design (core applications)	3/31/02	3/31/03	
Final W2K domain design	9/01/01	8/31/02	8/31/02
Begin W2K domain deployment	10/15/01	9/30/02	9/30/02
Begin W2K domain client migration	1/31/02	11/30/02	
Complete W2K Active Directory testing	3/31/02	7/31/02	8/31/02
Complete deployment of shared calendar software	5/31/02	7/08/02	7/8/02

While no measures can be 100 percent bulletproof in today's hostile Internet, the security environment that now prevails at the NRAO would have prevented essentially all of the intrusions that occurred before the Computing Security Policy was issued. The Distributed Denial-of-Service (DDOS) attack against the Charlottesville *ftp* server which began in the spring of this year continues, although at a much lower volume. Such attacks cannot be completely prevented since they require no penetration of our own network, and it is nearly impossible to stop them because they involve hundreds of remote systems (more than 600 so far in this case). However, the measures put in place in the spring continue to keep Charlottesville's *ftp* services available.

All of the software and hardware orders related to the new anti-virus email gateways were placed by the end of August 2002. The commercial Sophos Anti-Virus engine will be used as the core anti-virus detection technology, under the control of an open-source package called MailScanner. The first of these gateways was deployed in Charlottesville in late August, where an appropriate system was already available. In the first month of operation, it detected nearly 2,500 viruses in incoming email messages. This is considerably higher than we had previously suspected.

Configuration parameters for the software and mail handling have been agreed upon, to ensure that the setups are consistent across all sites, and that the external email gateways can act as backup for each other. Preparation of the remaining three systems is underway and should be completed well before the end of the next quarter. In addition to virus detection, the new setup allows tagging of probable "junk" email by a package called SpamAssassin, so that users can more easily filter the increasing quantities of unwanted messages in their electronic mailboxes. The new anti-virus and anti-spam capabilities were announced to NRAO staff before the first gateway was deployed.

VPN (Virtual Private Networking) 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. With construction now imminent there, work on deploying a special-purpose VPN box has begun. The experience gained with this setup will be useful in determining how to provide the same capabilities at the other three sites.

Due to limited staff time, the Computing Security Policy revisions have yet to be done. The Policy must be revised to accommodate VPN issues as well as special-purpose Web servers and wireless networking security requirements; more specific policies on VPN and wireless deployment are under separate development.

With the close of the Fiscal year on September 30, all remaining purchases from Central Computing Services (Observatory-Wide Computing) budget allocations have been completed, including equipment to begin installation of fiber-based networking at the AOC, real-time Linux systems for Green Bank, and some recurring-cost items such as workstation upgrades. With the FY2002 funds we received for recurring costs, we were able to replace approximately 20% of the Observatory's staff and public UNIX computer systems. This is the rate that needs to be sustained permanently, corresponding to their maximum useful lifetime of five years.

During the past quarter, progress continued on several major projects involving NRAO computer systems support staff. These projects include:

- *The Common Computing Environment project, or CCE (UNIX)*: The definition of versions and configurations for all critical infrastructure services and standards was completed during the past quarter. The working group is now discussing the processes by which we will standardize applications across NRAO sites, and will then determine the set of core UNIX applications that should be available on all desktop and public NRAO systems. It is likely that a questionnaire, directed to all NRAO computer users, will be used to help identify problematic inter-site differences.
- *CCE (Windows)*: The NRAO-wide Active Directory (AD) design and migration plan for the new Windows 2000 domain is essentially complete, including detailed analysis of the numerous security-related settings that must be configured in the Windows 2000 environment. Tests for this design were largely completed this past quarter. The new Active Directory domain has now been created and the agreed-upon settings are being implemented on the first domain controller, to ensure that the policies are applied to all computers as they migrate into the domain. In addition, Dynamic DNS (DDNS) has been enabled in nearly all NRAO DNS zones. The Windows group will also work toward common OS installation and application standards under Windows 2000, as the UNIX CCE group is doing in the UNIX environment.
- *Mirrored Web Servers/Information Infrastructure*: significant progress has been made in preparing the new dual processor Linux-based login and utility servers (polaris and sirius replacements); virtually all services have been configured and are working. In addition, the migration of home areas from the old polaris server to the Network Appliance (cvfiler) has been moving faster than expected; we have already started the secondary migration of home areas off individual unix workstations and windows (NT, 2000)

PCs to cvfiler. This is part of a paradigm change in how Charlottesville provides backup services (from distributed to central).

- *Deployment of workstation upgrades:* with the summer students gone, most of the planned upgrades are now in place, with only one outstanding, due to the individual's schedule. Several additional unplanned upgrades were also carried out (and some still pending) due to various factors including hardware failure.
- *MailScanner/Sophos AntiVirus shield, and SpamAssassin:* the MailScanner/Sophos system is up and running on NRAO's main mail gateway (nrao.edu, a.k.a. "cv3"). It has already been extraordinarily successful in trapping and disinfecting incoming e-mail-based computer virii. A welcome bonus is the use of SpamAssassin to tag suspected "spam" e-mail; with a 93-95% success rate and almost no false positives, this has made a huge difference to the several testers who are now actively using the tags to file unwanted spam out of the way.
- *A wireless networking policy was put in place for Charlottesville;* this is also being considered for NRAO-wide use by the Common Computing Environment Working Group.

Web Services:

- *Web servers:* the four servers were shipped to all sites, and service for www.nrao.edu and the local (www.{site}.nrao.edu) site activated thereon.
- *Mirroring of www.nrao.edu:* this is now complete and operational. The content of NRAO's main web server is in place on all four servers, one per site. The mirroring system causes changes made at any site to be propagated to the master repository and thence back to the other three sites in a matter of hours during the working day, and nightly on weekends. In addition, the content of www.gb.nrao.edu is now mirrored to the New Mexico server, albeit in a master-slave arrangement.
- *Round-robin DNS:* the www.nrao.edu name resolves to three IP addresses: the servers in Charlottesville, Socorro, and Tucson. Whichever one your browser picks first (this will be semi-random) is the one you will get for that session. This has vastly improved both performance, reliability, and availability of NRAO's main web presence.
- *Search Engine:* the "crawls" to generate the search engine database have been re-started; they were suspended after the "configfest" work in June. Also, the engine itself has been upgraded to the latest vendor-supplied version.
- *Image Gallery:* the PHP-based active content engine behind the new image gallery is now working correctly (in the mirrored web server environment). The submission form for getting new content from Staff here and elsewhere has also gone live.
- *Redundant server backup:* a dedicated server is now operational, its sole purpose being to provide a disk-based backup for donar, the main web server in Charlottesville. Unlike the mirroring mentioned above, this system ("ranod") backs up the entire web server disk, not just the www.nrao.edu portion; so it gets the ftp server and other virtual server content as well. Disk backup is now more cost effective than high capacity tape backup.

Observatory-wide Communications

Milestones	Original Date	Revised Date	Date Completed
Complete software upgrade of video conferencing units	11/30/02		
Add additional T1 service GB to CV	11/30/02		
Deploy VPN service in CV	12/31/02		
Upgrade network service to VLBA KP antenna	12/31/02		

The video conference equipment in the ten locations has been successfully in use for more than six months. As planned, the increase in the number of units has had a positive impact. The VLA site now participates in regular video meetings with the AOC and Tucson. The equipment in the smaller conference rooms in Green Bank and Socorro has reduced the conflict with the use of the larger conference rooms; video meetings with a small local participation have moved to the smaller rooms, freeing the larger conference rooms for meetings with a larger attendance.

We are in the process of upgrading the software in the Polycom video conference units. When this is complete, we should see improved performance due to an enhanced algorithm, which is designed to give high prioritization of audio to improve clarity on congested circuits. The network bandwidth requirements between the sites are not driven by the video system; however, any problems with the service show up immediately in degraded performance of the conferencing systems. This is thus a very sensitive indicator of network problems. By policy, we have recently decided to run conferences at 384 kbps, reducing from the previous default of 512 kbps.

We have been actively exploring ways to add additional communication services by reducing costs on our existing intranet contract. To date, this has not been successful. There was a clear need for better communication between Socorro and the VLA site, especially to support the communication needs for the ALMA Test Facility (ATF). A second T1 was added at the end of June. There is also a demonstrated need for improved network performance at the VLBA sites. This is being pursued. However, the only improvement in the short term is likely to be to the KP antenna. To give better access to the Green Bank Telescope, we have ordered an additional T1 link between Green Bank and Charlottesville, but we have not yet been given a service initiation date.

At the international SPIE meeting on Astronomical Telescopes and Instrumentation, the NRAO contributed five papers to the conference on Advanced Global Communications Technologies for Astronomy. Two of these talks were presented by engineers designing the fiber transmission systems for the EVLA. The other three presented work on the Green Bank network, video communications, and future high speed communication for the VLBA.

