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Quarterly Report January - March 2002

Executive Summary

ALMA

A Project Plan with scope, schedule, and cost consistent with information provided to the NSF, and with the funding schedule planned by the Foundation, was prepared as input to the ALMA Executive Committee. The AEC is to propose a joint Project Plan for adoption by the ALMA Coordinating Committee in April.

All major components of the prototype antenna have either been manufactured or are being manufactured now, with delivery expected at the end of July 2002. Plans for the testing of the antenna are in place.

Charles Cunningham has been appointed Head of the North American Front End Division, and will coordinate the Front End activities in Charlottesville, Tucson, and Victoria.

Major progress was made on the baseline correlator with the release to the foundry of the custom correlator chip.

EVLA

All hardware areas of the EVLA have now completed Preliminary Design Review (PDR) and are proceeding with design and prototype construction. The remaining PDRs, for Monitor and Control Software and Data Management Software, are scheduled for May and July 2002, respectively.

Green Bank Telescope

In late March, first tests of the active surface of the GBT were made using a look-up table of actuator positions generated from the structural finite element model (FEM) predictions. The aperture efficiency of the antenna was improved significantly, and is held essentially constant over a wide range of elevations.

Early scientific operation of the GBT shared time with commissioning activities. Observing programs included a number of pulsar studies, two runs in association with the VLBA, and a study of neutral hydrogen in a region near the Galactic Center.

Additional measurements of the azimuth wheel system revealed that the wheels exhibited a side-to-side rocking motion as they moved over a track joint. The issue is under careful study, and it is planned to replace a limited section of the grout which supports the track, to examine the suggestion that the grout is not supporting the track in the required manner.

Detailed testing, debugging, and repair of the spectrometer continues. Reduction in the level of spurious components of the 1600 MHz signal have been achieved, and the chip capacitors on the Long Term Accumulator boards are being replaced. The Prime Focus receiver and five receivers at the Gregorian focus were used during the quarter. Installation and commissioning of the cryogenics system are complete.

Software development focused on the effort to commission the system at 18-26 GHz (K-band). Control of the active surface was implemented. Additional capabilities were added to the Observer's Interface (GO) to allow for beam-switching and control of the K-band receiver. Improvements were made in other parts of

the control system, especially in certain functions in the servo system. Network controlled access has been implemented for the antenna, so the operator can control who has access at the lowest levels in the system.

Upgrades to the operating system Red Hat 7.2 were completed, and both the Monitor & Control and the AIPS++ systems were recompiled. The bulk of the networking infrastructure upgrades are now complete, and the replacement of coax segments by fiber connections was implements ahead of schedule in order to support the site-wide initiative in RFI suppression.

Good progress is being made on a number of development projects undertaken to support the GBT.

- The Precision Telescope Control System includes the laser ranging devices which will be used to measure the antenna pointing and surface deflections, and the Quadrant Detector, used to measure rapid motions of the Feedarm. Installation of the Quadrant Detector is planned for early May, with tests to follow later in the month.
- Design decisions have been reached on the dewar windows, IR filters, and Orthomode Transducers for the 3 mm receiver, and procurement of many other components is underway. Development work on the 1 cm (26-40GHz) receiver began in earnest.
- Design work continues on a beam forming array for the 18-21 cm band. A Memorandum of Agreement with the University of Pennsylvania to develop a 3 mm bolometer camera has now been signed, with the project expected to require three years.
- Projects were undertaken to suppress RFI from the GBT Feedarm Servo system and the GBT Laser Rangefinders. The design is mostly complete and parts are being fabricated.

A number of regular preventive maintenance duties were undertaken, including testing of the track grout, and modification of the track covers. An RFQ was issued and bids received for a weld and structural inspection plan. A plan is being developed for the painting of the GBT backup structure.

Green Bank Site Engineering, Operations, & Projects

Operation of the OVLBI tracking station concluded on February 28, 2002. The station had the best performance in the network of stations acquiring data from the VSOP/HALCA satellite, and demodulator equipment built by NRAO for the station was adopted for use by the DSN 11m subnet.

Progress on the Astronomy Education Center was good. The details are given in the Education and Public Outreach section of this document.

Very Large Array & Very Long Baseline Array

Three public tours, with a total of more than 2,100 visitors, were conducted at the VLA site; these were the first such tours since the 10-year anniversary of the VLA in 1990. A program was begun to retrofit new VLA 22-GHz feeds in order to correct a problem with moisture buildup inside the feeds. The rebuild of an azimuth bearing previously removed from antenna 17 has been completed. Replacement of the VLA's

1987-vintage Modcomp computers by newer Modcomps has been completed; this will serve as a bridge to the revamped Monitor/Control system for the EVLA.

Eight new public computers with dual 1.7 GHz processors have been installed for visiting astronomers. Video conferencing capabilities have been greatly enhanced, with a total of three facilities now available in Socorro and one at the VLA site. VLBA station computer software was updated, with no significant problems. A prototype VLBA data-calibration service has begun, with data from experienced observers being used for tests. Electronics modules have been built to enable VLBI use of the VLA antenna that "donates" its back-end racks to the Pie Town link; since another antenna no longer needs to be given to the VLBA, this now enables use of 27 antennas (26 at the VLA and 1 at Pie Town) during VLA-Pie Town link observing.

Central Development Laboratory

Good progress has been made in the design and development of SIS mixers for several ALMA bands. The first wafer for the 84-116 GHz band was successfully fabricated at UVA and sent to the Herzberg Institute of Astrophysics. It now appears as if the four-chip balanced sideband-separating mixer for the 211-275 band (Band-6) is feasible, and has given good performance in tests. A new single-ended mixer for the band is being designed to take advantage of the improved circuit fabrication process now in use at UVA.

Tests of the ALMA 4-12 GHz preamplifier prototype showed a tendency to oscillate at about 3 GHz. The problem was associated with the mounting of the mixer-preamp and has been solved. Another approach is being developed in collaboration with SRON, and involves an NRAO model of the SRON mixer using a linear microwave simulator. Initial results have been encouraging.

The exploration of the use of an overmoded waveguide between the output of the LO multiplier on the 70 K stage and the Band-6 mixer at 4 K has been disappointing, with efforts to damp out higher mode resonances showing no substantial improvement. Alternative coupling schemes will be considered. Work continued on the programmable Band-6 LO source. All RF components have been assembled on a mounting plate, and all power supplies and bias cards have been installed in a chassis which is now being wired.

The Dewar used to test SIS mixers developed problems, the solution of which led to the development of a new, connector-less heatsink. A second test Dewar incorporating the improved heatsink has been fabricated. A new analysis of the feed system at 3 GHz was made for the EVLA. Feeds for the GBT for use at the bands 68-92 GHz and 26.5-40 GHz were designed.

All three of the pulsar logic cards to support pulsar observations with the GBT spectrometer have now been tested in the system. Other work on this spectrometer concentrated on the checkout of several modes of operation. Work continued on a system to stream VLBA data from a VLBA playback unit onto a high-density computer RAID disk. Logic design for the ALMA station control card was finished, as was the design of cards for the station bin power and the correlator card power. Preliminary design is in progress for the ALMA station bin motherboard, the correlator bin motherboard and the signal cable paddle board.

Work continues on the development of 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 ALMA receivers. The multipliers use varactor and varistor circuits operating in the range of 50 to 950 GHz, and are also currently being developed. The effort is focused on a 80/240 GHz tripler, and a 110/220 GHz doubler, the latter a collaboration with JPL and the University of Michigan.

Major progress has been made in the design of the superstructure of the fully-sampled, focal plane array feed intended to provide an imaging capability for the GBT at a wavelength of 21 cm. Preliminary designs for the antenna, ground plane, dewar configuration, and support structure that meet the stringent size and weight restrictions imposed by the GBT prime focus location are well under way. A rudimentary design for the low-noise amplifier has been completed.

Data Management

Good progress has been made in the e2e project. A definition of the initial scope of work has been completed and the corresponding development cycle has been started. The goals are to develop an interim archive for the VLA, and an interim pipeline which can move data in and out of the archive.

The prototype archive is being based on the AIPS++ MeasurementSet data holder. Because of this it is anticipated that the system will be portable to other radio observatories. Discussions with the ALMA group will explore areas of common interest. The GBT archive will also be developed by e2e.

The EVLA project is one of the customers of the e2e project, and hence e2e staff participate in the EVLA coordination and review meetings.

The primary focus of the Data Management Technology Development is the management of the AIPS++ project. The current emphasis is on scientific completeness, usability improvements, and enhancements in performance and robustness. An important component of this management is to achieve a close collaboration with the scientific testers. Good progress has been made in the evaluation test of AIPS++ with data made from the IRAM interferometer on Plateau de Bure. Additional activities include a series of tutorials and the publication of a user newsletter. Another strong priority is the GBT, where a significant effort has been devoted to the direct support of the commissioning activities.

The effort to improve the security of the computing environment continues. Past efforts have successfully reduced the number of break-ins to two, both minor. The current concern is with the use of protocols such as telnet which cannot encrypt account passwords. Other areas in which progress has been made include the effort to ensure a common computing environment for both UNIX and Windows systems, the evaluation of a commercial facility scheduling tool, and the improvement of Web services.

The deployment of the new video conference equipment was completed this quarter. All ten systems are now in regular use. The contract for intranet services was extended for another year, to provide an additional period for the evaluation of other options for this service.

Education and Public Outreach

Construction is underway on the Green Bank Astronomy Education Center, funded jointly by the NSF and NASA. The total project is about 17 percent complete, and construction is expected to be finished December 15, 2002. The facility will serve the dual purpose of a visitor center for the general public and an education center for K-16 programs. An associated Astronomy and Education Center Dormitory is under design, and the 90 percent Design Review is scheduled for April 2002.

Three special public tours of the VLA were held this quarter, and attracted 2100 visitors. It has been recommended that the Visitor Center be augmented with the addition of a gift shop, and the possibilities are being explored.

Development of a comprehensive and user-friendly image gallery has begun. This will be a searchable database with white papers and descriptive paragraphs on the astronomical objects.

Green Bank

Detection of the youngest radio pulsar - 3C58: The GBT has been used to detect radio pulsations from the 820-year old X-ray pulsar at the center of the supernova remnant 3C58. This is the youngest radio pulsar yet detected. The pulsar was detected at both 820 MHz and 1375 MHz, and is only the second detection of a pulsar in the 800 MHz frequency band. The pulse averaged flux density of the pulsar in the 1400 MHz band is only 45 μJy, and is among the weakest one percent of radio pulsars ever detected. The detection provides important information about the luminosity function of young pulsars. The ability of the GBT to make weak detections of this sort opens a new region of phase space to a significant detection potential.

Investigators: *F. Camilo (Columbia), I. Stairs (NRAO), D. Lorimer, M. Kramer, M. McGlaughlin (Jodrell Bank), D. Backer (UC, Berkeley), S. Ransom (McGill Univ.), B. Klein, R. Wielebinski, P. Muller (MPIfR), Z. Arzoumanian (NASA-GSFC).*

Very Large Array

NVSS Shows Effect of Galaxy's Motion Through the Universe - The standard cosmological model has passed another test, performed using data from the NRAO VLA Sky Survey (NVSS). The dipole temperature anisotropy in the cosmic microwave background (CMB) has indicated the Milky Way is moving at about 370 km/s with respect to the "rest frame" of the universe. If the standard model is correct, a similar dipole should be seen as an enhancement in the surface density of distant galaxies in the direction of motion. Using the NVSS data, investigators found just such an enhancement, in the same direction as the CMB's temperature dipole. Detecting this enhancement, at about the 1 percent level, required first subtracting nearby radio sources from the NVSS data, leaving only sources presumed to be at cosmological distances.

Investigators: *C. Blake and J. Wall (Oxford).*

Very Long Baseline Array

VLBA Reveals Magnetic Field Changes in Blazar Jets - A 6-epoch high-frequency polarimetric monitoring program was carried out on 12 blazars, highly variable radio sources that are thought to have relativistic jets pointed nearly along the line of sight to the Earth. The polarization in the cores of several objects changes orientation by large amounts at both frequencies within a year, indicating significant changes in underlying magnetic field structure. Features in the parsec-scale radio jets of the blazars often increase in fractional polarization with time, and show a tendency for increasing alignment of the magnetic field axes with the jet axes. This suggests that the order in the longitudinal magnetic fields increases as the jets propagate away from the central black holes that power the blazars. The research, enabled by the VLBA's unique capability of repeating similar VLBI imaging at regular and frequent intervals, was published in the March 20, 2002, issue of *The Astrophysical Journal.*

Investigators: *D. Homan, R. Ojha, J. Wardle, D. Roberts (Brandeis University); M. Aller, H. Aller, P. Hughes (University of Michigan)*

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.

A considerable effort was expended by the ALMA(U.S.) project, NRAO, and AUI management during the quarter to devise a Project Plan that was consistent with the scope of work, schedule, and cost presented to the NSF and with the planned funding schedule in the FY2003 budget submitted by the President to the Congress. That plan was given by the North American side to the ALMA Executive Committee, which is charged with presenting an ALMA Project Plan for adoption by the ALMA Coordinating Committee at their April 19-20 meeting.

VertexRSI has revised the scheduled delivery date for the prototype antenna to July 29, 2002. The delivery date includes completion of all contractor acceptance tests. This slip in schedule is due to the late delivery of some built-in components such as the Invar cone and shipment of the mount/receiver cabin structure. The production of primary reflector panels is the critical path of the antenna delivery. Various efforts are being made by VertexRSI to do as much integration work in the shop as possible in order to improve the on-site performance and delivery date. No major technical problems have arisen. Progress continues to be made in all areas. All major components are either manufactured or being manufactured at this time with a scheduled delivery consistent with the revised delivery date.