Education

During summer, at Socorro, there was a Chautauqua short course from the University of Dayton; while at Green Bank there were two Hands-On-Universe workshops for teachers and the annual SARA (Society of Amateur Radio Astronomers) conference. Five RETs (Research Experience for Teachers) completed their encounters at the NRAO with three at Green Bank and two at Socorro. They came from Massachusetts, West Virginia (2), Minnesota, and Oregon. Their collective results included conceptual designs for exhibits on gravitational lensing and active galactic nuclei, software script development to remove stray radiation from 140-foot telescope data, noise diode intensity research of some of the GBT receivers, and software and hardware refinement for a demonstration radio telescope at the VLA visitor center. Green Bank secured funding for two teacher workshops next summer, while Socorro is preparing a collaborative teacher workshop grant request with New Mexico Tech.

The NRAO hosted extended overnight visits, including observing with the 40-foot telescope, for the National Youth Science Camp, Harrisonburg High School, WV Governor's Honor Academy, Snowshoe Institute, Mt. Union College, Villanova University, and the week-long ERIRA Program (Educational Research in Radio Astronomy) a cooperative effort with the NRAO, the University of Chicago, and Ohio State University.

A total of thirty-one undergraduate students worked at the NRAO this summer, fifteen REUs (Research Experience for Undergraduates), thirteen SSRAPs (Summer Student Research Assistant Program), two co-op students, and one summer employee. Nine of these students were based in Green Bank, four in Charlottesville, two in Tucson, and sixteen in Socorro. They came from eighteen states and twenty-five colleges and universities. Their projects ranged from enhancing AIPS++ usage, to assisting with interference protection, to surveying protostar molecular outflow, to imaging of low luminosity AGN's, to reducing VLA planetary nebulae data, to making observations of high redshift quasars (see http://www.nrao.edu/education/students/NRAOstudents_projects02.shtml).

Six Socorro High School students completed a summer project to translate some NRAO EPO web pages into Spanish, which was conceived and supervised by an NRAO NSF postdoctoral fellow. The project, financed in part by NASA, resulted in a number of the introductory public-education Web pages available in Spanish. In addition, the students themselves received exposure to the NRAO, astronomy, and the scientific process. The project was mentioned in the local area news media.

Community Programs

The Green Bank Science Center construction is proceeding rapidly. The contractor still hopes to be finished on schedule, but realistic planning prospects are for a somewhat later completion date. Aspects of the project 90% or more complete include demolition, concrete curb & gutter, masonry, pre-cast concrete sills, steel erection, metal roof deck, metal framing, and storm drainage. The total project is currently deemed two-thirds complete in terms of submitted pay estimates by the contractor and approved by the architect. Current expectations are that the Center should open for "advance preview" business in early spring and for official dedication in late spring. A new presentation video on the NRAO and radio astronomy for the VLA Visitor Center was completed and will commence showings in October. The new presentation video for the Green

Bank Science Center is still in production, but is expected to be finished before the end of the year. The architectural plans for a gift shop at the VLA Visitor Center are scheduled for their final "boiler plate" formatting so that they may be sent out in an RFP next month. Operation of this gift shop will provide for staffing of the presently unmanned Visitor Center for a majority of its open hours.

Ground breaking was held at the Etscorn Campus Observatory on the campus of New Mexico Tech for a two-element instructional interferometer, a cooperative effort between the NRAO and New Mexico Tech. In connection with this, NRAO staff members are involved in planning curriculum for a course for the Master of Science Teaching program as well as various projects for introducing the concept of radio interferometry.

Visitors were surveyed at both the Green Bank and VLA centers in an attempt to gain some understanding of the demographics of our visitors and some notion of where they obtain their information about the sites. Socorro, having an unmanned site, received fewer returns, but due to that already has the data compiled. Results of that survey include that the typical visitor is on an extended vacation averaging nearly two weeks. Another result was that most people learned of the VLA site either through word of mouth, just driving by, or via travel services. Not surprisingly more than half the visitors were from southwest states, though 24 states were represented for a one-month period. More than half of the visitors were at the VLA for the first time and children comprised only about 16% of the visitors for those who responded to the survey. Anecdotal evidence from the Green Bank facility also illustrates this relatively low percentage of children among tourists compared to typical demographics at science centers. This difference in expected attendance will be part of our future planning for both centers.

Attendance at Green Bank, based on head counts from the bus tours, was 13,249 for the quarter and gift shop sales were $34,639. For their special activities, they had 132 attendees at the High Tech tours, 63 at StarLab presentations, and the three star parties had an average attendance of 30-35. The last star party in September even included volunteers with telescopes from the Charlottesville area.

Socorro summer students gave guided tours of the VLA to the general public on weekends, with an estimated total of 1,000 visitors served. Twenty tours were also scheduled for education groups, with 400 people in attendance.

NRAO-Socorro EPO staff attended a STARTEC (State-of-the-Art Telescope Educational Collaboration) meeting at McDonald Observatory and participated in hammering out plans for a website and a teacher exchange.

Public Awareness

After nearly six months of planning, research, and development, the NRAO's new on-line Image Gallery was launched and is now available for public use. This gallery reflects the combined talents and efforts of the NRAO's scientific, EPO, and computing division staff. Featuring a multi-level format, low- medium- and high-resolution images, and a versatile search engine, the image gallery offers scientists and the general public an easy and well-organized source for radio astronomy images. In addition, the site includes an on-line image submission tool to allow NRAO staff and other astronomers to submit their work to the gallery. Currently, there are more than 200 images on-line.

Local area populace cultivation in Chile for the Atacama Large Millimeter Array (ALMA) continues. NRAO-Charlottesville staff worked with staff in Chile to develop a Spanish language NRAO brochure for

distribution in local sites there. Additionally, NRAO logo items were disseminated among the local school children to help build awareness of this important scientific installation.

Media Relations

Public information staff worked with Green Bank staff on several media relations items, including a nationally syndicated story on the Robert C. Byrd Green Bank Telescope, distributed by Reuters. EPO staff also documented an azimuth bearing change in Antenna 7 at the VLA which is posted on the general public page of the VLA website. Shrinivas "Shri" Kulkarni was named the recipient of the 2002 Jansky Lecture. Promotion and marketing developed for this lecture includes a poster series, newspaper ads, postcards, and public service announcements. Information about the lectures was also distributed to the national planetarium community through their list server and the International Planetarium Society's email Astronomy Update service.

The Bon Jovi Band produced a music video, scheduled for release in October, at the VLA. A documentary on the making of this music video appeared on VH1 in September. The filming was completed in a single day without adverse effect on NRAO's operations. All expenses of this video, including overtime, security, etc., were borne by the film crew.

Telescope Usage

The following telescopes have been scheduled for research and maintenance in the following manner during the first quarter of 2002. Note that time lost and actual observing for the arrays are computed at fractions of the total antenna arrays. For example, losing 27 VLA antennas for one hour counts as 1.0 hours of time lost, while losing one out of 10 VLBA antennas for one hour counts as 0.1 hours of time lost. The VLA downtime was larger than usual due to an early onset of the spring windy season in March.

	VLA	VLBA	GBT
Scheduled Observing (hrs)	1690.3	1033.25	703.0
Scheduled Maintenance and Equipment Changes	253.2	267.0	519.0
Scheduled Tests and Calibration	270.6	315.4	964.0
Time Lost	87.4	50.0	34.0
Actual Observing	1603.0	983.25	784.0

GBT Observing Programs

Quarterly Report July - September 2002

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

No.	Observer(s)	Programs
A057	Andre, P. (Saclay) Lestrade, J. F. (Obs Paris / DEMIRMD) Bontemps (Obs Bordeaux) Charlot, P. (Obs Bordeaux) Ducourant, C. (Obs Bordeaux)	Kinematics and distances of the rho Oph Protocluster 3.5 cm
BG125	Garrett, M. (JIVE) Wrobel, J.	A very deep VLBA-GBT pilot survey of the NDWFS. 21 cm
GBT01A-040	Lockman, F. J.	Corotation of the HI Halo in the Inner Galaxy. 21 cm
GBT01A-054	Langston, G. Bastian, T.	Search for cyclotron emission from known extra-solar planets. 90 cm
GBT01A-079	Thorsett, S. (UC, Santa Cruz) Stairs, I. (Univ of British Columbia) Arzoumanian, Z. (NASA/GSFC)	Timing fast pulsars at the GBT. 21 cm
GBT02A-003	Darling, J. (Cornell) Giovanelli, R. (Cornell)	Do hyperluminous IR galaxies produce OH gigamasers? 21 cm
GBT02A-008	Roberts, M. Maddalena, R. Haynes, M. (Cornell) Hogg, D.	A study of the hydrogen reservoir surrounding galaxies. 21 cm
GBT02A-012	Minter, A. Balser, D.	Probing HI structure on sub-A.U. - A.U. scales: hydrodynamical or MHD turbulence? 21 cm
GBT02A-021	Lockman, F. J. Roshi, A. Balser, D.	A search for recombination lines from diffuse gas in the Galactic Center region. 6, 11, 21 cm