Plans for the testing of the antenna following completion of the acceptance tests have matured. VertexRSI has agreed to help mitigate the impact of the schedule delay by agreeing to share access to the antenna prior to acceptance. This will allow early integration of the ALMA software with the antenna, as well as provide an opportunity to begin installation of cables, cryogenics, and refrigerant lines. This shortens the time between completion of the contractor acceptance tests and the start of antenna evaluation.

We are pleased to report that Charles Cunningham of the Herzberg Institute of Astrophysics (Victoria, Canada) has been appointed Head of the North American Front End Division. Charles takes over from John Payne, who will concentrate on coordinating the critical developments in the Photonics area. Charles will coordinate all of the Front End activities being carried out in Charlottesville, Tucson, and Victoria. In addition, he will participate in the overall leadership of the Front End IPT, serving as the Deputy IPT Leader. This is an exciting example of the close cooperation among the North American ALMA partners.

Major progress was made on the baseline correlator with the release to the foundry of the custom correlator chip. Prototype quantities of these chips will be available in May. The printed circuit card to accept these chips is complete. It has 10,500 power connections, 7,500 signal connections, and 20,000 plated-through-holes. It has already been extensively tested without the correlator chips installed. Final tests will be completed after the chips are installed this summer.

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
Complete Q-band build	12-31-02		
Complete K-band build	12-31-02	06-30-03	
Continue development of 10 Gbps fiber optic link for ALMA project; work may transfer to EVLA project	12-31-01	03-30-02	
Build and install five more 7mm receivers	01-31-01	01-30-03	
Start trench fiber installation	08-01-02	10-01-02	
Array fiber termination panel installation	09-01-02		
Trench fiber installation complete	09-01-04		
Demonstrate RFI from samplers and fiber optic transmitters can be reduced to acceptable levels	12-31-01	04-30-02	
Monitor RFI environment at VLA 1 - 18 GHz	12-31-01	05-17-02	
Develop block diagram for M&C, wye alarms, voice communication (DCS, LO/IF, Comp. Div. ES Div)	12-31-01	03-30-02	03-12-02
Build second "SOIDA" receiver test stand	12-31-01	07-15-02	
Test WVR on antenna	12-31-01	06-30-02	
Modify helium lines to facilitate testing new receivers (Cryo)	01-31-01	01-31-03	
Test higher volume helium compressor (Cryo)	12-31-01	04-15-03	
Test vacuum pump upgrade (Cryo)	12-31-01	04-15-03	
M/C engineering requirements version 2	03-15-02	04-30-02	
M/C operations requirements version 2	03-15-02	04-17-02	
Selection of RTOS	04-30-02		
Complete construction of fiber termination room	06-01-02		03-05-02
LO/IF PDR	01-22-02		01-22-02

Milestones	Original Date	Revised Date	Date Completed
Feed/Rx PDR	02-12-02		02-12-02
Requirements for correlator back-end	03-05-02		03-05-02
Build prototype Beowulf System	05-30-02		
M/C Hardware PDR	03-15-02		03-14-02
M/C Software PDR	03-15-02	05-15-02	
Start WIDAR correlator architecture	04-15-02		
Earn value baseline schedules complete	04-19-02		
Array fiber trenching plan complete	05-09-02		
Fiber cable installation internal CDR	05-09-02		
Bid award of array fiber cable	05-10-02		
Correlator M/C MIB selection	05-13-02		
C-band OMT analysis complete	05-17-02		
Vertex room mockup complete	05-24-02		03-15-02
Rack/bin/module internal design review	06-04-02		
Correlator MIB RTOS selection	06-13-02		
Start prototype testing of 8-bit sampler	06-17-02		
Antenna RTOS on development board	06-19-02		
Hardware & software interface control documents complete	06-24-02		
Feed cone prototype complete	06-28-02		
Overall data processing architecture PDR	07-16-02		
Array fiber delivered and tested	07-16-02		
Preliminary antenna fiber wrap design complete	08-01-02		

Management

The Project Book and Work Breakdown Structure were put under revision control March 1. The project has in place a Change Control Board to review and approve significant design, cost, and schedule changes. An earned value analysis of the level 2 detailed schedule is proceeding for measuring work progress against the project budget.

The members of the EVLA External Advisory committee were appointed and the date for the first meeting of the Committee, in June 2002, was settled.

Electronics

Preliminary Design Reviews (PDR) have been conducted for the LO/IF, Front End, and Monitor & Control hardware areas of the project, completing the hardware PDRs. The plan for the phased-locked LO synthesizers has been reworked as a result of the reviews. Concerns about 2:1 bandwidth ratios and orthomode transducer interfaces are being studied. Results of the reviews are available via the EVLA Project Web page. Development of a prototype design is proceeding with plans to install the equipment on a test antenna 2Q 2003.

Construction of new K- and Q-band receivers proceeds under the aegis of the Expansion Project and the schedule calls for completing the deployment of both on the VLA by the middle of next year. This is somewhat slower than originally planned because manpower has been diverted onto other, more urgent, EVLA receiver design tasks. Currently, there are 25 Q-band receivers and 19 K-band receivers deployed. To facilitate testing of the new receivers, a second test stand has been assembled.

Monitoring of the RFI environment at the VLA from 1 – 8 GHz has been completed. The work included a thorough study of the FAA DME transmissions in the 1 – 1.2 GHz region. Plans are to continue the monitoring from 8 –40 GHz this year. To conduct the monitoring, the "front end" for the monitoring system was completely rebuilt to provide remote control, lightning protection, and calibration sources. A surplus spectrum analyzer is being used for the signal measurements. A shielded chamber has been installed at the VLA for RFI testing of all new electronic equipment to be installed at the VLA.

Installation of fiber optic communication cables for the VLA is planned for this year and the procurement process has been initiated.

A 3-channel K-band water vapor radiometer has been bench-checked satisfactorily, the main criteria being a gain stability of 1 part in 10, 000 over a period of 1000 seconds. Two prototypes will be built and checked on the sky this year.

Computing

Further refinement and reconciliation of the labor figures for the Monitor and Control effort were supplied in early 2002. Much time was spent discussing the Module Interface Board (MIB) selection for the antenna M&C system, and the Real Time Operating System (RTOS) to run on this MIB. To some extent, this discussion applies to the correlator M&C MIBs as well. We expect to make choices in all these areas during the second quarter of 2002. An initial draft of a requirements document for the correlator backend was published March 5, 2002.

The EVLA M&C hardware PDR was held in March, with contributions by the computer division. The M&C software PDR was moved from March to May to allow time to complete the required work, and the deadlines associated with this were moved accordingly.

Engineering Services

The antenna vertex room mockup is complete and a prototype K-Band redesign has been released for fabrication. RFQ's for Feed Cone panels and extruded shapes have been issued. Preliminary design for the Laminated Horn Ring machine is complete and is almost ready to build.

The Shielded Chamber was erected, with minor electrical work and the installation of an isolation fence remaining. The fiber termination panel room is made ready and conduits to the first fiber manhole are installed. The fiber installation project has slipped to October due to fiber delivery delays. Three major fiber installation acquisitions have been made with the purchase of a grader, a backhoe and a trencher. Delivery of all three items is expected by the end of June.

Correlator

(Report from Canadian Partner)

EVLA correlator project activities in the last quarter have mainly involved gearing up for full development and going through a new round of detailed budgeting and planning for the Canada Foundation for Innovation (CFI) grant application to fund the correlator. A dozen or so telephone and on-site interviews of engineering candidates were performed. This was a successful process with the result that the first new hardware engineer started on February 4, and the second hardware engineer started on April 2. In addition to engineers, the Mentor Graphics EDA tools have been selected for chip and printed circuit board development. These are top-of-the-line (and expensive) tools that are believed necessary to ensure successful implementation of high-speed correlator circuitry. Recently, design work has commenced using these tools. In mid January, a full grant application for correlator funding was submitted to the CFI. In early May, the CFI board will meet with external referees to discuss the project and a funding decision will be made shortly thereafter. Because of its high rating in Canada, optimism is high that the project will be funded.

Antenna

Milestone	Original Deadline	Revised Deadline	Date Completed
Install lower feed arm lasers	09-15-00	09-01-02	
Measure az track profile	09-15-99	06-01-02	
Install optical guide scope	04-30-01	06-01-02	

GBT Mechanical Engineering and Central Instrument Shop Work

Milestone	Original Deadline	Revised Deadline	Date Completed
Design & fab. feed arm laser rangefinder handling container.	08-24-01	02-28-02	02-15-02
PF2 Dewar mount & cart	11-09-01	01-30-02	01-25-02
GBT Access Ladder Modification	01-30-02	04-15-02	
Design & fab. feed arm laser rangefinder cover.	09-28-01	06-15-02	
Design & fab. quadrant detector mount	04-18-02	05-01-02	
Servo RFI Box	02-28-02	06-20-02	
Ka band OMT's (3)	04-30-02		
Ka band Phase Shifter (4)	05-30-02		
Ka band Transition Mandrel	05-15-02		

GBT Software and Computing

Milestone	Original Deadline	Revised Deadline	Date Completed
Observer (GO) interface completion	03-23-01	06-01-02	
Prepare for visiting observers	06-30-01	06-01-02	

GBT Operations

Milestone	Original Deadline	Revised Deadline	Date Completed
Operations of GBT from Jansky Lab	08-01-01	01-18-02	01-28-02
Begin four maintenance days per week	01-07-02		01-07-02
Decision on use of GBT Warehouse	02-15-02		02-15-02

Milestone	Original Deadline	Revised Deadline	Date Completed
VLBI observing capability at L and S Bands	02-15-02		02-15-02
Six-month structural inspection plan for GBT	07-30-01	06-01-02	
Decision on date of 20m Mothball	03-30-02	06-01-02	
Six month Inspection of GBT welds /structure	06-30-02	11-01-02	
Implementation of calc of monthly stats in Ops Log	06-30-02		
Expansion of Cable Building complete	07-01-02		
Begin three maintenance days per week	07-01-02		
Refinement of GBT painting plan	07-01-02		
Repair bowed GBT BUS member	09-01-02		
Complete implementation of maj tasks in Ops Log pgrm	10-01-02		
Continued site access improvements	12-31-02		

GBT Project Summary

Scientific Commissioning Status

In the past quarter, the staff has concentrated on developing observing capability in the 18-26 GHz (K-band) range. This has required development in a number of areas, including the K-band receiver itself, implementation of beam switched observing in regard to pointing control, receiver configuration, and data reduction. It has required development of the 800 MHz Spectrometer bandwidth mode which is needed for the first observing projects. Perhaps the most major, new requirement is that the active surface of the GBT be implemented in open loop control using the structural finite element model (FEM) predictions.

This development program has proceeded extremely well. All individual requirements for K-band observing have been completed, and the system is being integrated and tested. The active surface work has been particularly successful. In late March, first tests of the active surface were made using a look-up table of positions generated from the FEM. The aperture efficiency of the antenna was improved significantly and is held at a level of ~55±5% at elevation angles from ~15-85 degrees. Sidelobe structure of the beam was also significantly improved. The successful use of the active surface is a major milestone in GBT development and paves the way for further development to higher frequencies.

Early scientific operation of the GBT has shared time with commissioning activities. In late January, the first visitor spectral line observing session was conducted. Neutral hydrogen observations of a region near the Galactic Center were successfully made. A number of pulsar observing runs were also conducted and have yielded several new detections and timing results, such as the 3C58 result described in the Science Highlights section. We have established VLBI capability on the GBT, and are able to process VLBA observing scripts. Two regular VLBA observing proposals were conducted in February and March. Additional excellent continuum images at 9 GHz were obtained in the first quarter. The GBT continues to

prove itself an outstanding imaging instrument, which is a direct consequence of the unblocked aperture design.

In the coming quarter, emphasis will be on refinement and consolidation of observing capabilities. During the summer months, observing will be primarily at frequency bands below ~10 GHz. We will concentrate on instruments, facilities, and procedures relevant to these frequencies.

Azimuth Track

As reported last quarter, some issues have arisen with the condition of the azimuth track and the grout that supports it atop the concrete ring wall. Late last year and during the first quarter of this year, it was noticed that gaps had appeared at the upper and lower surfaces of the grout in many places. After a rain, water was observed to be squeezed out of these gaps as the azimuth wheels rolled over the areas. There was also evidence of particulate matter emerging with the water, particularly in the area of the splice plates that form the supporting structure underneath joints in the track. In March, it was further observed that as the azimuth wheels rolled over a track joint, they exhibited a slight side-to-side rocking motion. There was also evidence of unexpectedly large wear in the track wear plates in the vicinity of the joints. Together, these things indicated a loosening or deterioration of the grout, particularly in the splice plate area.

The Observatory notified the contractor of these problems in February, and requested that they be addressed as a warranty issue. The contractor is considering this request. The Observatory also contracted with an established structural engineering consulting firm, Modjeski and Masters, to test the grout and advise on any possible remedies that may be required. This issue is still under careful study, but it is possible that a grout replacement program may be required this summer. It is likely that these activities can be combined with other planned summer maintenance activities so that the net, additional down-time for the track work can be minimized.

Contract Close-Out Status

The contractor's remaining punch-list items on the GBT construction contract have been completed and contract closeout is underway. The warranty on GBT systems as a whole expired on 1 April 2002. The grout issue described above is currently under negotiation with the contractor.

GBT Electronics Development

GBT Spectrometer Hardware

Detailed testing, debugging, and repair of the spectrometer continues. To date, the 50 MHz 2 IF 1-, 2-, and 4-quadrant modes have been tested. Work is underway on the 800 MHz 2 IF modes. Modifications to the 1600 MHz phase-locked loops in the samplers have been designed and tested. These modifications

reduce the levels of spurious components of the 1600 MHz signal by at least 30 dB, and tune the loop bandwidth to take better advantage of the phase stability of the VCXO. A printed circuit board was designed to accommodate the required supply filtering. Due to many repair and testing tasks on the spectrometer, this task is still to be completed. To enhance reliability, chip capacitors on the Long Term Accumulator boards are being replaced. To date, eight of the ten have been completed.