GBT02A-038	Thilker, D. (Johns Hopkins) Braun, R. (NFRA) Walterbos, R. (NM State) Corbelli, E. (Astrofisico Arcet) Lockman, F. J. Murphy, E. (Virginia)	Probing the ultra-low NH environment and outer disks of M31 and M33. 21 cm
GBT02A-039	Camilo, F. (Columbia Laborato) Klein, B. (MPIfR) Mueller, (MPIfR) Wielebinski, R. (MPIfR) Kramer, M. (NRAL) Lorimer, D. (Manchester) McLaughlin, M. (Manchester) Stairs, I.(Univ British Columbia) Backer, D. (UC, Berkeley)	Searching for radio pulsations from the (X-ray) pulsar J0205+6449 in SNR 3C58. 21 cm
GBT02A-052	Stairs, I.(Univ of British Columbia) Manchester, R. (Australia Telescope) Lyne, A. G. (NRAL)	Multifrequency monitoring of a massive pulsar system. 11, 21, 50 cm
GBT02A-060	Nice, D. (Princeton) Stairs, I. (Univ British Columbia) Arzoumanian, Z. (NASA/GSFC)	Timing and polarimetry of two eclipsing binary pulsars. 21, 50 cm
GBT02A-062	Camilo, F. (Laborato Columbia) Halpern, J. P. (Columbia University) Stairs, I. (Univ British Columbia) Backer, D. (UC, Berkeley)) Arzoumanian, Z. (NASA/GSFC)	Studying PSR J2229+6114: an energetic gamma-ray emitting young astrophysics pulsar. 21 cm
GBT02B-009	Roshi, A. Deshpande, A. (Raman Research Institute)	AU scale HI structures: a probe using scattering of pulsar signals. 21 cm

GBT02B-013	Nolan, M (Arecibo) Campbell, D. (Cornell) Howell, H. (Arecibo) Black, G. Margot, J. L. (Caltech)	Target-of-Opportunity: Bistatic radar observations of near-Earth asteroids . 11 cm
GBT02B-014	Arzoumanian, Z. (NASA/GSFC)	The fate of a control experiment: a proposal to time the binary pulsar B0655+64. 21, 70 cm
GBT02B-019	Stairs, I. (Univ British Columbia) Ransom, S. (McGill University) Kaspi, V. (McGill University) Hessels, (McGill University) Backer, D. (UC, Berkeley) Lorimer, D. (Manchester)	Timing of newly discovered globular cluster pulsars. 21 cm
GBT02B-021	Chandler, A. (Caltech) Jacoby, B. (Caltech Astronomy) Anderson, (Caltech) Kulkarni, S. (Caltech) Prince, T. (Caltech) Backer, D. (UC, Berkeley)	Timing the six millisecond pulsars in M62. 21 cm
GBT02B-030	Lockman, F. J. McNamara, B. (Ohio University)	Hi from cooling flow cluster of galaxies: Abell 1068. 21 cm
GBT02C-023	Lockman, F. J.	A study of the HI clouds in the Galactic halo. 21 cm
GBT02C-034	Camilo, F. (Columbia Laborato) Stairs, I. (Univ British Columbia) Lorimer, D. (Manchester) Backer, D. (UC, Berkeley) Ransom, S. (McGill University)	Timing observations of the young pulsar in supernova remnant 3C58. 21, 38 cm

VLA Observing Programs

No.	Observer(s)	Programs
AA270	Anderson, J. Ulvestad, J. Ho, L. (DTM/Carnegie)	Spectral energy distributions of low-luminosity AGN. 2, 3.6, 6 cm
AA271	Armstrong, E. (Columbia) Helfand, D. (Columbia)	Stellar radio candidates from the FIRST survey. 3.6, 20 cm
AA274	Anderson, J. Ulvestad, J.	Survey of low luminosity active galactic nuclei. 0.7, 1.3, 2, 6 cm
AA276	Anderson, J. Ho, L. (DTM/Carnegie) Ulvestad, J.	Globular cluster black hole in M31. 3.6 cm
AA277	Araya, E. (Puerto Rico)	H2CO emission toward IRAS 18566+0408. 20 cm
AB0950	Becker, R. (UC, Davis) White, R. (STScI) Helfand, D. (Columbia)	The FIRST survey. 20 cm
AB1017	Blomme, R. (Belgium) Prinja, R. (U. College London) Runacres, M. (Belgium)	The distant stellar wind of hot stars. 20 cm
AB1019	Brunthaler, A. (MPIR, Bonn) Falcke, H. (MPIR, Bonn) Aller, M. (Michigan) Aller, H. (Michigan) Terasranta, H. (Helsinki) Bower, G. (UC, Berkeley)	Monitoring the radio-intermediate quasar PG2209+184. 1.3, 2, 3.6, 6, 20, 90 cm
AB1035	Butler, B.	330 MHz observation of Venus. 90 cm
AB1036	Best, P. (Royal Obs)	SCUBA sources in z~1 clusters: confirmation of cluster membership. 20 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

AB1041	Bosma, A. (Marseille Obs) Freeman, K. (Mt. Stromlo) Bureau, M. (Columbia) Athanassoula, E. (Marseille Obs) O'Brien, J. (Mt. Stromlo)	The edge-on barred spiral NGC 5746. 20 cm
AB1042	Berger, E. (Caltech) Kulkarni, S. (Caltech) Frail, D.	Gamma-ray burst host galaxies. 20 cm
AB1045	Bower, G. (UC, Berkeley) Baganoff, F. (MIT)	Radio identification of Chandra sources in the Galactic Center. 3.6 cm
AB1052	Berger, E. (Caltech) Martin, E. (Hawaii) Rutledge, R. (Caltech) Bildsten, L. (UC, Santa Barbara) Basri, G. (UC, Berkeley) Gizis, J. (IPAC) Hawley, S. (Michigan State) Fleming, T. (Arizona) Liebert, J. (Arizona)	L3.5 dwarf 2MASSW J0036159+182110. 3.6 cm
AB1057	Bagchi, J. (IUCAA)	Diffuse sources in merging cluster Abell 3376. 20, 90 cm
AB1058	Benz, A. (SFIT, ETH) Bastian, T. Mann, G. (Ondrejov Obs) Gary, D. (NJIT)	Imaging of electron beam emissions in the solar corona. 20, 90 cm
AB1063	Berger, E. (Caltech) Kulkarni, S. (Caltech)	Type Ib/c SN 2002dg and SN 2002dn. 3.5, 6, 20 cm
AB1065	Blomme, R. (Belgium)	Early type stars with non-thermal emission: HD168112 and HD167971. 3.6, 6, 20 cm
AC624	Clemens, M. (Cambridge) Alexander, P. (Cambridge) Cotter, G. (Cambridge) Longair, M. (Cambridge) Nikolic, B. (Cambridge)	Comparison of thermal continuum emission with mid-IR PAH features. 3.6 cm

AC626	Carraminana, A. (INAOE, Mexico) Rodriguez, L. (Mexico/UNAM) Grenier, I. (CNRS, France)	Egret sources with Beppo-SAX identifications. 3.6, 6 cm
AC641	Cheung, C. (Brandeis) Roberts, D. (Brandeis) Wardle, J. (Brandeis) Sambruna, R. (George Mason) Maraschi, L. (Brera Obs) Tavecchio, F. (Brera Obs) Urry, C. (Yale) Scarpa, R. (ESO)	Deep 22 GHz imaging of new X-ray/optical jets in AGN. 1.3 cm
AC645	Carilli, C. Bertoldi, F. (MPIR, Bonn) Menten, K. (MPIR, Bonn) Hasinger, G. (MPIA, Heidelberg)	Going deeper in the Lockman Hole. 20 cm
AC654	Cannon, J. (Minnesota) Kunth, D. (Paris) Leitherer, C. (STScI) Mas-Hesse, M. (LAE, Madrid) Ostlin, G. (Stockholm) Petrosian, A. (ARI, Heidelberg) Skillman, E. (Minnesota)	HI imaging of HST selected LyA starburst galaxies. 20 cm
AC656	Choi, M. (SA/IAA, Taiwan) Tatematsu, K. (NAOJ)	Class 0/I protostar with hard X-ray flares in the R CrA Cloud. 0.7 cm
AC662	Claussen, M. Wootten, H. A.	Observations of water and hydroxyl masers toward stars with planetary systems. 1.3, 20 cm
AC663	Chandler, C.	H_20 masers in planetary systems.
AD458	Dickey, J. (Minnesota) Heiles, C. (UC, Berkeley)	Variations in the HI optical depth toward compact continuum sources. 20 cm
AD459	Dolag, K. (MPIAP, Munich) Govoni, F. (Bologna) Schindler, S. (Liverpool JMU) Feretti, L. (Bologna)	Faraday rotation in nearby hot galaxy clusters. 6 cm

AD466	Darling, J. (Cornell) Carilli, C. Cox, P. (IAP, Paris) Bertoldi, F. (MPIR, Bonn) Omont, A. (IAP, Paris) Djorgovski, S. (Caltech)	Does the IR quasar PSS 2322+1944 produce an OH gigamaser? 90 cm
AD470	Dahlem, M. (ESO) Ehle, M. (ESA, Spain)	HI observations of galaxies with radio halos. 20 cm
AD473	Dunn, D. (UC, Berkeley) de Pater, I. (UC, Berkeley) Molnar, L. (Iowa)	Observations of Saturn's Rings at large opening angles. 3.6, 6 cm
AE147	Edge, A. (Durham) Ebeling, H. (Hawaii)	Evolution of radio galaxies in clusters of galaxies. 20 cm
AF390	Ferrari, C. (Cote d'Azur) Feretti, L. (Bologna) Giovannini, G. (Bologna) Maurogordato, S. (Cote d'Azur)	Radio galaxies and diffuse emission in the merging cluster A521. 20 cm
AG623	Gizani, N. (Lisbon) Cohen, A. (NRL) Kassim, N. (NRL)	Spectral aging in Hercules A. 90 cm
AG625	Gomez, Y. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Ramos-Larios, G. (Guadalajara)	Low-mass pre-main sequence stars around HII regions. 3.6 cm
AG626	Gaensler, B. (CfA) Brogan, C. Kassim, N. (NRL) Lazio, T. J. W. (NRL)	Survey of the inner galaxy. 90 cm
AG627	Gaensler, B. (CfA) Pooley, D. (MIT) Lewin, W. (MIT) D'Amico, N. (Bologna) Kaspi, V. (McGill)	Globular clusters NGC 6266 and 6366. 20 cm

AG629	Gibb, A. (Maryland)	L379: a possible cluster of young massive stars. 2, 3.6, 6 cm
AG636	Greenhill, L. (CfA) Kondratko, P. (CfA) Lovell, J. (CSIRO) Moran, J. (CfA) Kuiper, T. (JPL) Jauncey, D. (CSIRO)	Newly discovered water masers in AGN. 1.3 cm
AH752	Hunter, D. (Lowell Obs) Hunsberger, S. (Lowell Obs) Wilcots, E. (Wisconsin) Simpson, C. (Florida Int) Elmegreen, B. (IBM)	Origin of dwarf galaxies. 20 cm
AH753	Hunter, D. (Lowell Obs) Elmegreen, B. (IBM) Brinks, E. (Guanajuato U.) Westpfahl, D. (NMIMT) Nordgren, T. (Lowell Obs) Wilcots, E. (Wisconsin)	Clouds, porosity, and star formation in normal irregular galaxies. 20 cm
AH764	Hardcastle, M. (Bristol, UK) Kraft, R. (CfA) Worrall, D. (Bristol, UK)	Searching for proper motion in the jet of Centaurus A. 3.6 cm
AH766	Hardcastle, M. (Bristol, UK) Worrall, D. (Bristol, UK) Birkinshaw, M. (Bristol, UK)	Jets in a Chandra sample of B2 radio galaxies. 6 cm
AH775	Hyman, S. (Sweet Briar College) Lazio, T. J. W. (NRL) Denn, G. (Sweet Briar College) Kassim, N. (NRL)	Monitoring the galactic center for transient detection. 90 cm
AH782	Hardcastle, M. (Bristol, UK)	Microquasar GRS 1758-258. 20 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. 0.7, 1.3, 3.6 cm
AH786	Hoare, M. (Leeds) Lumsden, S. (Leeds) King, T. (Leeds)	Survey of red MSX sources in the outer galaxy. 6 cm
AH788	Holzapfel, W. (UC, Berkeley) Carlstrom, J. (Chicago) Dawson, K. (UC, Berkeley)	Identification of point source contaminants to anisotropy fields. 6 cm
AH800	Henkel, C. (MPIR, Bonn) Tarchi, A. (MPIR, Bonn) Peck, A. (CfA) Nagar, N. (Arcetri) Moscadelli, L. (Bologna)	Water kilomasers in the FIR bright galaxies NGC 253 and NGC 3556. 1.3 cm
AH803	Hardcastle, M. (Bristol, UK) Sakelliou, I. (Birmingham)	4C34.16 - a WAT with X-ray emission. 18 cm
AJ289	Johnson, K. Goss, W. M. Sjouwerman, L. Goss, W. M.	Imaging of the M31 nuclear region. 6 cm
AJ292	Jura, M. (UCLA) Reid, M. (CfA) Lipscy, S. (UC, Los Angeles)	Companion to VY CMa. 1.3, 2 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. 0.7, 1.3, 2, 3.5, 6, 20 cm

AK543	Koopmans, L. (Caltech) deBruyn, A. (NFRA) Fassnacht, C. (STScI) Wambsganss, J. (API, Potsdam) Blandford, R. (Caltech)	Radio micro lensing in B1600+434. 2, 3.6, 6, 20 cm
AK545	Kishimoto, M. (UC, Santa Barbara) Antonucci, R. (UC, Santa Barbara) Whysong, D. (UC, Santa Barbara) O'Dea, C. (STScI)	Radio quiet quasars in elliptical hosts. 90 cm
AK546	Kempner, J. (Virginia) Condon, J.	Emission from the UGC 10853 group. 20 cm
AK555	Kondratko, P. (CfA) Greenhill, L. (CfA) Moran, J. (CfA) Lovell, J. (CSIRO) Jauncey, D. (CSIRO) Kuiper, T. (JPL)	Newly discovered water masers in AGN. 1.3 cm
AL557	Lovell, J. (CSIRO) Bignall, H. Jauncey, D. (CSIRO) Tzioumis, A. (CSIRO) Kedziora-Chudczer, L. (CSIRO) Reynolds, J. (CSIRO) Rickett, B. (UC, San Diego) Marcquart, J. (Groningen/Kapteyn)	Northern hemisphere intra-day variable survey. 3.6, 6 cm
AL563	Lu, F. (Massachusetts) Lang, C. (Massachusetts) Wang, D. (Massachusetts)	The Crab-like SNR G54.1+.3. 6, 20 cm
AL566	Lonsdale, C. (Haystack) Kassim, N. (NRL) Lane, W. (NRL)	Relic radio lobes in 3C249.1. 90 cm
AL575	Lee, J. (Arizona) Impey, C. (Arizona) van Zee, L. (Indiana)	Kinematics of low surface brightness galaxies. 20 cm

AL576	Lee, S-W. (Toronto) Irwin, J. (Queens) Dickey, J. (Minnesota) Henriksen, R. (Queens) Chavez, T. (Queens) Seaquist, E. (Toronto)	Probing the halo-dynamics of the edge-on galaxy NGC 3556. 20 cm
AL577	Lim, J. (SA/IAA, Taiwan) Liang, M-C. (SA/IAA, Taiwan) Choi, M. (SA/IAA, Taiwan) Yu-Nung, S. (NCU, Taiwan)	Imaging the circumstellar dust of intermediate mass stars. 0.7, 1.3 cm
AL578	Landt, H. (STScI) Perlman, E. (Maryland) Padovani, P. (STScI)	A faint sample of BL Lacertae objects. 20 cm
AM681	Miller, N. (NASA/GSFC) Ledlow, M. (KPNO-NOAO)	Radio continuum survey of the Shapley supercluster. 20 cm
AM702	Markovic, T. (NMIMT) Owen, F. Eilek, J. (NMIMT)	Radio halos in Abell Clusters of galaxies. 20 cm
AM714	Mack, K. (NFRA) Prieto, A. (ESO) Brunetti, G. (Bologna)	Resolving radio hot spots. 3.6, 6, 20 cm
AM722	Marti, J. (U. Jaen) Paredes, J. (Barcelona)	Search for micro quasars outside the galactic plane. 3.6, 6, 20 cm
AM723	Marscher, A. (Boston) Jorstad, S. (Boston) McHardy, I. (Southampton)	Chandra imaging of quasar jets. 2 cm
AM726	Martin, E. (Hawaii) Berger, E. (Caltech) Rutledge, R. (Caltech)	Survey of radio-emission in ultracool dwarfs. 3.6 cm

AM727	Monnier, J. (CfA) Greenhill, L. (CfA) Tuthill, P. (Sydney) Danchi, W. (NASA/GSFC) Danchi, W. (NASA/GSFC)	Colliding wind binary WR 112. 3.6 cm
AM729	Murgia, M. (Bologna) Parma, P. (Bologna) Mack, C. (NFRA) de Ruiter, H. (Bologna)	Ultra steep spectrum radio galaxies. 20 cm
AM730	Morganti, R. (NFRA) Oosterloo, T. (NFRA) Pihlstrom, Y. van Moorsel, G. Tadhunter, C. (Sheffield) Wills, K. (Sheffield)	Large scale distribution of neutral hydrogen in radio galaxies. 20 cm
AN112	Neff, S. (NASA/GSFC) Rots, A. (NASA/GSFC) Fabbiano, G. (CfA) Zezas, A. (CfA)	Radio continuum in the Antennae merger system. 20 cm
AP430	Pedlar, A. (Manchester) Muxlow, T. (Manchester) Wills, K. (Sheffield)	327 MHz observations of Messier 82. 90 cm
AP434	Petric, A. (Columbia) Carilli, C. Rupen, M. Strauss, M. (Princeton) Fan, X. (Princeton) Omont, A. (IAP, Paris) Cox, P. (IAP, Paris) Bertoldi, F. (MPIR, Bonn) Menten, K. (MPIR, Bonn)	Radio emission from the highest redshift QSOs. 20 cm