Other Back-ends

The Spectral Processor was used this quarter for debugging and RFI measurements, and is ready for general use as a GBT backend. The Digital Continuum Receiver has also been in regular use by the GBT commissioners. Several VLBI runs were made.

Front-ends

The Prime Focus receiver (300 - 800 MHz) was in use this quarter. It was removed from the telescope to repair some defective PIN diode switches. It was returned to the telescope and resumed observations.

The L, S, X, Ku, and K band Gregorian focus receivers were in use during this quarter. Maintenance was provided on all of them. The L band receiver was removed from the telescope and fitted with a notch filter to remove a radar signal from the band. This filter is switchable through software control. The K band receiver will be removed this summer for repair work internal to the dewar. The Q band and C band receivers are in storage. The C band receiver is to be installed in April.

LO/IF Systems

The LO/IF systems were maintained this quarter. A synthesizer was sent to Agilent for repair, and two of the IF fiber optic links were repaired due to failed RF components. All eight links are currently operational.

Cryogenics

Installation and commissioning of the cryogenics system at the GBT are complete. All lines have been cold-trapped. Several receivers have been cooled. Five of six compressors are installed, and the sixth is being built.

GBT Computing and Software Development

GBT Software Development

Although there remains a significant amount of bug-fixing and reliability improvements to be made for L-band observing, the decision was made at the end of 2001 to push on as rapidly as possible to K-band, to allow commissioning and some science observations before summer 2002. This has driven the majority of the software group efforts for the reporting period.

Effective observations at K-band (18-26GHz) require open-loop control of the Active Surface. Software was implemented to derive actuator demands from the antenna FE model, appropriate for the elevation midpoint of the scan, and send these to the Active Surface Control Software (ASCS). The interface to, and reliability of the ASCS itself was significantly improved as a result of testing early in the year, and this is now robust and reliable. Preliminary astronomical tests of the active surface were made on 27/28th March; the systems worked well and the initial results (improvements of efficiency at low and high elevations) look extremely encouraging.

In other K-band work, functionality was added to GO (the Observer's Interface) to allow set-up for beam-switching and control of the K-band receiver. Although considerably more work on configuration remains to be done, it is now possible to configure all the standard switching schemes and command K-band observations through GO. The Spectrometer auto-leveling software was generalized to apply to all receivers (prior to this, it was only available for L-band). Preliminary software development for K-band observing is now complete (ahead of the schedule planned in January). We now plan to spend some months consolidating all released observing modes and capabilities from prime-focus through K-band, to generally improve the ease, reliability and efficiency of observing.

Apart from the K-band work, progress was made in a number of other areas. Considerable work has been done to improve antenna control functionality. Much of this work was done at the servo level, and included cleaning up a number of important areas of functionality that had not been addressed by the contractors. These included adding motor controller fault and over-speed checks in the servo; improvements to the stow/unstow capabilities; the ability to move to snow-dump at slow rate; and a variety of other more minor features.

The IF Manager software was upgraded to allow it to act as a "signal path server," providing information on the I.F. connectivity for other Managers (e.g., LO1) as required. At the same time, significant speed improvements have been made to the calculations of the I.F. paths, and the ability to chart these on demand through CLEO. This facility now provides a greatly enhanced diagnostic capability.

Firmware modifications have been made to the Spectrometer to improve serial-line communications, and to correct some blanking problems during frequency-switching. Similar problems have also been found and corrected in the DCR; these are indicative of a number of short-comings in the handling of switching signals in general. All of these have work-arounds, but this area will need a more systematic review at some

point. The port of the LO1 system to linux, as described in the previous report, has been put on hold due to the higher-priority K-band work.

Network controlled access has been implemented for the antenna, so that the Operator can control who has access at the lowest levels in the system (a higher level of access control is also available through CLEO). A number of bug-fixes have been made for the Spectral Processor. The BCPM machines have been upgraded to Solaris 2.8. After some months of limping along with minor problems, a thorough review was made of the Interim Analysis and Real-time Display System (IARDS), and a number of problems in the glish communication facilities identified and cured. The system has been much more reliable in recent months. After remaining GBT linux machines were upgraded to RedHat 7.2, both the Green Bank AIPS++ installation, and subsequently the M&C software was recompiled, built and installed under RH7.2. With the almost complete shift to linux for user machines, support for the Solaris version of AIPS++ has been dropped in Green Bank.

Software support for the PTCS project continues, as described in the separate project report.

Finally, a concerted recruitment exercise took place throughout the quarter to recruit the three positions (Head of Software Development and two software engineers) which were still open at the start of the year. The interviewing and selection process took a significant amount of time on the part of all the current group members. In the end, two excellent candidates were identified. Nicole Radziwill began work on 25th March as Head of the Division; Melinda Mello will start work in April as a Scientific Programmer Analyst. The third position is under review. These new staff are extremely welcome additions to the group, and will allow us to make considerably more progress in the coming months.

Green Bank Computing

This quarter has been a period of much-needed consolidation for the Green Bank Computing Division. The upgrades to Red Hat 7.2, the installation of new machines, and the "trickle" down of old ones, as described in the previous report, are now complete. This trickle-down has allowed us to assemble a number of 200MHz class Pentium machines, and donate them to the local school. Although basically obsolete, these are better than the 486 class machines they have been using! Ten new Dell workstations have been specified and ordered; these start the next round of desktop replacements. They will initially be used for summer students/teachers, and then redeployed to the most deserving permanent staff members.

With the addition of new engineering staff, the pace of RFI suppression work has significantly increased. In support of this, a number of site-wide overnight computing equipment shut-downs were held. This was made possible due to the fact that all essential servers are now in the shielded room. After these preliminary tests were complete, normal operating practice resumed, but we will need to develop much stricter guidelines for the power-off of computing equipment in the coming months.

The bulk of the networking infrastructure upgrades are now complete; the remaining work is at the level of ongoing maintenance. Replacement of a number of coax segments by fiber connections was brought ahead of schedule to support the RFI work described above.

Green Bank only has two systems administrators, one for each of Windows and Unix, and so their work is dominated by ongoing operational support. However, both have managed to make time to assist in the NRAO-wide common computing environment (CCE). Charlie Myers has been active in the design, testing and deployment of the Windows 2000 domain with Active Directory, including a trip to Tucson to participate in a face-to-face planning meeting. Wolfgang Baudler has now come up to speed on the Unix side of the CCE, and is contributing especially in the area of kickstart and patching mechanisms. Finally, after an intensive recruitment exercise a candidate, Chris Clark, has been identified for the vacant Head of Computing Division. This recruitment is contingent on Chris successfully obtaining a work visa, but if all goes well he will start work in June 2002.

GBT Development Projects

Precision Telescope Control System (PTCS) Project

The main focus of this work in the last three months has been to complete the development and deployment of the Quadrant Detector. Initial characterization of the laser/detector combination in the metrology lab is now complete. The precise locations of the laser and detector on the antenna have been decided, and a clear line-of-sight through the backup structure confirmed, including the location of the hole in a surface panel. Mechanical designs for the mounts and enclosures are complete, and these are currently being fabricated in the Central Instrument Shop. Measurement and Control system software is in development. We continue to plan for installation on the antenna by early May, and plan our first series of instrument tests and feed-arm characterizations for late May.

As a stepping stone to the complete precision measurement system, we have much more clearly defined the concept of the Engineering Measurement System (EMS). This will be a complete system which will allow routine and straightforward scheduling of the rangefinders and delivery of deduced XYZ positions in near real time. The EMS will interface to the rangefinder software through standard IPC mechanisms, and be implemented in Matlab to allow rapid development and prototyping. The algorithms to convert from raw ranges to XYZ positions will build on those currently being developed by Don Wells. The EMS will serve three purposes: making astronomically significant measurements, e.g., alidade collimation errors, that can be compared to traditional pointing model parameters; to allow the metrology group to easily perform the rangefinder measurements required for the antenna performance measurement program; and to allow exploration of the algorithms needed for robust estimation of antenna parameters, which will be required for the production system.

Don Wells continues to work on the phase-closure experiments described in the previous report. The rms residuals remain at the 200μm level; since we have not been able to find any errors in the analysis, we now suspect more firmly a problem with the data (perhaps in the rangefinder calibrations).

Stimulated by the desire to proceed with the EMS, the metrology group has started performing weekly tests of the ground rangefinders. These have shaken out a number of software and hardware problems, which are being addressed as they occur.

In support of the K-band (18-26GHz) observing campaign, we implemented a prototype system to derive actuator demands from the FE model as a function of elevation. These are sent at the start of each scan to the Active Surface Control System, which had a major overhaul during the reporting period. Preliminary efficiency measurements made of calibrators at high and low elevations (on 27/28th March) indicate that this system is working extremely well.

3 mm Receiver Module 1

Work on the 3 mm receiver has proceeded well in the past quarter. This receiver will ultimately have two modules, the first covering the 68-92 GHz band, and the second the 90-116 GHz band. Module 1 is funded for construction and will be a dual-beam, dual polarization, pseudo-correlation receiver having excellent continuum and spectral line performance. In the past quarter, design decisions have been reached on the dewar windows, IR filters, and Orthomode Transducer (OMT) designs. Most other components are specifically identified and procurement is underway. The OMT will be developed at the NRAO Tucson facility. The feeds will be under manufacture in the NRAO Central Instrument Shop in Green Bank. A Critical Design Review is expected in early autumn.

1 cm Receiver

Development work on the 1 cm (26-40 GHz, or Ka-band) Receiver also began in earnest this quarter. The project had previously passed its preliminary design review in the previous quarter. This receiver will have a similar design to the 3 mm receiver Module 1, that of a dual-beam, dual-polarization, pseudo-correlation receiver.

Beam Forming Array

Another priority development project for the GBT is the beam forming array. This is a research and development project that will result in a 7-19 beam receiver for the 18-21 cm wavelength band. The receiver uses a packed array of planar feeds that sample the electric field in the focal plane. The beams on the sky are formed electronically and can be configured for full sampling. Work on this project is being done in Green Bank, the Central Development Laboratory and the University of Virginia. Details of current work are provided in the CDL section of this report.

Penn Array Bolometer Camera

In late February, the NRAO signed a Memorandum of Agreement with the University of Pennsylvania to develop a 64-pixel, 3 mm band, bolometer camera for the GBT known as the Penn Array. This project is part of the university-built instrumentation initiative in which the NRAO is funding the construction of unique instrumentation for the GBT. This project has developed as a collaboration between UPenn, NASA-Goddard Space Flight Center, and the NRAO. The project duration will be approximately three years, and the total cost as funded by the NRAO will be approximately $530k.

RFI Suppression

Two full-time EMI/RFI engineers started work in early January 2002 to assist in the RFI suppression efforts and NRQZ management. In addition to these new full time people, several engineers, technicians, and scientists have been laboring on this task for the last quarter. This quarter we continued suppressing locally generated RFI. Projects were undertaken to suppress RFI from the GBT Feedarm Servo system and the GBT Laser Rangefinders. The servo system RFI reduction design is mostly complete, and many parts are currently being fabricated by the Central Instrument Shop. Installation of this will be done this spring or summer. The prototype Laser Rangefinder RFI improvement parts have been fabricated by the Shop and are awaiting technicians to retrofit one system before releasing the remaining 19 systems to production. This project is slated to take the remainder of 2002.

GBT Mechanical Engineering Development

During the first quarter the Mechanical Engineering Division continued supporting RFI mitigation by fabricating prototypes of a laser range finder cable pass through, and a new RFI servo cable pass through box. A modification to the main telescope access ladder will be completed next quarter. Work is progressing on the Quadrant Detector mounting design and fabrication and the entire system is expected to be installed by 5/1. Work was complete on a cart to ease the handling of the prime focus receiver Dewars. Work has also begun on Ka band phase shifters, OMT's, and transition mandrels for the GBT Ka band receiver.

GBT Operations Summary

Telescope Operations Personnel Changes

During the first quarter of 2002 the OVLBI position was terminated; the operator was kept on part-time for an additional two months. One GBT operator (a GB operator of more than 30 years) retired in January 2002.

GBT Operations Documentation

Development and updating of operational procedures documentation continued. Areas of the documentation started or updated involve many operational and preventive maintenance procedures and information specific to operations. Documentation of the preliminary operators electronic logging system was completed in the first quarter.

GBT Maintenance

The decision on the location of the telescope mechanics' offices was made during the first quarter of 2002. The cable building will be expanded to house the mechanics' offices (mid to late 2002) and will represent their reporting station and coordination point at the beginning of each work day. The GBT warehouse will hold most of the GBT spares and will act as temporary coordination point for specific GBT tasks.

The number of regular preventative maintenance duties continued to increase during the first quarter, especially inspections. Regular maintenance activities included receiver and feed changes throughout the quarter. The one member found in last quarter's inspection of the top 20 critical/high fatigue members with a detectable problem (very slight bow) will be fixed during the third quarter of 2002.

Expansion of GBT access stairs and leveling of ground around foundation was completed during the first quarter of 2002. Other activities undertaken during the first quarter were (a) testing of the track movement and grout analysis, (b) the fabrication, installation and repair of the GBT track covers, (c) fabrication and installation of track cover skirts, (d) fabrication and installation of GBT foundation skirts started, (e) investigation of grout problems at JPL and assessment of their relevance to GBT grout problem.

An RFQ was issued and bids received for a weld and structural inspection plan. The current goal is to have the contract for the plan issued during the second quarter with a plan in hand during the first part of the third quarter. The target for the completion of the six-month inspection is the end of 2002. Work continued on refining the GBT spares list especially for the GBT elevators.

Preliminary bid estimates for painting of the GBT BUS structure were received from four potential contractors. The high cost forced reevaluation of the possibility of NRAO performing the painting. A preliminary plan using summer temporaries was completed during the first quarter. The plan will be refined during the second quarter of 2002.

The number of scheduled maintenance days per week was reduced from five to four at the beginning of the first quarter of 2002. The number will then be reduced further to three days per week beginning during the third quarter.

Training

Additional operator training in specific GBT subsystems and controls (including hands on) continued during the first quarter (largely needed because of dynamically changing hardware and software). The

training of one GBT operator continued during the first quarter. The training of the OVLBI operator was completed during the first quarter.

The telescope operators received training on VLBI setup and post observations follow-up. They also received training in the use of the new operators electronic logging system. Training in the use of the work order/PM scheduling program, Mainsaver, continued during the first quarter of 2002.

GB Maintenance Bookkeeping

The data entry of the Mainsaver inventory continued during the first quarter of 2002. More extensive use of this system occurred during the first quarter of 2002 with the inclusion of preventative maintenance scheduling on major mechanical sub systems. The work order part of Mainsaver is now in regular use by Telescope Operations. One major PM cycle was turned on and work orders automatically issued for the major PM task of monthly PMs on the GBT wheel and trucks. Effort will continue through the end of 2002 to bring more sub systems into the PM scheduling part of Mainsaver as well as reporting of broken hardware.

GBT Operations

Some effort of converting the Operator Advancement Proposal into a plan continued during the first quarter of 2002. Work on duty descriptions and an operational employment concept for the new "Observing Assistant" position is being considered by the NRAO human resources department.

Some operating procedures were refined and new ones implemented during the last quarter. The move of the control of the GBT from the Jansky Lab was completed in January of 2002. The first observations of scheduled global VLBI observing was during the first quarter of 2002.

A preliminary electronic logging program to replace the existing three system paper logs was implemented during the last half of the first quarter. Work will continue on refining the program during the second and third quarters of 2002. During the second quarter the replacement of the labor intensive calculation of monthly statistics with an automated function in the operator logging program will be implemented.

NRAO Central Instrument Shop

Milestone	Original Deadline	Revised Deadline	Date Completed
Fab. L-band OMT for Arecibo (contract)	11-15-01	01-18-01	01-21-02
Fab. parts for ALMA Nutator (with add.)	01-30-02		02-17-02
Fab. Stow Pin and Park Parts for ALMA	12-21-01	Canceled	
K band feeds for VLA (2)	04-19-02		

Astronomy Education Center Project

Milestone	Original Deadline	Revised Deadline	Date Completed
AEC dormitory 90% design review	09-10-01	04-15-02	
AEC dormitory pre-bid conference	05-03-02		
AEC dormitory bid due date	05-24-02		
AEC dormitory start of construction	07-01-02		
AEC main building construction complete	10-15-02	12-15-02	

NRAO Central Instrument Shop

A number of items in support of the ALMA Nutator assembly were completed in January. Some additional Nutator stow pin and park parts have also been requested and completed. Work was completed on the L-band orthomode transducer for Arecibo and it has been successfully tested and delivered. The Shop also has again begun production of the K-band feeds and OMT's for the VLA with deliveries scheduled to begin in the second quarter.

Operations - Other Telescopes

20 Meter and GBI, 85-3 Telescopes

The mothballing of the 20 Meter will be delayed until a decision is made regarding its use in future VLBI tests with the GBT. Routine preventative maintenance and general repair maintenance of the 20 Meter and 85-3 (Pulsar monitoring) telescopes continued as resources permitted. Inspection of the 140 Foot telescope continued during the fourth quarter.

OVLBI Tracking Station

Operation of the OVLBI tracking station concluded on February 28, 2002. The operation was run under contract with NASA over the past five years. The station had an outstanding track record, having ~99% success in tracking and data passes, the best performance in the network of stations acquiring data from the VSOP/HALCA satellite. Demodulator equipment built by NRAO for the station was adopted for use by the DSN 11 m subnet.

Management and Scientific Services

Milestones	Original Date	Revised Date	Date Completed
VLA/VLBA Proposal Deadline	02-01-02		02-01-02
Recommendations on Office Space Solutions	02-15-02		02-11-02
Evaluate VLBA dynamic scheduling	03-08-02		03-01-02
Complete Visiting Committee Report	03-29-02		03-14-02
Revise VLA Proposal Form	04-19-02		03-05-02
Teacher Workshop at VLA	04-19-02		
Last of 4 VLA Public Tours	04-21-02		
Update VLA High-Frequency Web Pages	04-30-02		
Complete VSOP Support	05-15-02		
Release Jobserve Cookbook	09-30-01	05-29-02	
VLBA Calibration Service Prototype Testing Complete	05-29-02		
VLA/VLBA Proposal Deadline	06-03-02		
"New Radio Universe Session" at AAS	06-05-02		
Hold Synthesis Imaging Summer School	06-24-02		
Automated Monitoring of AIPS Software Downloads	06-30-02		
Update Astronomer Information on Web	09-30-02		
Debut New VLA Visitor Center Film	10-31-02		
First Fringes on Mark 5 Recorder Prototypes	11-30-02		
VLA Visitor Center Gift Shop Opening	02-28-03		

Electronics

Milestone	Original Deadline	Revised Deadline	Date Completed
VLA/VLBA Pie Town Link (LO/IF)			
Reduce temperature sensitivity	01-31-01	04-30-02	03-01-02
Use spare VLA antennas in VLBI	06-30-02		03-01-02
Complete construction & checkout of spares	01-31-01	05-30-03	
Receivers (FE)			
Replace Y-coupler on 86 GHz receivers #2 to #4	08-30-01	02-01-02	03-15-02

Milestone	Original Deadline	Revised Deadline	Date Completed
Build and install three more 86 GHz receivers	10-31-01	05-30-02	
Identify and correct moisture buildup problem in new VLA 22 GHz feeds (FE)	12-31-01	09-30-02	
Build and install one more 86 GHz receiver for a total of 9	12/30/02		
Install new 1.4 GHz receiver windows as the old ones fail	Open ended		
VLBA Improvements			
Test new Metrum heads	06-30-02		
Pointing Improvements, Modification to encoder electronics, other	12-30-02		
VLA Improvements			
Install Iridium Filters (FE) at 1.6 GHz	12-31-01	09-27-02	

Electroformed parts for 86-GHz receiver No. 8 did not arrive as planned; seven receivers are currently deployed.

PT link spares identified to date were built and checked out successfully. Based on that experience, two additional spares were selected for build since the major sub-assemblies are already on-hand.

Engineering Services

Milestones	Original Date	Revised Date	Date Completed
Complete A Array reconfiguration	01-25-02		01-25-02
Complete BnA reconfiguration	05-17-02		
Complete B array configuration	06-07-02		
Mechanical Group			
Azimuth Bearing repair/rebuild	03-01-02		03-01-02
Dish panel adjustments on Antenna #24	03-30-02		03-22-02
Maintenance Visit to St. Croix VLBA	04-08-02		
Dish panel adjustments on Antenna #23	04-30-02		
Dish Panel adjustments Antenna #15	05-15-02		

Milestones	Original Date	Revised Date	Date Completed
Dish Panel adjustments Antenna #5	05-30-02		
Paint Antenna #21	06-15-02		
Maintenance Visit to Hancock VLBA	06-15-02		
North Liberty AZ rail repair	06-15-02		
K-Band Feed retrofits	06-30-02		
Paint Antenna #24	07-15-02		
Antenna #7 Azimuth Bearing change	07-15-02		
Paint Kitt Peak VLBA	07-22-02		
VLBA Subreflector re-work	12-31-02		
Electrical Group			
Cryo Air Conditioner installation	10-30-01	01-30-02	01-21-02
Radio upgrade	12-28-01	06-30-02	
Site & Wye Group			
ALMA base course application	06-29-01	03-01-02	03-15-02 (partial)
ES Engineering Group			
Vertex house mock-up complete	05-24-02		03-15-02
Feed cone prototype complete	06-30-02		

The new system handheld radios have been a priority and are in use; installation of new mobile radios is ongoing. The ALMA base course application will continue when the remaining two foundations are installed.

Computing Division

Milestones	Original Date	Revised Date	Date Completed
Replacement Public Machines	09-30-01	01-15-02	01-14-02
View dynamic scheduling from OMS	01-15-02		01-18-02
Arana Removal	09-30-00	01-31-02	03-15-02
Video Conferencing	01-31-01	01-31-02	02-25-02

Milestones	Original Date	Revised Date	Date Completed
Solaris 2.8 installation	07-31-01	01-31-02	03-31-02
VLBA station computer software upgrade	01-31-02		01-31-02
Investigate Mainsaver Asset Swap	02-01-02	02-01-02	02-01-02
RedHat 7.2 installation	07-01-31	02-28-02	02-28-02
Modcomp replacement	10-31-01	03-15-02	01-10-02
NRAO DNS/DDNS Testing	02-28-02	03-20-02	03-20-02
Release JObserve 1.6.5	02-28-02	04-01-02	
Ancillary data procedures-> VLA ops	05-30-01	04-01-02	
Upgrade Ingres User Access	04-01-02		
VLBA Recorder Test Software	01-31-02	05-01-02	
Build 2_ Terabyte SAN	11-30-01	05-01-02	
Atmospheric Phase Interferometer	05-01-02		
Future of Mainsaver/Sybase	05-01-02		
Correlator Controller in Continuum	05-31-01	05-13-02	
NRAO DNS/DDNS implementation	05-30-02		
Off-load zia server	09-30-01	05-31-02	
Streamline VLA observe file submission	12-31-01	06-01-02	
Database modifications for Mark 5	06-01-02		
Alterative to 9 track tape at VLA Site	03-31-02	12-31-02	
Web/ftp servers	08-31-01	Deferred	
Establish NRAO-NM laptop policy	02-28-02	Deferred	

Replacement Public Machines

All of the public systems are installed and functioning. We now have eight high-end dual processor PCs running Linux, and two Suns for a total of 10 public machines.

View/Edit Dynamic Scheduling Properties from OMS

This addition to OMS allows the users to view and modify a project's dynamic scheduling attributes used by Barry Clark's scenario program. It was put in place on schedule.

Arana Server Removal

Arana has been taken off the network, proving that all functionality has been successfully taken over by other servers. The physical removal will take place shortly, but this item can be regarded as finished.

Video Conferencing Upgrade

All of the video conferencing equipment is installed and functioning. Apart from the upper conference room, we now have additional video conferencing capabilities in the auditorium, one other conference room, and the VLA site. There are minor tuning changes to be made but represent day to day maintenance and are not part of the original project.

Solaris 2.8 Installation

This item was concluded during this quarter. All Suns are running Solaris 2.8 apart from very few systems that for specific reasons require an earlier version and that never will be upgraded.

VLBA Station Computers

All sites (except VLA) have been updated with the current OS (VxWorks 5.4). Old VME hardware has been relegated to nonessential duties in anticipation of future failures without adequate replacement hardware being available. Several sites report persistent errors with the battery-backed clock chips during reboots, this is being investigated

Agenda Weekly Coordination Meeting

Over the years, the agenda of the weekly coordination meeting had been maintained using home-grown software. A project to convert this to run under MS Access was concluded. Staff has been trained to update these notes on a weekly basis, and the notes have been made available on the Web.

Mainsaver Asset Swap

Since Mainsaver had no easy way to relocate/swap assets within its asset hierarchy system, we developed a method to accomplish this ourselves. Cayenta (Mainsaver's parent company) is not expected to add this capability before 2003.

RedHat 7.2 Installation

All Linux boxes which can be upgraded to RedHat-7.2 have been. For reasons of compatibility with ESO, all of the ALMA systems cannot be upgraded till after April. A handful of servers must remain at the oldest revision for backwards compatibility so they will remain at 6.2 until the ALMA systems are upgraded. This is beyond our control, so we consider this item done.

Modcomp Replacement

The replacement Modcomps were successfully installed in January and have been in successful operation since then. A few little understood problems remain, but data integrity and system performance have not suffered. These problems will be dealt with during the coming months.

NRAO DNS/DDNS Testing

Testing was completed in Tucson from March 19-22. We will be propagating the information from the testing at the end of April which will spawn the actual implementation project.

Ingres User Access

Knowledge Management is being implemented in order to set up groups and roles within the Ingres database. This will allow us to more easily assign user access within Ingres, provide audit trails and help identify system problems.

Implement 2+ Terabyte SAN

All SAN equipment has arrived, and work has begun on configuring the hardware. Final configuration and general availability will occur after all testing is completed by the end of April.

Atmospheric Phase Interferometer (API)

The system is being documented for EVLA and a method being developed to alert astronomers of system failures.

Mainsaver/Sybase

Cayenta Software will no longer support the Sybase database after summer of 2002; they will only support Oracle. We are exploring alternatives to both Mainsaver and Sybase, along with costs and effort of implementation.

Streamline Observe File Submission

Preliminary analysis and design are complete. Next step will be to review and finalize with operations, then put into place.

Mark 5 Support

Modifications are required in the Ingres database for a 32-character VSN (currently eight). We will analyze and test all software associated with this change to assure no interruption in service.

AIPS

Distribution and Versions

The 31DEC01 version of AIPS was frozen and has been released. The move to Socorro of the midnight job and master version for 31DEC02 has been completed, and the midnight job now runs under the Unix "cvs" utility. At the moment, counts of "fetches" of the AIPS versions are disabled due to complexities associated with the move of the master copy and local cgi scripts.