AP438	Pisano, D. (CSIRO) Guzman, R. (Florida) Kobulnicky, C. (Wisconsin) Gallego, J. (Complutense) Bershady, M. (Wisconsin)	Dynamics and star formation properties of blue compact galaxies. 20 cm
AP439	Perlman, E. (Maryland) Biretta, J. (STScI) Baum, S. (STScI) O'Dea, C. (STScI) Harris, D. (CfA) Martel, A. (Johns Hopkins)	Structure and physics of extragalactic jets. 1.3, 3.6 cm
AP442	Pihlstrom, Y. Conway, J. (Chalmers, Onsala)	Excited OH in 1323+321. 6 cm
AP444	Paredes, J. (Barcelona) Ribo, M. (Barcelona) Marti, J. (U. Jaen)	Orbital modulation in the micro quasar LS 5039. 3.6, 6 cm
AR476	Rupen, M. Mioduszewski, A. Dhawan, V.	Galactic X-ray binaries and transients. 0.7, 1.3, 2, 3.6, 20, 90 cm
AR477	Rawlings, S. (Oxford) Willott, C. (Oxford) McLure, R. (Oxford) Mitchell, E. (Oxford) Dunlop, J. (Edinburgh) Jarvis, M. (Leiden) Hill, G. (Texas)	Radio structures over a wide range of luminosities. 3.6, 6, 20 cm
AR479	Rusin, D. (CfA) Biggs, A. (Manchester) Fassnacht, C. (STScI) Koopmans, L. (Caltech) Lovell, J. (CSIRO) Winn, J. (CfA)	Which new radio lenses are variable? 3.6 cm
AR482	Rodriguez, L. (Mexico/UNAM) Reipurth, B. (Hawaii)	Exciting source of HH 92. 3.6 cm

AR485	Rupen, M. Migliari, S. (Amsterdam) Jonker, P. (Cambridge) Fender, R. (Amsterdam) van der Klis, M. (Amsterdam) Homan, J. (Milano Obs)	RXTE and VLA observations of 4U 1728-34, Ser X-1, 4U 1820-30 and GX17+2. 1.3, 2, 3.6, 6, 20 cm
AR488	Reid, M. (McMaster) Wilson, C. (McMaster)	Ammonia (1,1) and (2,2) in star forming cores. 1.3 cm
AR489	Rottgering, H. (Leiden) Cohen, A. (NRL) Best, P. (Royal Obs) Kassim, N. (NRL) Perley, R. Pierre, M. (CNRS, France) Refregier, A. (CNRS, France) Rengelink, R. (Leiden) Birkinshaw, M. (Bristol, UK) Bremer, M. (Bristol, UK) Liang, H. (Bristol, UK) Zanichelli, A. (Milano Obs)	Radio source population and XMM large scale structure survey. 90 cm
AR500	Roy, S. (NCRA, India) Rao, A. (NCRA, India)	Magnetic field direction in Sgr-C. 3.6, 6 cm
AR502	Ribo, M. (Barcelona) Paredes, J. (Barcelona) Bloom, J. (Caltech) Marti, J. (U. Jaen)	Micro quasar candidates. 6 cm
AS687	Soifer, B. (Caltech) Helou, G. (IPAC) Werner, M. (JPL) Shupe, D. (Caltech) Storrie-Lombardi, L. (Caltech) Condon, J.J. Cotton, W.D.	The SIRTF first-look survey. 20 cm

AS720	Schindler, S. (Liverpool JMU) Feretti, L. (Bologna) Wambsganss, J. (API, Potsdam) Schwope, A. (API, Potsdam) DeFillippis, B. (Liverpool JMU) Castillo-Morales, A. (Granada)	Distant galaxy cluster RBS797. 20 cm
AS729	Subrahmanyan, R. (CSIRO) Saripalli, L. (CSIRO)	Restarting beams in the giant radio galaxy B11545-321. 6 cm
AS730	Simpson, C. (NAO, Japan) Rawlings, S. (Oxford) Ivison, R. (Royal Obs) Sekiguchi, K. (NAO, Japan)	Radio imaging of the Subaru/XMM Newton deep survey field. 20 cm
AS734	Saikia, D. (TIFR) Hota, A. (TIFR)	Radio study of a sample of blue compact dwarf galaxies. 3.6 cm
AS735	Sridharan, T. (CfA) Zhang, Q. (CfA) Wyrowski, F. (MPIR, Bonn) Hunter, T. (CfA) Beuther, H. (MPIR, Bonn) Schilke, P. (MPIR, Bonn)	Resolving disks around two high-mass (proto) stars. 1.3 cm
AS739	Schmitt, H.	Search for HI absorption in the Seyfert galaxy IRAS 01475-0740. 20 cm
AS744	Sjouwerman, L. Dickel, J. (Illinois) Garcia, M. (CfA) Primini, F. (CfA)	L2 Puppis. 3.5, 6 cm
AT258	Thilker, D. (Johns Hopkins) Elmegreen, B. (IBM) Efremov, Y. (Moscow/SSAI) Larsen, S. (Copenhagen)	HI imaging of giant bubbles and arcs in NGC 6946. 20 cm

AT275	Tinti, S. (Brera Obs) Celotti, A. (Brera Obs) Dallacasa, D. (Bologna) Stanghellini, C. (Bologna)	Bright high frequency peakers. 1.3, 2, 3.6, 6, 20 cm
AT277	Torrelles, J. (IAA, Andalucia)	Possible water maser in a planetary nebula. 1.3 cm
AT278	Taylor, G. Chandler, C.	Increasing the sky coverage of VLA calibrators. 0.7 cm
AT285	Thornley, M. Kennicutt, R. (Arizona) Kewley, L. (CfA) Regan, M. (DTM/Carnegie) Walter, F. (Caltech)	HI in galaxies in the SIRTIF Nearby Galaxies Survey. 20 cm
AV257	Venturi, T. (Bologna) Bardelli, S. (Bologna) Dallacasa, D. (Bologna) Brunetti, G. (Bologna) Hunstead, R. (Sydney)	Low frequency observations of the radio halo in A3562. 90 cm
AW563	Williams, P. (Edinburgh) Dougherty, S. (DRAO)	Continuing monitoring of WR 125. 3.6, 6, 20 cm
AW576	Winn, J. (CfA) Biggs, A. (Manchester) Fassnacht, C. (STScI) Koopmans, L. (Caltech) Lovell, J. (CSIRO) Rusin, D. (CfA)	Time delays in gravitational lenses. 3.6 cm
AW579	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)	Properties of radio supernovae. 2, 3.6, 6, 20, 90 cm

AW582	Webster, Z. (UC, Berkeley) DiFranceso, J. (UC, Berkeley) Anglada, G. (IAA, Andalucia) Welch, W. (UC, Berkeley) Wilner, D. (CfA) Rodriguez, L. (Mexico/UNAM)	The embedded protostars in NGC 1333. 0.7 cm
AW584	Wilson, T. (MPIR, Bonn) Gaume, R. (USNO) Megeath, S. (CfA)	Spectral indices of the W3-IRS5 source(s). 0.7, 1.3 cm
AW585	Wang, W-H. (Hawaii) Chen, J. (Chicago) Gao, Y. (IPAC) Lo, K. (SA/IAA, Taiwan) Dinh, V-T. (SA/IAA, Taiwan) Liang, M-C. (SA/IAA, Taiwan)	HI in early stage interacting galaxies: NGC 6670 and Arp 256. 20 cm
AW587	Wu, Y. (Peking Obs) Zhang, Q. (CfA) Mao, R. (Purple Mt.) Miller, M. (Cologne) Wang, J. (Peking Obs) Jarken, L. (Peking Obs)	Search for water masers and continuum emission in dense cores. 3.6 cm
AW588	Wilcots, E. (Wisconsin) Sanders, W. (Wisconsin) Doane, N. (Wisconsin)	Searching for "local bubbles" in face-on spirals. 20 cm
AW590	Willson, R. (Tufts) Holman, G. (NASA/GSFC) Sui, L. (Catholic U.)	VLA-HESSI-SOHO observations of solar flares and micro flares. 2, 3.6, 6 cm

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
AY132	Young, L. (NMIMT) Rundle, D. (NMIMT)	Elliptical galaxies: radio continuum and star formation. 20 cm
AY136	Yusef-Zadeh, F. (Northwestern) Law, C. (Northwestern) Cotton, W.	327 MHz mapping near l,b = -1d, -0.5d. 90 cm
AZ136	Zhao, J-H. (CfA) McGary, R. (CfA) Goss, W. M. Bower, G. (UC, Berkeley)	Monitoring the 106-day cycle of Sgr A. 0.7, 1.3, 2 cm
BA061	Attridge, J. (Haystack) Homan, D. (Brandeis) Pollack, L. (UC, Berkeley)	Polarimetric imaging of the blazar J1058+0133. 2, 3.6, 6 cm
BB138	Bach, U. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus. J. A. (MPIR, Bonn)	Motion in the counter jet of Cygnus A. 2, 6 cm
BG129	Greenhill, L. (CfA) Chandler, C. Reid, M. (CfA) Moran, J. (CfA) Diamond, P. (Manchester)	SiO proper motions in Orion KL. 0.7 cm

BH097	Hoffman, I. (New Mexico) Goss, W. M. Brogan, C. Claussen, M.	Full stokes observations of the 1720 MHz OH masers in W28. 18 cm
BM180	Marvel, K. (AAS) Mannings, V. (IPAC)	Water maser kinematics near Herbig Ae/Be stars. 1.3 cm
BS102	Sahai, R. (JPL) Claussen, M. Morris, M. (UCLA)	The water masers in the "water-fountain" protoplanetary IRAS 16342-3814. 1.3 cm AA267