Key Developments

1. In association with the moving of the code to Socorro, the master AIPS world-wide web pages also have been moved to Socorro. Most critical links and scripts work. Some dependence on cgi scripts specific to Charlottesville has been found, causing occasional problems. The Charlottesville version of the AIPS web pages has been removed except for re-directs to the Socorro version.
2. Systems activities associated with midnight jobs and installation questions from users (general installation, multiple machines, remote TV displays, and so on) take an ever-growing fraction of AIPS programmer time, currently estimated at 50% of a person-year. With dedicated systems assistance no longer available for AIPS, this time is taken away from applications programming, and results in delays in meeting applications targets. The Socorro Computer Division occasionally helps out on questions that involve both AIPS issues and more global computing system issues.

3. The AIPS configuration tasks (e.g., CONFI and UVCON) have been used by the AIPS group to develop tentative arrangements for the E configuration (new compact configuration) of the VLA, that is proposed as part of Phase II of the EVLA project. The configuration work has been used to determine the locations of the fiber optic runs in the center of the array for EVLA Phase I, so that the fiber locations do not impact possible future addition of the E configuration. For possible simulations of SKA stations using multiple antennas, CONFI now has the option of multiplying the array beam by the antenna primary beam, in order to optimize sidelobes.
4. A new task, RMSD, was added to compute the rms in a two-dimensional moving window through each plane of an image. This enables noise to be determined in different planes in the vicinity of real signals, and can be used as input to XMOM in order to compute image moments with useful flux cutoffs. Since RMSD operating on each pixel is a very time-consuming task, the user-controllable XINC and YINC parameters have been included in order to operate on subsets of all the pixels.
5. Continued work took place on the VLBA data-reduction utilities. This included fixing some default parameters, determining whether data sorting and indexing are necessary (and doing them if needed), and combining the table-merging steps into the data-loading utility. A new version of Appendix C of the AIPS Cookbook, covering VLBA data calibration, has been installed. This version now describes the VLBAUTIL procedures as the first choice, with the more complicated AIPS tasks considered as "backups" for those who want to adjust more parameters.
6. A new task, WETHR, has been added. This task processes and plots weather data in various ways, and also can be used to create flags based on weather parameters.
7. Various changes have improved the capabilities of wide-field imaging, or corrected previously erroneous documentation. The new task BOXES allows a box file to be inserted (e.g., with NVSS sources) so that low-frequency, wide-field maps can easily clean out the many sources in a field.
8. The Cookbook has been revised. It includes a new guide to VLA high-frequency data reduction.
9. The memo comparing FRING and KRING has been held up by some uncertainties about the statistics of the distribution of phase errors. These uncertainties now have been resolved, and the memo should be released early in the 2nd quarter of 2002.
10. A new package of procedures, WRTPROCS, has been developed to enable writing and reading of files to and from disk. The verb SG2RUN enables save/get files to be copied to text files for later use as RUN files (e.g., on a computer of another architecture).

Goals for Q2 2002

1. Continuing maintenance and user support, including systems support.
2. Resurrect the monitoring of fetching of copies of 31DEC01 and 31DEC02.
3. Add a guide to low-frequency, wide-field imaging as a Cookbook appendix.
4. Code new Gaussian fit error tests into programs such as SAD and JMFIT.
5. Complete and issue the memo comparing KRING and FRING.
6. Support data-reduction workshops at the Synthesis Imaging Summer School.

Major Developments

Milestone	Original Date	Revised Date	Date Completed
Design L-band amp using InP devices.	03-16-01	04-30-02	
Study use of overmoded w/g in LO transmission	03-16-01	08-31-02	
Demonstrate 211-275 GHz balanced sideband-separating SIS mixer with integrated 4-12 GHz IF preamps.	07-31-01	06-30-02	
Construct second test receiver	12-31-01	05-17-02	
Design GBT Q-band optics.	09-30-01	06-30-02	
Evaluate final design of K_a-band feed.	12-31-01	03-31-02	03-31-02
Finish detailed design of W-band feed.	12-31-01	03-31-02	03-31-02
G/T optimization of feed taper at 3 GHz	03-31-02		03-31-02
G/T optimization of feed taper at 10 and 30 GHz	03-31-02	06-30-02	
Feed pointing optimization of the VLA antenna	06-30-02		
ALMA Correlator:			
1) Write and release ALMA memo on the filter card testing.	09-30-01	01-31-02	02-20-02
2) Completion of the prototype filter card testing and release of ALMA memo on the filter design and performance.	09-30-01	01-31-02	02-20-02
1) Start design of FPGA chip for the ALMA correlator chip test fixture card.		04-15-02	
2) Complete design of the station motherboard.			03-29-02
3) Start mechanical design of system bins and racks.			01-15-02
4) Start PCB layout of station power supply card.			03-01-02
5) Start design of the correlator motherboard.	03-31-02		02-15-02
6) Finish design of system interface paddle boards.		05-15-02	
7) Finish correlator/LTA test fixture and begin testing correlator card.			03-01-02
8) Using correlator card/LTA test fixture to start developing control card software.			02-15-02
1) Complete design of FPGA chip for the ALMA correlator chip test fixture card.	06-30-02		
2) Complete testing of the prototype ALMA correlator chip using both the chip test fixture and the prototype correlator card.	06-30-02		
3) Perform design reviews and start PCB layout of the two ALMA correlator motherboards, the paddler board, and the quadrant control card.	06-30-02 06-30-02		
4) Complete mechanical design of the correlator bin.	06-30-02		

Milestone	Original Date	Revised Date	Date Completed
5) Complete testing of the GBT spigot card.			
Initial test of prototype ALMA correlator.	12-21-02		
Design MMIC doubler chips for ALMA Band 7.	06-01-01	06-30-02	

Amplifier Design and Development

The amplifier group has continued to support the ALMA project with manpower and construction assistance in the SIS-integrated amplifier development effort. One amplifier assembly/test technician dedicated 75% of his time to ALMA activity. A second technician was involved, for several weeks, in learning and developing coil winding techniques for the magnetic bias structures used with the SIS junctions. The 18 Q-band amplifiers produced during the last quarter of 2001 have required a fair amount of evaluation and tuning, and are now in the final test and documentation stage.

Amplifier Production

A total of 13 amplifiers was assembled during the quarter. Four additional amplifiers were essentially rebuilt, having been damaged by users outside of NRAO. New production included four 8-18 GHz amplifiers and two K-band amplifiers used for receiver construction at the VLA, three K_a-band amplifiers and four W-band amplifiers for VLBA use. Production of K-, K_a-, and W-band LNAs is ongoing.

Superconducting (SIS) Millimeter-Wave Mixer Development

SIS Mixer Development

Band 3 (84-116 GHz) SIS mixer: Last quarter we completed the design of a tunerless SIS mixer for Band 3 capable of operation with a 4-12 GHz IF. Funding for wafer fabrication at UVA was provided by the Herzberg Institute of Astrophysics as part of the Canadian contribution to ALMA. UVA has successfully fabricated and delivered the first wafer to HIA. The NRAO mixer block drawings were checked by HIA's drafting staff, and final production drawings sent to J&E Precision Tool for fabrication. Initial mixer evaluation will be carried out as soon as the blocks are delivered.

Band 6 (211-275 GHz) SIS mixers: Last quarter we had not decided between single-chip SIS mixers (balanced or sideband separating) or multi-chip mixers using two or four simple elemental mixers. It was not clear whether the much simpler mixer blocks and assembly of the single chip designs would outweigh the much larger number of chips per wafer and potentially higher wafer yields of the multiple chip designs. Now the CDL Shop has succeeded in machining the more complex mixer blocks for the four-chip balanced

sideband-separating mixer (see the section on the CDL Shop, below), and we believe the multi-chip approach to be preferable.

Band 6 (211-275 GHz) balanced sideband-separating SIS mixer — multi-chip design: To implement this approach we will use four separate building-block SIS mixers of established design (ALMA Memo 205), mounted in a block containing three waveguide quadrature hybrids and an in-phase power divider. The wafers were fabricated at UVA, and have given good performance as single-ended mixers with L-band and 4-12 GHz IFs. The first mixer block has been fabricated in the CDL Shop. We are awaiting a pair of 4-12 GHz IF preamplifiers and the magnetic circuit components.

Band 6 new elemental SIS mixer: A new elemental (single-ended) mixer is being designed which will take advantage of the new UVA niobium circuit fabrication process which uses a sputtered SiO_2 insulator in place of SiO. This should give fewer pinhole short circuits and more consistent results. At the same time, the mixer is being reoptimized for the actual ALMA band (210-275 GHz) which is narrower than the original design band (200-300 GHz), and uses a quasi-lumped element RF tuning circuit which increases the inherent bandwidth. The RF choke is being redesigned to present less capacitance to the 4-12 GHz IF amplifier.

ALMA 4-12 GHz IF Preamplifier Development

As reported previously, the 4-12 GHz preamplifier worked well with a single-ended Band-6 mixer. Bias for the mixer was provided by a bias-T in the preamp body. The preamp was redesigned to accommodate a second mixer bias-T as required for operation with a balanced mixer. Initial tests of this amplifier with a balanced Band-6 mixer gave good results as described above. Subsequently, the preamplifiers have shown a tendency to oscillate at ~3 GHz, which was found to be due to a slight warping of the lids. Also, mounting brackets in the SIS test Dewar, when connected with the balanced mixer, put stress on the amplifier lid which made it separate from the body, causing oscillation when cold. Proper attention to the tension between the mixer-preamp and the brackets used to strap the mixer-preamp to the 4 K cold stage eliminated the oscillation. We are now working on optimizing the IF coupling circuit in the mixer.

We have been collaborating with Andrey Baryshev of SRON on the development of an internal IF amplifier for their Band-9 mixer (currently, a single-ended design). The first phase of this collaboration is to develop a model of their mixer using a linear microwave simulator (MMICAD), which will allow optimization of the mixer-preamp to achieve good performance over the full 4-12 GHz IF band. During a visit to SRON in December, comparisons were made between different IF configurations. Measurements were made (i) with the amplifier connected to the mixer with a short cable but without an isolator, and (ii) with the same configuration but including a 4-8 GHz isolator. The mixer worked well when connected directly to the IF amplifier, and did not show any sign of instability. There was a ripple in noise and gain vs. (intermediate) frequency, but the average performance was as good as that measured with the isolator over the narrower 4-8 GHz IF range. The results of these measurements were presented at the 2002 Space THz Symposium at Harvard-Smithsonian.

SRON had paid for the development of a 4-12 GHz cryogenic isolator by Pamtech, Inc. The CDL has just obtained a prototype unit and has been asked to measure its return loss and insertion loss at 4 K. The

isolator will also be installed between a single-ended Band-6 mixer and 4-12 GHz IF amplifier to compare its performance with that of the integrated mixer-preamp. The large physical size of these isolators will have to be taken into account in the cartridge layout.

ALMA Band-6 Cartridge Development

During this quarter, responsibility for design and production of the ALMA Band-6 cartridges was assigned to the CDL. Cost and labor estimates were drawn up for the design of the cartridge and the required test equipment. Cartridge production cost and labor estimates will be developed during the next quarter.

Components for ALMA Band 6 Mixer Production Test Set

We have continued exploring the use of an overmoded stainless-steel waveguide between the output of the LO multiplier on the 70 K stage and the SIS mixer at 4 K. Simulations and measurements on scale models (in the absence of a vector network analyzer for Band 6) indicate that it is difficult to avoid all higher-mode resonances in highly overmoded waveguide. The higher modes are excited by the tapers from fundamental to oversize waveguide and are trapped in the oversize guide, giving sharp high-Q resonances. Attempts to damp out the resonances by filling the waveguide with slightly lossy material have resulted in no substantial improvement. In the next quarter we will explore alternative coupling schemes.

Compact multi-conductor heatsinks are required for the many bias and monitor wires in the cartridges and test receivers. We are evaluating two designs: a compact design using Nanonics miniature connectors and thermal isolation by a thin layer of epoxy adhesive, and a connectorless design inserted in a wiring harness, which uses commercial thermally-conducting grease. Thermal equivalent circuits are being measured for the two designs.

Computer-Controlled SIS Mixer Testing

Construction of the second mixer test Dewar was completed during the quarter, which included installation of all wiring using a new heatsink design. Difficulties in reaching a cold-stage temperature of 3.8 K have delayed the use of this Dewar for exploratory testing.

Wiring in the existing test Dewar developed several short circuits during the quarter. The shorts occurred in the phosphor-bronze wires which pass through a layer of GE varnish on the 50 K radiation shield. A new, connectorless heatsink was designed and built during the quarter and is currently being installed in the Dewar. This heatsink may have applications in the ALMA cartridges.

The database schema for developmental and production mixer test data was redesigned in the light of recent experience processing large amounts of mixer test data. During the next quarter, real measurement data will be loaded into the database to validate its architecture.

Work continued on the programmable Band-6 LO source with the design and construction of several key subsystems. An existing NRAO HFET bias card was redesigned to power the active doubler and W-band amplifier with their 200 mA drain currents. LO power level is controlled by varying the gate bias on the W-band amplifier, and an isolation circuit was designed and built to isolate the control voltage generated by the control computer from the circuits connected to the amplifier. All RF components have been assembled on a mounting plate, and all power supplies and bias cards have been installed in a chassis which is now being wired.

EM Simulation Software

There is considerable interest at all NRAO sites in using EM simulators for microwave circuit design. The recent emergence of two commercial Finite Difference Time Domain simulators allows three-dimensional structures such as waveguide components to be analyzed fast and with fine frequency resolution — a major advance from the Finite Element EM simulator such as HFSS available a few years ago. To establish the accuracy of the FDTD simulators QuickWave 3-D and CST Microwave Studio, CDL and Green Bank engineers are comparing several benchmark circuits for which careful VNA measurements have also been made. This study is being written up as an internal report.

CDL Mixer Fabrication Lab

Some time was lost again this quarter to equipment failures, particularly our dicing saw. This instrument is used in the assembly of mixers for all bands to dice and thin quartz mixer chips to precise dimensions, and is also used in making several components for HFET amplifiers. The present saw is more than 20 years old and was acquired on loan from NASA in 1984.

CDL Shop

After a long period during which software incompatibility between the new high-precision Bostomatic CNC milling machine and the MasterCam CNC software package seriously limited the use of this machine, we now have a functional postprocessor. Now the CDL Shop has succeeded in machining the complex mixer blocks for the four-chip Band-6 balanced sideband-separating mixer. This mixer block includes three waveguide quadrature hybrids and an in-phase power divider (as described in ALMA Memos 343 and 381) and is made using end mills as small as 0.005" diameter operated at up to 30,000 rpm's. Dimensional accuracy of the finished parts is within ± 100 microinches.

Publications and Memos

A. R. Kerr, "Saturation by Noise and CW Signals in SIS Mixers," *Proc. 13th Int. Symp. on Space THz Tech.*, Harvard-Smithsonian, Cambridge, MA, 26-28 March 2002.

A. Baryshev, E. Lauria, R. Hesper, T. Zijlstra and W. Wild, "Fixed-Tuned Waveguide 0.6 THz SIS Mixer with Wide-Band IF," *Proc. 13th Int. Symp. on Space THz Tech.*, Harvard-Smithsonian, Cambridge, MA, 26-28 March 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 was carried out at 3 GHz. A feed taper of -17 dB yielded maximum efficiency, and a taper of -18 dB yielded the optimum G/T.

The cause of resonances in the K-Band (18.0-26.5 GHz) feed was identified, and the necessary modification to the feed was made.

GBT

A compact corrugated feed horn and transitions required for the W-band (68-92 GHz) receiver were designed. The feed will have a taper of -13 dB at the edge of the subreflector, and the worst cross-polarization is -27 dB.

Design of a compact corrugated feed horn for the K_a-band (26.5-40.0 GHz) receiver was completed.

Spectrometers/Correlators

Work during the last quarter concentrated on design of the ALMA correlator and testing support of the GBT spectrometer.

Logic design for the station control card was finished, and the PCB layout of the card is nearly complete. Design of the last full-size logic card, the quadrant control card, for the ALMA correlator was started during the quarter. (Another card, the adder tree card, will not be started until after the two-antenna prototype correlator has been delivered.)

Also completed were the design and the PCB layout of the correlator card power mezzanine card, the station bin power card, and a test fixture card for the station control card.

Most other logic cards for the ALMA correlator are now complete, and prototype cards for most designs have been assembled and tested.

Designs for the station bin motherboard, the correlator bin motherboard, and the signal cable paddle board were brought to the point of a complete preliminary design. A formal design review will be needed prior to starting PCB layouts.

Work on the ALMA correlator control software via the internal correlator CAN bus was started.

The prototype run of the 4096-lag ALMA correlator chip at a silicon foundry in Taiwan continued.

Design of the ALMA correlator bin hardware was started during the quarter. The station bin hardware was completed and submitted for mechanical build.

All three of the pulsar logic cards to support pulsar observations in the GBT spectrometer have now been tested in the system, and all card software is complete and awaiting checkout.

Other work in support of the GBT spectrometer concentrated mainly on mode checkout with several modes requiring minor FPGA redesign.

Work continued on a system to stream VLBA data from a VLBA playback unit onto high-density computer RAID disc.

Accomplishments of the ALMA correlator group during the last quarter include:

1) Completed preliminary testing (testing in the absence of correlator chips) of the ALMA correlator card, the LTA, the correlator bin power supply card, and the correlator card test fixture.
2) Completed mechanical design of the ALMA correlator station bin.
3) Tested the GBT pulsar spigot card in the GBT spectrometer.
4) Completed software for the GBT spigot card.

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.

Work this quarter has focused on preparing for and beginning designs of InP MMIC power amplifiers and GaAs Schottky mixers/multipliers for the active multiplier chains (AMCs). We will be collaborating with JPL and CalTech on designs for each process. We are designing 95-120 GHz and 120-144 GHz power amplifiers for the Band 7 and Band 9 LO drivers, respectively. We will also be designing amplifiers which can be used for development of future ALMA bands.

We have also been optimizing the prototype Band 3 and Band 6 MCs using commercial MMICs to minimize noise and spurious harmonics. A plan has been developed showing which chips will be used for the AMC and power amplifiers for all four of the required LO drivers.

We have also looked into how the ALMA LO work and upcoming wafer runs can be used to help the EVLA project.

We have been preparing discussion points both for the LO group alone and in conjunction with the Band 6 cartridge group for the upcoming ALMA week cartridge meeting.

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 results of the tests performed on the first prototype of the 80/240 GHz frequency tripler were summarized in the previous quarterly report. The need for redesigning

the tripler block was explained therein. The design of the improved (and simplified) block is now complete, and its fabrication is in process. The finished block is expected to be available in 2-3 weeks. The mask set for the modified quartz circuit for the new block has been received from the vendor. Fabrication of new circuits is expected to conclude around the same time that the block becomes available for another iteration of assembly and testing. The tripler will use the same Schottky diode MMIC chips that were used previously. There is ample stock of these on hand.

JPL/University of Michigan Collaboration: The previous quarterly report summarized the performance of the 110/220 GHz doubler using the diode arrays (having less than the desired capacitance) fabricated at the University of Michigan. The cause of the low capacitance was traced to lower than specified doping of the epitaxial layer. The wafer manufacturer is working to correct the problem and to deliver new wafers to the Michigan laboratory for another diode fabrication run.

Toward the goal of developing viable substrates and structures for ALMA Band-7 multiplier MMIC work, a structure comprising of beam-leads on thinned Si-substrates was successfully fabricated. The test circuit is comprised of two back-to-back probes for a microstrip to reduced height WR-10 waveguide transition. The finished thickness was 2 mil, though it could be made smaller. Eight beam-leads (four along either edge) were fabricated integral to the chip along its length. For multiplier work, these beam-leads can be extremely helpful in grounding applications and render the block-assembly process simpler by eliminating the need for several wire-bonds. Currently, work is under way to fabricate a test chip with the devices on thinned GaAs supported by a silicon frame and having beam-leads. The knowledge gained as a result of this exercise will help set parameters for designing a MMIC multiplier on such a substrate.

Fully-Sampled, Focal Plane Array Feed

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. The 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.

Major progress has been made in the design of the array superstructure. Preliminary designs for the antenna, ground plane, dewar configuration, and support structure that meet the stringent size and weight restrictions imposed by the GBT prime focus location are well under way. An antenna impedance test setup is nearing completion. Test fixtures for measuring the dielectric constant, loss factor, vacuum seal, and thermal conductivity of various materials are currently under way. A rudimentary design for the low-noise amplifier is completed. Components for a down-converter prototype have been purchased. Evaluation boards for candidate A/D converters have been purchased.

A meeting was held in Green Bank to discuss enhancements to the outdoor antenna test range for making beam-forming array measurements. A preliminary plan is in place, and a prototype of the proposed phase-locking system is being assembled.

A preliminary design of the signal processor has been completed, but progress this quarter has been slowed due to GBT commissioning activities.

Meetings

2002 URSI Conference, Boulder, CO, January 9-12, 2002 (Srikanth, Webber).
NSF Management Review meeting, Socorro, January 28-30, 2002 (Webber).
EVLA Receiver PDR meeting, Socorro, February 12-13, 2002 (Srikanth).
13th Int. Symp. on Space THz Tech., Harvard-Smithsonian, March 26-28, 2002 (Ediss, Kerr, Lauria, Pan).
ALMA Band-3 SIS meeting, Harvard-Smithsonian, March 28, 2002 (Kerr, Pan).
ALMA Mixers meeting, Harvard-Smithsonian, March 29, 2002 (Ediss, Kerr, Lauria, Pan).

e2e Project

Milestone	Original Deadline	Revised Deadline	Date Completed
Install interim VLA archive server	12-01-01	04-15-02	
Internal tests of VLA interim archive	01-15-02	06-01-02	
External tests of VLA interim archive	03-15-02	08-01-02	
Announce VLA interim archive server	06-01-02	10-01-02	
Archive RFP issued	10-01-01	07-01-02	
End of e2e phase 1	07-01-02		
EVLA e2e PDR	07-15-02		
Purchase GBT archive hardware	09-15-01	09-01-02	

The first round of definition of the e2e (End-to-End) project has concluded, and has been described in the e2e Project Book. Since much of the areas being developed in e2e are new to NRAO (both scientists and developers), an iterative spiral model for development has been adopted. The spiral model is a well-known software development methodology that is well-suited to projects such as e2e in which a complete set of scientific requirements cannot be developed at the very beginning. Instead, the spiral model iteratively refines scientific requirements as the project proceeds. The e2e project will proceed over a number of 9-month long development phases, each with well-defined goals and resources. At the end of each development cycle, all aspects of the overall project will be re-evaluated using the knowledge acquired. The goals for the first phase are to develop an interim VLA archive, and an interim pipeline that can read and write data to and from the archive. This development cycle will conclude in July 2002.

The status of the activities in the first development cycle are:

- Catalogs have been constructed in AIPS++ tables from MeasurementSets filled into AIPS++, and also from transfer of the existing VLA catalog into AIPS++. A number of query functions have been tested, both from the command line in AIPS++ and from test web page. Current work focuses on further testing, and improving the web interface.
- A design for a prototype pipeline has been developed and implemented in AIPS++. An initial test has been conducted. This test consisted of reading project information from the AIPS++ catalog described above, retrieving and filling the data tapes into an AIPS++ MeasurementSet, complete editing, calibration, and imaging (including self-calibration), and publication of the results to a set of web pages.
- A pipeline server (an IBM 4 processor machine running RedHat Linux 7.1) has been acquired and is now in use. Deployment of the archive server (a Storage Area Network plus a computer to serve data) has been slowed down by over-commitment in the AOC computing group. We now expect to have this server up and running by the end of April. Our work on the catalog and pipeline software has not been affected by this delay, but the deployment of a working system for use by astronomers has been set back correspondingly.
- A Java-based interface to the new VLA/VLBA calibrator database has been developed and is now in testing. This web-accessible tool will allow users of the VLA and VLBA to search for and identify

suitable calibrator sources for observations. It will replace a much simpler web-page interface that has been in use for a number of years.

The prototype archive is being based upon the AIPS++ MeasurementSet data holder, thus enabling trivial extension of the archive capability to any radio telescope for which there is an AIPS++ data filler. The archive catalog is being implemented as AIPS++ tables. Hence the entire system will be portable to other radio observatories, as agreed would be done under the COBRA proposal partially funded by NSF/ITR. We are engaged in discussions with members of the ALMA Archive subsystem team to see if work can be shared between the two groups.

The EVLA project is one of the customers of the e2e project, and is providing support via two positions, one of which has been hired. E2e staff participate regularly in EVLA meetings, such as weekly coordination meetings and special Monitor & Control/e2e liaison meetings. These latter meetings have concentrated on the interfaces between e2e and the EVLA. An interface definition document is now being written to cover these areas. In addition, we have monthly progress review meeting with our EVLA contract manager, Gustaaf van Moorsel.

DM will be responsible for the Pipeline Framework and Off-line Processing subsystems of the ALMA project. Negotiations with ALMA computing are underway concerning how this work will be done, with the goal of starting development in both areas by July 2002. We expect to start the hiring process for positions in the Pipeline development within a few weeks.

e2e is also responsible for providing a working archive system for the GBT. We expect to be in a position to purchase the necessary hardware by the end of FY2002, with a goal of deploying a working system by the beginning of 2003. The software will be closely modeled on that for the VLA archive.

e2e staff are participating in the development of technology for the National Virtual Observatory, as funded by NSF ITR. NRAO is a partner in the collaboration, and work performed for NVO is complementary to that planned for e2e. We have received funding for one position but it has not yet been advertised or filled. Our main effort this quarter has been to attend and follow the meta-data group meetings. We have also implemented a cone-search which is an NVO prototype way to offer data up via a web service. Our contribution to NVO will increase once we have hired into our funded position.

Technology Development

Milestone	Original Deadline	Revised Deadline	Date Completed
AIPS++ Developers Pre-release	09-24-00	09-01-02	
ALMA AIPS++ test	08-15-01	04-30-02	
Prototype VLA pipeline	09-01-01	04-01-02	03-31-02
GBT science observing	10-01-01	12-15-01	12-15-01
AIPS++ Release v1.6	10-15-01	11-15-01	12-18-01
WBS for AIPS++ Release v1.7	10-20-01	11-20-01	12-21-01
Formalize AIPS++ user support and operations division	11-01-01		10-24-01
Form AIPS++ Technical Advisory Group	11-15-01	04-01-02	

Milestone	Original Deadline	Revised Deadline	Date Completed
AIPS++ booth at AAS, Washington, D.C.	01-10-02		01-10-02
AIPS++ developer conference	05-28-02		
AIPS++ booth at AAS, Albuquerque	06-02-02		
AIPS++ release v1.7	06-15-02		
AIPS++ WBS for v1.8	06-15-02		
AIPS++ participation at NRAO summer school	06-18-02		

The primary current responsibility of DM Technology Development is management of the AIPS++ project. The AIPS++ project is in an integration phase at present, with a priority focus on scientific completeness, usability improvements and enhancements in performance and robustness. All release planning during the integration phase reflects these priorities. The package is in a regular 6-month development and release cycle, and this quarter covers the first half of the v1.7 development cycle. The v1.7 release will be issued in June 2002. The work breakdown structure for this release was published at the start of the quarter, and can be found at: http://aips2.nrao.edu/daily/docs/notes/248/248.html.