VLBA Observing Programs

Quarterly Report July - September 2002

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

No.	Observer(s)	Programs
BA045	Alberdi, A. (IAA) Gomez, J. (IAA) Marcaide, J. (Univ. Valencia) Marscher, A. (Boston) Perez-Torres, M. (IRA)	Interaction of moving and standing components in 4C39.25. 1, 2, 0.7 cm
BA053	Attridge, J. (Haystack) Homan, D. (Brandeis) Phillips, R. (Haystack) Wardle, J. (Brandeis)	86 and 43 GHz linear polarization of five AGN with the VLBA. 0.3, 0.7 cm
BA057	Andre, P. (CNRS, France) Lestrade, J. (Paris Obs) Bontemps, S. (Bordeaux) Charlot, P. (Bordeaux) Ducourant, C. (Bordeaux)	Kinematics and distance of the Oph Protocluster. 3.6 cm
BA061	Attridge, J. (Haystack) Homan, D. (Brandeis) Pollack, L. (UC, Berkeley)	Polarimetric imaging of the blazar J1058+0133. 2, 3.6, 6 cm
BA062	Anderson, J. Ho, L. (Carnegie Obs) Ulvestad, J.	Survey of emission mechanisms in low-luminosity active galactic nuclei. 2, 4, 6, 13 cm
BB138	Bach, U. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	Motion in the counter jet of Cygnus A. 2, 6 cm
BB149	Baan, W. (ASTRON) Garrett, M. (JIVE) Hofner, P. (Puerto Rico) Klockner, H-R. (Kapteyn) Pihlstrom, Y.	TORUS/Disk structures in powerful OH megamasers. 20 cm

BB157	Black, G.	Near earth asteroid 2002 NY40. 13 cm
BC123	Fomalont, E. Chatterjee, S. (Cornell) Backer, D. (UC, Berkeley) Benson, J. Brisken, W. Cordes, J. (Cornell) Ellis, R. (UC, Santa Cruz) Fomalont, E. Golden, A. Goss, W. M. Kramer, M. Lazio, T. J. W. Lyne, A. McKinnon, M. Thorsett, S. (UC, Santa Cruz) Wong, D. (Cornell)	First-epoch pulsar astrometry with the VLBA. 20 cm
BC130	Choliet, E. Anderson, J. Brisken, W. Cyganowski, C. Devine, K. Glendenning, L. Petric, A.	Crab pulsar observation. 20 cm
BE023	Edwards, P. (ISAS) Piner, G. (Whittier)	Markarian 421-Monitoring after a TeV outburst. 1 cm
BG103	Gabuzda, D. (JIVE) Pushkarev, A. (ASC)	Unique parsec scale properties of the BL lac object 0820+225. 1, 2, 4, 6, 0.7 cm
BG120	Gawronski, M. (Poland) Booth, R. (Onsala) Kus, A. (Poland) Wilkinson, P. (Jodrell Bank)	Study of helical jet and strong interaction with ISM in the CSS quasar 3C309.1. 2 cm

BG121	Gabuzda, D. (Cork) Cawthorne, T. (Lancashire) Pashchenko, I. (Moscow) Pushkarev, A. (ASC)	High-frequency polarization observations of a complete sample of BL lac objects. 0.7, 1, 2 cm
BG125	Garrett, M. (NFRA) Wrobel, J.	Very Deep VLBA GBT pilot survey of the NOAO deep-wide field. 18 cm
BG128	Gabuzda, D. (Cork) Rastorgueva, E. (Moscow/SSAI) Smith, P. (Arizona)	Simultaneous optical and VLBI polarization observations. 0.7, 1.3, 2 cm
BG129	Greenhill, L. (CfA) Chandler, C. Reid, M. (CfA) Moran, J. (CfA) Diamond, P. (Manchester)	SiO proper motions in Orion KL. 0.7 cm
BG130	Gabuzda, D. (Cork) Pushkarev, A. (ASC)	Unique parsec-scale properties of the BL lac objects 0820+255. 1, 2, 4, 6, 0.7 cm
BH083	Hirota, T. (Kagoshima) Hachisuka, K. (Graduate Univ.) Imai, H. (NAO) Omadaka, T. (Kagoshima) Sasao, T. (NAO)	Measurements of proper motion of the Orion-Monoceros molecular cloud complex. 1 cm
BH096	Hong, X. (Shanghai) An, T. (Shanghai) Jiang, D. (Shanghai) Venturi, T. (IRA) Wang, W. (Shanghai)	Why do some EGRET detected blazars show double radio structures? 2, 4, 6 cm
BH097	Hoffman, I. (New Mexico) Goss, W. M. Brogan, C. Claussen, M.	Full stokes observations of the 1720 MHz OH masers in W28. 18 cm

BH099	Hachisuka, K. (NAO) Horiuchi, S. (JPL) Inoue, M. (Kagoshima) Miyoshi, M. (NAO) Mochizuki, N. (NAO) Umemoto, T. (NAO)	Determination of outer galactic rotation curve through phase-referencing VLBI astronometry with water masers II. 1 cm
BI024	Imai, H. (NAOJ) Diamond, P. (Jodrell Bank)	Collimated molecular jet in W43A traced by water maser emission. 1, 20 cm
BJ042	Johnston, K. (USNO) Fey, A. (USNO) Boboltz, D. (USNO) Ma, C. (NASA/GSFC) Gordon, D. (NASA/GSFC) Gaume, R. (USNO) Kingham, K. (USNO) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) Shaffer, D. (Radiometrics) Fomalont, E. Walker, R.C.	Geodesy/astrometry observations for 2002. 3.6 cm
BK076	Kurayama, T. (NAO) Sasao, T. (NAO)	Parallax measurement of Miras for period-luminosity relation. 1 cm
BK085	Kopeikin, S. (Missouri) Fomalont, E. Gwinn, C. (UC, Santa Barbara)	Measuring the propagation of gravity by VLBI. 3.6 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
BK087	Koopmans, L. (Caltech) deBruyn, G. (NFRA)	Relativistic speeds in the gravitationally lensed jet of B1600+434. 2 cm

BK092	Krichbaum, T. (MPIfR) Aller, H. (Michigan) Aller, M. (Michigan) Bach, U. (MPIfR) Polatidis, A. (MPIfR) Ros, E. (MPIfR) Terasranta, H. (Metsahovi) Ungerechts, H. (IRAM) Witzel, A. (MPIfR) Zensus, A.J. (MPIfR)	Monitoring of 1633+382 during a major millimeter flare. 0.7, 1, 3 cm
BK093	Kunert, M. (Copernicus/Torun) Marecki, A. (Copernicus/Torun) Spencer, R. (Manchester)	Weak and small CSS sources. 18 cm
BK095	Kortenkamp, P. (Iowa) Mutel, R. (Iowa) Spangler, S. (Iowa)	Inner solar wind turbulence using VLBI phase scintillations. 3.6, 6, 13 cm
BK096	Kulkarni, S. (Caltech)	SN1998 bw-like object. 4 cm
BL098	Lovell, J. (ATNF) Edwards, P. (ISAS) Jauncey, D. (ATNF) Jones, D. (JPL) Reynolds, J. (ATNF) Tzioumis, A. (ATNF) Wieringa, M. (ATNF)	Improving the precision of H measured from the gravitational lens 1830-211. 1, 2, 4 cm
BL107	Lara, L. (IAA) Cotton, W. Feretti, L. (IRA) Giovannini, G. (IRA) Marcaide, J. (Valencia) Venturi, T. (IRA)	Parsec-scale properties of large angular size radio galaxies. 6 cm
BL110	Lazio, T. J. W. (NRL) Lockman, F. J. Roshi, A.	Search for ionized gas in the galactic warp. 20 cm

BL112	Lazio, T. J. W. (NRL)	B1849+005 and PSR B1849+00: A scattering comparison. 13 cm
BM162	Marscher, A. (Boston) Aller, M. F. (Michigan) Jorstad, S. (Boston) McHardy, I. (Southampton)	Relationship between X-ray flares and superluminal ejections in blazars. 1, 0.7 cm
BM166	Middelberg, E. (MPIfR) Gabuzda, D. (Cork) Roy, A. (MPIfR)	Polarimetry of compact radio sources. 2 cm
BM170	Middelberg, E. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Roy, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	The complex jet in NGC 3079. 3.6, 6, 18 cm
BM171	Marscher, A. (Boston) Aller, M. (Michigan) Gomez, J. (IAA) Jorstad, S. (Boston) McHardy, I. (Southampton)	Relationship between X-ray events and superluminal ejections. 1, 0.7 cm
BM175	Middelberg, E. (MPIfR) Krichbaum, T. (MPIfR) Roy, A. (MPIfR) Walker, R. C.	Beating the sensitivity limits: 3 mm imaging of NGC 4261. 0.3, 0.7, 2 cm
BP089	Piner, B. (Whittier) Edwards, P. (ISAS) Jones, D. (JPL)	Monitoring of ultra-fast blazars. 0.7, 1, 2 cm
BP090	Perez-Torres, M. (IAR) Alberdi, A. (IAA) Guirado, J. (Valencia) Marcaide, J. (Valencia) Ros, E. (MPIfR)	M81* at 43 GHz. 0.7 cm