A close collaboration with scientific testers remains an important component of the integration phase efforts. Within NRAO this proceeds in partnership with the NRAO AIPS++ Users Group (NAUG), which is coordinated from the AIPS++ Operations Division. In addition, user outreach and training efforts continue as an integral part of package deployment. The v1.6 release was issued publicly at the 199th AAS meeting, held in Washington, D.C., from Jan 6-10. In keeping with past practice, we staffed an exhibition booth at the AAS meeting and conducted tutorials for attendees on request. The AIPS++ display booth now uses display materials and brochures in the common NRAO format. In addition, a number of user tutorials were held this quarter. A single-dish tutorial for JCMT staff was held in January 2002. Visiting Arecibo staff was also assisted with AIPS++ single-dish training during this quarter. A tutorial covering AIPS++ synthesis capabilities was held in Socorro for NRL personnel in early March. An edition of the AIPS++ user newsletter was also published this quarter. In the area of user documentation, the AIPS++ recipes web page, which acts as a repository of data reduction script examples, was substantially overhauled and revised. A mechanism was established to solicit and check-in user reduction scripts, and thus allow use the AIPS++ recipes web page as a clearing house for scientific reduction scripts which other users in the community may find useful.

This quarter has seen substantial progress in the evaluation test of AIPS++ with data from the IRAM Interferometer on Plateau de Bure. This test was agreed in the fall of 2001 and has made good progress in reducing the designated IRAM dataset in AIPS++ and in migrating CLIC/GILDAS algorithms into the package. The ALMA project has also formed a closer tie to AIPS++ this quarter. By mutual agreement between the ALMA project and the AIPS++ Executive Committee, ALMA will be now be directly represented on the AIPS++ Executive Committee in order to conduct discussion on future reciprocal resource obligations related to ALMA support within AIPS++.

The GBT remains a strong priority for AIPS++, and this focus has continued during this quarter. This has included direct support of GBT commissioning activities as well as enhancements in the general single-dish reduction package. We continue to work directly with commissioning scientists at Green Bank as well

as early scientific observers. Improvements in continuum imaging capabilities have allowed imaging at unprecedented dynamic range (12,000:1 in one case).

Central Computing Services

Milestone	Original Deadline	Revised Deadline	Date Completed
Revise Security Policy	02-15-01	06-30-02	
Testbed VPN	09-30-01	06-30-02	
IDS purchase	12-31-01	02-28-02	02-28-02
Anti-virus email gateway purchases	12-31-01	05-15-02	
Turn off telnet/rlogin/rsh/rcp into NRAO	07-01-02		
Web-server deployment in GB, NM, TU	07-31-01	05-31-02	
Complete CCE-compliant UNIX upgrades (GB, TU, NM)	10-15-01	02-28-02	03-15-02
Complete CCE-compliant UNIX upgrades (CV)	10-15-01	04-30-02	
CCE design (to infrastructure level)	10-31-01	05-31-02	
CCE design (core applications)	03-31-02	08-31-02	
Final W2K domain design	09-01-01	04-30-02	
Begin W2K domain deployment	10-15-01	05-31-02	
Complete W2K Active Directory testing	03-31-02	05-31-02	
Issue memo on Windows XP moratorium	02-28-02		02-04-02
Complete deployment of shared calendar software	05-31-02		

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. In the past quarter we experienced two minor break-ins, both limited to a small number of systems and both repaired within days of discovery. Our multi-faceted approach to security continues to prove its value. However, we cannot prevent all possible types of attack. Shortly before the end of the quarter, the *ftp* server in Charlottesville was the target of a Distributed Denial-of-Service (DDOS) attack. It is impossible to entirely prevent such attacks since they require no penetration of our own network, and nearly impossible to stop them because they involve hundreds of remote systems (about 450 in this case). We have taken steps to deflect the attack, but will not be able to restore access using the standard ftp.cv.nrao.edu service alias until the malicious traffic stops.

In the last quarter, we purchased hardware which, in combination with widely-used public-domain software, will improve our intrusion-detection and log-monitoring capabilities and reduce the staff time that would otherwise be needed to perform them. A formal RFQ for software to detect and handle viruses and other malicious attachments at our email delivery gateways, to supplement desktop anti-virus detection, was issued in late February 2002; evaluation of the bid received in mid-March, possibly including a demo of the package, should be complete by late April.

For some time we have been concerned about the continuing use of protocols which cannot encrypt account password and other sensitive information, thus exposing them to monitoring anywhere along the connection path. Following the lead of other institutions similar to the NRAO (such as Jodrell Bank and NOAO), we have announced our intention to block several of these protocols for connections from non-NRAO sites to NRAO systems, and instead require the use of Secure Shell. This change will take effect for *telnet, rlogin, rsh,* and *rcp* on July 1, 2002. We will provide training and documentation to NRAO staff that need remote login access, and are using a variety of ways to notify our external user community. The lead time will not only give the affected groups time to adapt to the change, but will also allow us to modify the services we provide which are affected and ensure that alternatives are available.

Due to limited staff time, the Computing Security Policy revisions and VPN (Virtual Private Networking) tests have yet to be done. VPN is needed for employees who are required to work frequently or for extended periods of time at non-NRAO locations, and to support telecommuters during construction at Edgemont Road in Charlottesville. The Policy must be revised to accommodate these issues as well as special-purpose Web servers and wireless networking security requirements.

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

- *Improving Web services*: The first of four new Web servers was deployed in Charlottesville and is now serving the main NRAO Web pages, the ALMA Web pages, and local site pages as well as mailing list management software and local *ftp* service. Mirroring will be configured and tested in the coming quarter, after which the remaining three systems will be shipped to Green Bank, Socorro, and Tucson.
- *Electronic calendar/event scheduling:* With the growth in collaborations resulting from projects such as ALMA and greater communication between staff at NRAO sites, we have seen a drastic increase in the difficulty of scheduling meetings involving multiple locations (some external to the NRAO). This has become even more complicated with the enhancements to our videoconferencing facilities this past quarter. We can no longer manage this scheduling by hand. In February, we began testing a software package which will allow shared event/facility booking calendars, including vital support for multiple timezones. We expect all NRAO meeting facility scheduling to be migrated to this package (WebEvent Publish) before the end of the coming quarter.
- *The Common Computing Environment project, or CCE (UNIX)*: NRAO-wide, there are more than 300 systems affected by the current round of CCE-compliant UNIX upgrades. Solaris 8 upgrades are complete in Green Bank, Tucson, and Socorro, and are close to completion in Charlottesville. RedHat Linux 7.2 upgrades began last November and are now complete in Green Bank, Tucson, and Socorro; they should be complete in Charlottesville by the end of April 2002. During this time, the group has continued to work on the definition of standards in the most important remaining infrastructure services. Before the end of the coming quarter, we expect to be ready to begin the next step: determining the set of core UNIX applications that will be installed on all desktop and public NRAO systems.
- *CCE (Windows)*: This group is developing an NRAO-wide Active Directory (AD) design and migration plan for the new Windows 2000 domain, and will also work toward common OS installation and application standards under Windows 2000, as the UNIX CCE group is doing in the UNIX environment. Tests for this design continued this part quarter, including an intensive workshop in Tucson where the

main NRAO Windows administrators met for four days of focused effort. Also this part quarter, an NRAO-wide moratorium on Windows XP was issued, and will be in effect until Active Directory migration is well underway and thorough evaluation of XP's technical and licensing features can be conducted.

Telecommunications

Milestone	Original Deadline	Revised Deadline	Date Completed
Complete deployment of new video conferencing services	02-28-02		02-28-02
Complete fiber re-wiring in Green Bank	02-28-02		02-28-02
Upgrade GBT LAN connection to 1 Gbps	02-28-02	05-15-02	
Release RFP for new intranet contract	02-28-02	N/A	N/A

In 2001, we procured equipment to make significant enhancement to the video services at the major NRAO sites, particularly to allow much easier access to scientific colloquia between sites. In Socorro, Green Bank, and Charlottesville we have video installations in both the local auditorium and the main conference room; we also have equipment in the conference rooms in Tucson and at the VLA site. To complete the list, we have two additional installations in smaller conference rooms in both Green Bank and Socorro. Most of this equipment was installed in 2001. However, the New Mexico sites are now fully on-line. All ten video locations are regularly in use. Comprehensive documentation is available in the rooms in paper form and also on the web. Testing with different configurations has been successful: we have three concurrent video conferences at times, and we have held conferences with five different video participants.

We have slightly changed our strategy for the renewal of our inter-site communications (intranet) contract, which expired at the end of February 2002. First, we decided to extend the present contract for a twelve-month period. This will give us more time to investigate other options thoroughly and to plan a smooth transition from one vendor to another if appropriate. Although other technologies exist, our present survey of the market indicates that we will likely stay with frame relay service. Since a workable contract is in place, the proposal for new service will be deferred until the third quarter at least.

We are still hoping that the new contract will be cheaper than the present one. In that case, we will investigate improving the service to the VLA site, Green Bank, and the VLBA sites. In all cases, this will improve the service that we can provide to remote observers, either during observations or after a visiting observer has returned to his home institution. Finally, we will consider upgrading the service at the four major sites to provide a better infrastructure for the expected increase in video conferencing.

In Green Bank, essentially all of the 10 Mbps coaxial cable has been replaced. It had been planned to do this gradually throughout the year, but this task was given unexpected priority due to the detection of radio frequency emissions from the cable and the connectors. Although this was fully shielded and grounded when originally installed, it had gradually degraded with time so as to become troublesome. The conversion to use 10 Mbps fiber connections directly to the Ethernet switches provides much superior service

than sharing a 10 Mbps coax connection with other machines. Newer computers were given 100 Mbps service to the switches. Fiber connections in the individual rooms of the residence hall are complete, although the four apartments are still to be rewired.

The connection between the GBT alidade and the GBT control room in the Jansky Addition is connected by 100 Mbps Ethernet service; it will soon be upgraded to 1 Gbps. This upgrade was delayed to late delivery of the new router interface cards. It should be complete early next quarter.

Charlottesville

The NRAO headquarters and the Central Development Laboratory were featured in special Sunday section of the Daily Progress. The article outlined both NRAO's role in the national and international science community, as well as the cutting edge engineering that takes place in the CDL.

EPO staff from NRAO participated in the International Conference on Communicating Astronomy to the Public. The meeting took place in Tenerife, Spain, and allowed communications and EPO professionals from various observatories from around the globe to share their current activities and best practices in EPO. NRAO was featured in a poster session and an oral session on our EPO strategic plan. Following the meeting, participants discussed the possibility of NRAO hosting the next iteration of this event.

In responding the most recent User's Committee Meeting, two temporary, part-time employees were hired to create a comprehensive and user-friendly image gallery. This will be a searchable database with white papers and descriptive paragraphs on astronomical objects.

Green Bank

The Green Bank Astronomy Education Center is a joint NSF and NASA-funded project to construct a state-of-the-art education and visitor center. Exhibits are being developed via an NSF Informal Education grant, entitled "Catch the Wave." The building, an approximately 20,000 square-foot facility, will house a large exhibit hall, an auditorium, classrooms, a computer lab, an observing deck, as well as gift and café areas. The facility will serve the dual purpose of a visitor facility for the general public and an education center for K-16 programs. Green Bank already has a very active education program, and this facility will allow both the quantity and quality of those programs to be significantly enhanced.

Construction is underway on the building, with the contractor progressing very well. The total project completion is approximately 17 percent. Most of the concreted foundation walls are now complete, some structural steel has been placed, and underground piping under the footprint of the building is now complete. The total scope of the project construction is within the project schedule and estimate of costs. Construction is expected to be complete by December 15, 2002.

The 90 percent Design Review of the Astronomy and Education Center Dormitory is scheduled for mid April 2002. The bid process will take place in the second quarter, and construction will start at the beginning of the third quarter of 2002. This facility is planned to support school groups who visit the AEC complex. Because of the distance most groups must travel, the ability to stay overnight will allow them a longer stay and a much more meaningful visit. The dormitory will have bunk rooms for males and females accommodating about 30 each, shower facilities, and a small number of individual dormitory rooms for supervisors.

Socorro

For one weekend day a month in the first quarter of 2002, we provided guided tours for more than 2100 people at the Very Large Array. Tours for the public are generally self-guided as we don't have regular *tour*

staff, but for these three days, NRAO employees volunteered their time to show the VLA to interested guests. The program was a rousing success. We also hosted 300 students from schools in our regular tour program for education and astronomy groups.

The Visitor Center Committee has recommended the addition of a 400 sq. ft. gift shop to the existing Visitor Center at the VLA. We attempted to get the state to give the building back to us but they ran out of time and failed to do so during this short legislative session. We will try again next year. In the meantime we are proceeding with plans for remodeling. SMPC has been hired to draw the plans for the addition, including ADA upgrades to the building.

We have contracted with ESI of Charlottesville to produce a new ten-minute visual presentation for visitors at the VLA. We hope to have it completed in DVD format by the end of the summer.

In a cooperative effort with New Mexico Tech, we are partially funding a two-element radio interferometer to be built at the Etscorn Observatory on the Tech campus. It will be used as an instructional tool for Tech students and NRAO summer students and teachers. We expect it to be completed by the end of summer 2002.