BP095	Palmer, P. (Chicago) Devine, K. Goss, W. M.	1720 MHz OH emission in W3 (OH). 20 cm
BP097	Pihlstrom, Y. Aalto, S. (Onsala) Morganti, R. (NFRA) Oosterloo, T. (NFRA)	Evolution of ISM in radio galaxies - the radio properties of B21506+34. 20 cm
BR077	Ros, E. (MPIfR) Cohen, M. (Caltech) Kadler, M. (MPIfR) Kellermann, K. Lister, M. Vermeulen, R. (ASTRON) Zensus, J. A. (MPIfR)	Kinematics of parsec-scale structure in AGN. 2 cm
BR079	Lanyi, G. (JPL) Boboltz, D. (USNO) Charlot, P. (Bordeaux) Fey, A. (USNO) Gordon, D. (GSFC) Ma, C. (GSFC) Sovers, O. (RSAS) Taylor, G. Ulvestad, J.	Extending the international celestial reference frame to multiple wavelengths. 0.7, 1 cm
BR080	Ratner, M. (CfA) Bartel, N. (York U.) Bietenholz, M. (York U.) Lebach, D. (CfA) Lestrade, J. (Paris Obs) Ranson, R. (York U.) Shapiro, I. (CfA)	Astrometry of HR 8703 in 2002 for gravity Probe-B mission. 3.6 cm
BS084	Sarma, A. (Kentucky) Romney, J. Troland, T. (Kentucky)	Zeeman measurement of the magnetic field in 22 GHz H_20 masers in OH43.8-0.1 and W3 (OH). 1 cm

BS094	Sudou, H. (Tohoku) Iguchi, S. (NAO) Kameno, S. (NAO) Murata, Y. (ISAS) Taniguchi, Y. (Tohoku)	Search for an accretion disk and a dusty torus in NGC 4261. 0.7, 1, 2 cm
BS095	Shinnaga, H. (ASIAA) Claussen, M. Lim, J. (ASIAA) Tsuboi, M. (Ibaraki) Van Trung, D. (ASIAA)	Study of the circumstellar magnetic field of the peculiar red supergiant VY CMa. 0. 7 cm
BS096	Suda, H. (Univ. of Tokyo) Honma, M. (NAO) Sasao, T. (NAO)	Phase-referencing VLBA observations of water maser source in the inner galaxy for resolving distance ambiguity and determining galactic constants. 1 cm
BS102	Sahai, R. (JPL) Claussen, M. Morris, M. (UCLA)	The water masers in the "water-fountain" protoplanetary IRAS 16342-3814. 1.3 cm
BT065	Taylor, G. Hough, D. (Trinity) Venturi, T. (CNR)	Polarimetry of powerful radio galaxy cores. 6 cm
BV044	Vlemmings, W. (Leiden) Diamond, P. (Jodrell Bank) van Langevelde, H. (JIVE)	Polarization of circumstellar H_20 masers. 1 cm
BV045	Vir Lal, D. (IAA, Bangalore) Gabuzda, D. (Cork)	Structure and motion of Mrk 533. 2, 4, 6, 13 cm
BW054	Walker, R. C. Wrobel, J.	Jet collimation regions. 0.7 cm
BW064	Winn, J. (CfA)	Completion of a southern gravitational lens survey. 6 cm

NEW HIRES

Anderson, James	Research Associate, Junior	9/16/02
Baars, Jacob	Project Engineer	9/1/02
Bridger, Joshua	Research Assistant	7/8/02
Cai, Chunai	Software Engineer II	8/1/02
Farris, Allen	Software Engineer I	7/15/02
Forster, Vincent	Systems Administrator II	8/8/02
Lo, Kwok-Young (Fred)	Director	9/1/02
Osten, Rachel	Research Associate	8/27/02
Palmer, Patrick	Visiting Scientist	7/1/02
Patscheck, Christopher	Engineering Associate, Junior	8/12/02
Ridgeway, Robert	Electronics Engineer II	8/1/02
Rowe, Kevin	Systems Administrator I	7/1/02
Schinnerer, Eva	Research Associate	9/2/02
Shirley, Yancy	Research Associate	9/9/02
Walter, Fabian	Research Associate	9/2/02
Whiteis, Peter	Software Engineer I	9/2/02
Zhang, Haoxin	Software Engineer II	9/25/02
Saini, Kamaljeet*	Electronics Engineer II	9/3/02

TERMINATIONS

Palmer, Patrick	Visiting Scientist	7/31/02

PROMOTIONS

Braatz, James	to Associate Scientist	7/1/02
Chandler, Claire	to Associate Scientist	7/1/02
Dahlmeyer, Lothar	to Systems Administrator II	7/1/02
Glendenning, Marie	to Systems Administrator I	7/1/02
Hibbard, John	to Associate Scientist	7/1/02
Kogan, Leonid	to Scientist	7/1/02
Long, Kevin	to Systems Administrator I	7/1/02
Mangum, Jeffrey	to Scientist	7/1/02
Martin, George	to Systems Administrator I	7/1/02
Myers, Steven	to Scientist	7/1/02
Pisano, Jim	to Software Engineer I	7/1/02
Poindexter, Allan	to Systems Administrator I	7/1/02
Pokorny, Martin	to Software Engineer I	7/1/02
Rupen, Michael	to Scientist	7/1/02
Shepherd, Deborah	to Associate Scientist	7/1/02
Uphoff, Jeffrey	to Software Engineer I	8/12/02
Witz, Stephan	to Software Engineer II	7/1/02
Young, Wesley	to Software Engineer II	7/1/02

*Rehire

Publications

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

PREPRINTS RECEIVED, JULY-SEPTEMBER 2002

BAKKER, E.J.; LEINERT, C.; JAFFE, W.; GRASER, U.; PERCHERON, I.; CHESNEAU, O.; MEISNER, J.A.; COTTON, B.; DE JONG, J.; PEL, J.-W.; GLAZENBORG-KLUTTIG, A.W.; PERRIN, G.; PRZYGODDA, F. MIDI Scientific and Technical Observation Procedures.

BECK, S.C.; TURNER, J.L.; LANGLAND-SHULA, L.E.; MEIER, D.S.; CROSTHWAITE, L.P.; GORJIAN, V. Radio-Infrared Supernebulae in II ZW 40.

BENSON, J.; WATERS, B.; CORNWELL, T. Generic Archive Capability for Radio Telescopes in AIPS++

BOWER, G.C.; FALCKE, H.; MELLON, R.R. A Radio Survey for Linear and Circular Polarization in Low Luminosity Active Galactic Nuclei.

BROTHERTON, M.S.; LY, C.; WILLS, B.J.; LAURENT-MUEHLEISEN, S.A.; VAN BREUGEL, W.; ANTONUCCI, R.R.J. Multiband VLA Observations of the Faint Radio Core of 3CR 68.1.

CALABRETTA, M.R.; GREISEN, E.W. Representations of Celestial Coordinates in FITS.

CAMILO, F.; MANCHESTER, R.N.; GAENSLER, B.M.; LORIMER, D.R. Heartbeat of a Mouse: A Young Radio Pulsar Associated with the Axisymmetric Nebula G359.23-0.82.

CARILLI, C.L.; GNEDIN, N.Y.; OWEN, F. H I 21 Centimeter Absorption Beyond the Epoch of Reionization.

CHENG, J. Thermal Shape Change of Some CFRP-Aluminum Honeycomb Sandwiched Structures.

CHEUNG, C.C. Detection of Optical Synchrotron Emission from the Radio Jet of 3C 279.

CHILDERS, E.L.; HUNT, G.; BRANDT, J.J. Local Area Networking in a Radio Quiet Environment.

CLAUSSEN, M.J.; GOSS, W.M.; DESAI, K.M.; BROGAN, C.L. The Size of the Extragalactic Source J1801-231 and the Association of Pulsar PSR B1758-23 with the Supernova Remnant W 28.

COTTON, W.D.; DALLACASA, D.; FANTI, C.; FANTI, R.; FOLEY, A.R.; SCHILIZZI, R.T.; SPENCER, R.; SAIKIA, D.J.; GARRINGTON, S. Polarimetry of GPS and CSS Sources.

DELANEY, T.; KORALSKY, B.; RUDNICK, L.; DICKEL, J.R. Radio Spectral Index Variations and Physical Conditions in Kepler's Supernova Remnant.

FURUYA, R.S.; CESARONI, R.; CODELLA, C.; TESTI, L.; BACHILLER, R.; TAFALLA, M. G24.78+0.08: A Cluster of High-Mass (Proto)Stars.

FURUYA, R.S.; KITAMURA, Y.; WOOTTEN, A.; CLAUSSEN, M.J.; KAWABE, R. Water Maser Survey Towards Low-Mass Young Stellar Objects in the Northern Sky with the Nobeyama 45-m Telescope and the Very Large Array.

GREISEN, E.W.; CALABRETTA, M.R. Representations of World Coordinates in FITS.

HARDCASTLE, M.J.; BIRKINSHAW, M.; CAMERON, R.A.; HARRIS, D.E.; LOONEY, L.W.; WORRALL, D.M. Magnetic Field Strengths in the Hotspots and Lobes of Three Powerful FRII Radio Sources.

HARRIS, D.E.; FINOGUENOV, A.; BRIDLE, A.H.; HARDCASTLE, M.J.; LAING, R.A. X-ray Detection of the Inner Jet in the Radio Galaxy M84.

HARRIS, D.E.; KRAWCZYNSKI, H.; TAYLOR, G.B. X-ray Detection of the Inner Jet in the Radio Galaxy 3C 129.

HOMAN, D.C.; WARDLE, J.F.C.; CHEUNG, C.C.; ROBERTS, D.H.; ATTRIDGE, J.M. PKS 1510-089: A Head-on View of a Relativistic Jet.

HUNT, G.; ROMNEY, J.D.; WALKER, R.C. Directly Connecting the Very Long Baseline Array.

IVISON, R.J.; GREVE, T.R.; SMAIL, I.; DUNLOP, J.S.; ROCHE, N.D.; SCOTT, S.E.; PAGE, M.J.; STEVENS, J.A.; ALMAINI, O.; BLAIN, A.W.; WILLOTT, C.J.; FOX, M.J.; GILBANK, D.G.; SERJEANT, S.; HUGHES, D.H. Deep Radio Imaging of the SCUBA 8-mJy Survey Fields: Sub-mm Source Identifications and the Redshift Distribution.

KAPLAN, D.L.; KULKARNI, S.R.; VAN KERKWIJK, M.H. A Probable Optical Counterpart for the Isolated Neutron Star RX J1308.6+2127.

PREPRINTS RECEIVED, JULY-SEPTEMBER 2002

KERVELLA, P.; SEGRANSAN, D.; DI FOLCO, E.; GITTON, P.; KERN, P.; COUDE DU FORESTO, V.; BALLESTER, P.; PHAN DUC, T.; LONGINOTTI, A.; KIEKEBUSH, M.; COTTON, W.D.; SCHOLLER, M.; WILHELM, R. VINCI, the VLTI Commissioning Instrument: Status after One Year of Operations at Paranal.

KUIPER, L.; HERMSEN, W.; VERBUNT, F.; ORD, S.; STAIRS, I.; LYNE, A. High Resolution Spatial and Timing Observations of Millisecond Pulsar PSR J0218+4232 with Chandra.

LAING, R.A.; BRIDLE, A.H. Dynamical Models for Jet Deceleration in the Radio Galaxy 3C 31.

LANG, C.C.; GOSS, W.M.; MORRIS, M. The Molecular Component of the Galactic Center Arched Filament H II Complex: OVRO Observations of the CS(J=2-1) Line.

LE POOLE, R.S.; MILEY, G.; JAFFE, W.; GLINDEMANN, A.; BAKKER, E.; WATERS, R.; ROTTGERING, H.; COTTON, B.; PERCHERON, I.; MEISNER, J.; DE JONG, J.; D'ARCIO, L.; HEIJLIGERS, B. NEVEC: The NOVA ESO VLTI Expertise Center.

LEDLOW, M.J.; SMAIL, I.; OWEN, F.N.; KEEL, W.C.; IVISON, R.J.; MORRISON, G.E. Gemini Multi-Object Spectrograph Observations of SCUBA Galaxies Behind A851.

MARSCHER, A.P.; JORSTAD, S.G.; MATTOX, J.R.; WEHRLE, A.E. High-Frequency VLBA Total and Polarized Intensity Images of Gamma-Ray Bright Blazars.

MARSCHER, A.P.; JORSTAD, S.G.; MCHARDY, I.M.; ALLER, M.F.; BALONEK, T.J.; VILLATA, M.; RAITERI, C.M.; OSTORERO, L.; TOSTI, G.; TERASRANTA, H. The Relationship Between X-rays and Relativistic Jets.

MENNESSON, B.; PERRIN, G.; CHAGNON, G.; COUDE DU FORESTO, V.; RIDGWAY, S.; MERAND, A.; SALOME, P.; BORDE, P.; COTTON, W.; MOREL, S.; KERVELLA, P.; TRAUB, W.; LACASSE, M. Evidence for Very Extended Gaseous Layers Around O-Rich Miras and M Giants.

MILLER, N.A.; OWEN, F.N. Evolution of Star Forming and Active Galaxies in Nearby Clusters.

MUNDELL, C.G.; WROBEL, J.M.; PEDLAR, A.; GALLIMORE, J.F. The Nuclear Regions of the Seyfert Galaxy NGC 4151 -- Parsec-Scale H I Absorption and a Remarkable Radio Jet.

OMAR, A.; CHENGULAR, J.N.; ROSHI, D.A. Multi-frequency GMRT Observations of the H II Regions S 201, S 206, and S 209.

PERLMAN, E.S.; STOCKE, J.T.; CARILLI, C.L.; SUGIHO, M.; TASHIRO, M.; MADEJSKI, G.; WANG, Q.D.; CONWAY, J. The Apparent Host Galaxy of PKS 1413+135: HST, ASCA and VLBA Observations.

RICHARDS, M.T.; WALTMAN, E.B.; GHIGO, F.D. Statistical Analysis of 5-Year Continuous Radio Flare Data from beta Per, v711 Tau, delta Lib and UX Ari.

ROSHI, D.A. Cancellation of TV Interference.

RUNION, G.; BRIDLE, A.; HUNT, G. Working Together Across the Continent with Video Conferencing.

SARMA, A.P.; TROLAND, T.H.; CRUTCHER, R.M.; ROBERTS, D.A. Magnetic Fields in Shocked Regions: VLA Observations of H2O Masers.

SAVAGE, C.; APPONI, A.J.; ZIURYS, L.M.; WYCKOFF, S. Galactic 12C/13C Ratios from Millimeter-Wave Observations of Interstellar CN.

SAVOLAINEN, T.; WIIK, K.; VALTAOJA, E.; JORSTAD, S.G.; MARSCHER, A.P. Connections Between Millimetre Continuum Variations and VLBI Structure in 27 AGN.

SETH, A.C.; GREENHILL, L.J.; HOLDER, B.P. Water Masers as Tracers of Protostellar Disks and Outflows in the Intermediate Mass Star Forming Region NGC 2071.

SHEN, Z.-Q.; MORAN, J.M.; KELLERMANN, K.I. The Central Parsecs of the Bright Quasar PKS 1921-293.

SKINNER, S.L.; ZHEKOV, S.A.; GUEDEL, M.; SCHMUTZ, W. XMM-Newton and VLA Observations of the Variable Wolf-Rayet Star EZ CMa: Evidence for a Close Companion?

PREPRINTS RECEIVED, JULY-SEPTEMBER 2002

SMAIL, I.; OWEN, F.N.; MORRISON, G.E.; KEEL, W.C.; IVISON, R.J.; LEDLOW, M.J. The Diversity of Extremely Red Objects.

SNYDER, L.E.; LOVAS, F.J.; MEHRINGER, D.M.; MIAO, N.Y.; KUAN, Y.-J.; HOLLIS, J.M.; JEWELL, P.R. Confirmation of Interstellar Acetone.

SPLAVER, E.M.; NICE, D.J.; ARZOUMANIAN, Z.; CAMILO, F.; LYNE, A.G.; STAIRS, I.H. Probing the Masses of the PSR J0621+1002 Binary System Through Relativistic Apsidal Motion.

STAIRS, I.H.; THORSETT, S.E.; TAYLOR, J.H.; WOLSZCZAN, A. Studies of the Relativistic Binary Pulsar PSR B1534+12. I. Timing Analysis.

STEVENS-RAYBURN, S.; BOUTON, E.N. How to Succeed in Astronomy Without Having to Use a Telescope, or a Librarian's Guide to High Impact Papers.

THORSETT, S.E.; BRISKEN, W.F.; GOSS, W.M. Decapitating the Duck: The (Non)association of PSR B1757-24 and Supernova Remnant G5.4-1.2.

ULVESTAD, J.S.; HO, L.C. A Search for Active Galactic Nuclei in Sc Galaxies with H II Spectra.

VAN DER MAREL, R.; ALVES, D.R.; HARDY, E.; SUNTZEFF, N.B. New Understanding of Large Magellanic Cloud Structure, Dynamics and Orbit from Carbon Star Kinematics.

VELAZQUEZ, P.F.; DUBNER, G.M.; GOSS, W.M.; GREEN, A.J. Investigation of the Large-Scale Neutral Hydrogen Near the Supernova Remnant W28.

VISSER, A.E.; RICHER, J.S.; CHANDLER, C.J. Completion of a SCUBA Survey of Lynds Dark Clouds and Implications for Low-Mass Star Formation.

WILLIAMS, C.L.; PANAGIA, N.; VAN DYK, S.D.; LACEY, C.K.; WEILER, K.W.; SRAMEK, R.A. Radio Emission from SN 1988Z and Very Massive Star Evolution.

WOOTTEN, A. The Atacama Large Millimeter Array (ALMA)

WOOTTEN, A.; MANGUM, J.G.; HOLDAWAY, M. Debris Disks, Planetary Systems, and the Atacama Large Millimeter Array.

YIN, Q.F.; HUANG, J.H.; ZHENG, W. Starburst Ages of Two W-R Galaxies.