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)	1562.10	1225.20	271.00
Scheduled Maintenance and Equipment Changes	286.00	220.00	453.00
Scheduled Tests and Calibration	299.00	302.50	1395.00
Time Lost	105.70	50.70	27.25
Actual Observing	1456.40	1174.80	327.25

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

No.	Observer(s)	Programs
BF066	Fomalont, E. Kellermann, K. Richards, E. (Alabama, Huntsville) Garrett, M. (JIVE) Baan, W. (JIVE) Muxlow, T. (NRAL) Garrington, S. (NRAL) Alberdi, A. (IAA, Andalucia)	VLBI observations of the SA13 Deep Field. 21 cm
GBT01A-011	Dickey, J. (Minnesota) Lockman, F. J. McClure-Griffiths, N. (Minnesota)	Low latitude Galactic HI mapping with the GBT. 21 cm
GBT01A-017	Ransom, S. (McGill) Backer, D. (UC, Berkeley) Beasley, A. (OVRO) Greenhill, L. (CfA)	A search for binary and millisecond pulsars in globular clusters. 21 cm
GBT01A-069	Jacoby, B. (Caltech) Anderson, (Caltech) Kulkarni, S. (Caltech) Prince, T. (Caltech) Backer, D. (UC, Berkeley)	A Galactic bulge globular cluster pulsar search. 21 cm
GBT01A-075	Stairs, I. Manchester, R. (Australia Telescope) Lyne, A. G. (NRAL)	Multifrequency monitoring of a massive pulsar system. 11, 21, 50 cm
GBT01A-079	Thorsett, S. (UC, Santa Cruz) Stairs, I. Arzoumanian, Z. (NASA/GSFC)	Timing fast pulsars at the GBT. 21 cm
GBT02A-021	Lockman, F. J. Roshi, A. Balser, D.	A search for recombination lines from diffuse gas in the Galactic Center region. 11 cm

GBT02A-039	Camilo, F. (Columbia) Klein, B. (MPIfR) Mueller, (MPIfR) Wielebinski, R. (MPIfR) Kramer, M. (NRAL) Lorimer, D. (Manchester) McLaughlin, M. (Manchester) Stairs, I. Backer, D. (UC, Berkeley)	Searching for radio pulsations from the (X-ray) pulsar J0205+6449 in SNR 3C58. 21, 38 cm
GBT02A-043	Arzoumanian, Z. (NASA/GSFC) Strohmayer, T. (NASA/GSFC) Backer, D. (UC, Berkeley) McLaughlin, M. (Manchester)	Linking the pieces of an evolutionary puzzle: a search for millisecond radio pulsations from low-mass X-ray binaries. 21 cm
GBT02A-062	Camilo, F. (Columbia) Halpern, J. (Columbia) Stairs, I. Backer, D. (UC, Berkeley) Arzoumanian, Z. (NASA/GSFC)	Studying PSR J2229+6114: an energetic gamma-ray emitting young pulsar. 11, 21, 38 cm
GL026	Lonsdale, C. (Haystack) Lonsdale, C. (IPAC) Smith, H. (UC, San Diego) Diamond, P. (Manchester)	High sensitivity imaging of supernovae and masers in ARP 220. 21 cm

No.	Observer(s)	Programs
AA267	Alexander, P. (Cambridge) Riley, J. (Cambridge) Pooley, G. (Cambridge) Fabian, A. (Cambridge) Hardcastle, M. (Bristol, UK) Worrall, D. (Bristol, UK) Cotter, G. (Cambridge) Inskip, K. (Cambridge) Allen, S. (Cambridge) Crawford, C. (Cambridge)	Formation of cold clouds by FRII radio sources. 6, 20 cm
AA268	Avila, R. (Mexico/UNAM) Rodriguez, L.F. (Mexico/UNAM)	Monitoring the exciting sources of HH 212 and B335 outflows. 3.6 cm
AB0994	Berger, E. (Caltech)	Multi-frequency monitoring of the Brown Dwarf LP944-20. 1.3, 3.6, 6, 20 cm
AB1006	Berger, E. (Caltech) Rutledge, R. (Caltech) Bildsten, L. (UC, Santa Barbara) Martin, E. (Hawaii) Gizis, J. (IPAC) Basri, G. (UC, Berkeley)	Search for emission from L and late M stars. 3.6 cm
AB1008	Bruns, C. (Bonn U.) Kerp, J. (Bonn U.)	HI small-scale structure in the northern Magellanic Stream. 20 cm
AB1009	Beltran, M. (UC, Davis) Estalella, R. (Barcelona) Ho, P. T. P. (CfA) Anglada, G. (IAA, Andalucia)	Continuum survey of very young thermal radio jets. 0.7 cm

AB1016	van Breugel, W. (LLNL) Reuland, M. (LLNL) deVries, W. (LLNL) DeBreuck, C. (IAP, Paris) Rottgering, H. (Leiden) Carilli, C. Rottgering, H. (Leiden)	High resolution imaging of Z>3 radio galaxies. 3.6, 6 cm
AB1017	Blomme, R. (Royal Obs) Prinja, R. (U. College London) Runacres, M. (Royal Obs)	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
AB1020	Beck, S. (Tel-Aviv U.) Turner, J. (UCLA) Gorjian, V. (JPL)	Super nebulae in NGC 1808. 1.3, 2 cm
AB1022	Birkinshaw, M. (Bristol, UK) Worrall, D. (Bristol, UK) Wilkes, B. (CfA) Green, P. (CfA)	Radio counterparts of Chandra serendipitous sources. 3.6, 20 cm
AB1023	Beck, S. (Tel-Aviv) Turner, J. (UCLA)	Starburst in VII Zw 19. 2, 6, 20 cm
AB1028	Boboltz, D. (USNO) Diamond, P. (Manchester) Hollis, J. (NASA/GSFC) Johnston, K. (USNO) Fey, A. (USNO)	Statistical study of SiO maser emission toward late-type stars. 0.7 cm
AB1029	Brisken, W. Thorsett, S. (UC, Santa Cruz) Goss, W. M.	Proper motion of the Duck pulsar: B1757-24. 20 cm

AB1048	Blomme, R. (Royal Obs)	Observations of HD16112 & HD 17971 with XMM Newton. 3.6, 6, 20 cm
AC600	Clarke, T.	Faraday study of galaxy cluster core sources. 3.6, 6 cm
AC604	Claussen, M. Beasley, A. (OVRO)	Survey for water masers in the star-forming ring of NGC224 = M31. 1.3 cm
AC605	Claussen, M. Wilner, D. (CfA)	Monitoring continuum emission from TW Hya. 2, 3.6, 6, 20 cm
AC609	Choi, M. (SA/IAA, Taiwan) Ho, P. T. P. (CfA)	Photochemistry around the HH 270 protostellar outflow. 1.3 cm
AC612	Carilli, C. Petric, A. (Columbia) Bertoldi, F. (MPIR, Bonn) Menten, K. (MPIR, Bonn) Omont, A. (IAP, Paris) Cox, P. (IAP, Paris) Djorgovski, G. (Caltech) McMahon, R. (Cambridge) Isaak, K. (Cambridge)	CO emission from two infrared luminous high redshift QSOs. 0.7 cm
AC616	Colina, L. (IFCA) Alberdi, A. (IAA, Andalucia) Torrelles, J. (IAA, Andalucia) Panagia, N. (STScI) Wilson, A. (Maryland)	Search for new radio supernovae in NGC 7469. 3.6 cm
AC617	Chengalur, J. (TIFR) Nanekar, N. (TIFR) Clarke, T. Wrobel, J.	Rotation measure of an intervening spiral at Z=0.437. 20 cm

AC622	Carilli, C. Petric, A. (Columbia) Omont, A. (IAP, Paris) Cox, P. (IAP, Paris) Beelen, A. (IAP, Paris) McMahon, R. (Cambridge) Isaak, K. (Cambridge) Priddey, R. (Cambridge) Bertoldi, F. (MPIR, Bonn) Menten, K. (MPIR, Bonn)	Radio continuum properties of far-IR luminous QSOs at z~2. 20 cm
AC627	Cotter, G. (Cambridge) Readhead, A. (Caltech) Pearson, T. (Caltech) Mason, B. (Caltech) Wilkinson, P. (Manchester) Browne, I. (Manchester) Bolton, R. (Cambridge) Jones, M. (Cambridge) Saunders, R. (Cambridge) Taylor, A. (Cambridge) Pooley, G. (Cambridge) Waldram, E. (Cambridge) Grainge, K. (Cambridge)	Radio sources selected at high frequency. 0.7, 1.3, 6, 20 cm
AC629	Chatterjee, S. (Cornell) Cordes, J. (Cornell) Wong, D. (Cornell) Brisken, W. Goss, W. M. Fomalont, E. Benson, J. McKinnon, M. Thorsett, S. (UC, Santa Cruz) Kramer, M. (Manchester) Lyne, A. (Manchester) Lazio, T. J. W. (NRL) Backer, D. (UC, Berkeley) Golden, A. (Ireland)	VLA survey for pulsar astrometry with the VLBA. 3.6, 20 cm

AC630	Curiel, S. (Mexico/UNAM) Trinidad, M. (Mexico/UNAM) Canto, J. (Mexico/UNAM) Hernandez, L. (Mexico/UNAM) Torrelles, J. (IAA, Andalucia) Gomez, J-L. (IAA, Andalucia) Anglada, G. (IAA, Andalucia) Ho, P. T. P. (CfA) Patel, N. (CfA) Greenhill, L. (CfA) Rodriguez, L. (Mexico/UNAM) Garay, G. (Chile)	Powering source of the water maser bubble in Cepheus A. 3.6 cm
AC631	Sanchez Contreras, C. (JPL) Sahai, R. (JPL) Claussen, M.	The 1667 MHz OH Masers in the protoplanetary Nebula He 3-1475. 20 cm
AC635	Cohen, A. (NRL) Kassim, N. (NRL) Lazio, T. J. W. (NRL) Lane, W. (NRL) Gross, C. (NRL) Condon, J. Perley, R. Cotton, W.	Ultra-steep spectrum sources. 20 cm
AD458	Dickey, J. (Minnesota) Heiles, C. (UC, Berkeley)	Variations in the HI optical depth toward compact continuum sources. 20 cm
AD460	De Pree, C. (Agnes Scott College) Davis, L. (Agnes Scott College) Wilner, D. (CfA) Goss, W. M.	Young massive star formation region G20.08. 0.7 cm
AD461	Darling, J. (Cornell) Giovanelli, R. (Cornell)	Continuum snapshot survey of OH mega maser hosts. 6 cm

AD463	DeBreuck, C. (IAP, Paris) Carilli, C. Rottgering, H. (Leiden) Miley, G. (Leiden) Kurk, J. (Leiden) Pentericci, L. (MPIA, Heidelberg)	High redshift radio galaxies in proto clusters. 20 cm
AE145	Eyres, S. (Lancashire) Zijlstra, A. (Manchester) Kurtz, D. (Lancashire) Tyne, V. (Keele) Evans, A. (Keele) Smalley, B. (Keele)	Planetary nebula around V4334 Sgr. 2, 6 cm
AF386	Fish, V. (CfA) Reid, M. (CfA)	Ammonia absorption in HII regions. 1.3 cm
AF389	Forman, W. (CfA) Carilli, C. Birkinshaw, M. (Bristol, UK) Jones, C. (CfA) David, L. (CfA)	Radio structures and X-ray emitting gas in early-type galaxies. 20 cm
AG618	Giroletti, M. (Bologna) Giovannini, G. (Bologna) Treves, A. (Milano Obs) Falomo, R. (Padova) Dallacasa, D. (Bologna)	A sample of nearby BL lac objects. 3.6, 20 cm
AG619	Giovannini, G. (Bologna) Taylor, G. Feretti, L. (Bologna) Venturi, T. (Bologna) Cotton, W. Lara, L. (IAA, Andalucia)	The core of the super luminal giant radio source 1144+35. 0.7, 1.3, 2, 3.6, 20, 90 cm
AG621	Gomez, Y. (Mexico/UNAM) Anglada, G. (IAA, Andalucia) Torrelles, J. (IAA, Andalucia) Miranda, L. (IAA, Andalucia)	OH Zeeman observations of planetary nebula K 3-35. 20 cm

AG622	Greenhill, L. (CfA) Chandler, C. Reid, M. (CfA) Moran, J. (CfA)	Outflows from Orion BN/KL source I. 0.7 cm
AH761	Haarsma, D. (Calvin College) Buchalter, A. (Caltech) Falco, E. (CfA) Kochanek, C. (CfA) Lehar, J. (CfA) McMahon, R. (Cambridge) Winn, J. (CfA)	Search for gravitationally lensed radio lobes. 6 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
AH767	Hofner, P. (Puerto Rico) Cesaroni, R. (Arcetri) Rodriguez, L.F. (Mexico/UNAM) Marti, J. (U. Jaen)	The accretion disk around the high mass proto-star 20126+4104. 0.7 cm
AH768	Hoare, M. (Leeds) Pattison, I. (Leeds) Hartquist, T. (Leeds) Blitz, L. (UC, Berkeley) Pedlar, A. (Manchester) Garrington, S. (Manchester)	The dense HII regions in M33 and IC 10. 6 cm
AH771	Humphreys, E. (Chalmers, Onsala) Pihlstrom, Y. Sjouwerman, L.	Stellar SiO masers: where is the resolved out VLBA flux? 0.7 cm
AH774	Healy, K. (Arizona State) Claussen, M. Hester, J. (Arizona State)	Monitoring water maser emission from low-mass stars in HII regions. 1.3 cm

AH775	Hyman, S. (Sweet Briar) Lazio, T. J. W. (NRL) Denn, G. (Sweet Briar) Kassim, N. (NRL)	Monitoring the galactic center for transient detection. 90 cm
AH778	Harper, G. (Colorado/JILA) Brown, A. (Colorado/JILA) Guinan, E. (Villanova)	Extended atmosphere of Alpha Orionis. 1.3, 2, 3.6, 6, 20 cm
AI098	Ivison, R. (Royal Obs) Dunlop, J. (Edinburgh) Hughes, D. (INAOE, Mexico) Blain, A. (Caltech) Smail, I. (Durham)	Deep survey in the Lockman-E field. 20 cm
AI099	Ivezic, Z. (Princeton) Knapp, G. (Princeton) Rupen, M.	Radio properties of the SDSS bright quasar survey. 3.6, 20 cm
AJ286	Johnson, K. Kobulnicky, H. (Wisconsin) Goss, W. M.	Search for ultra dense extra galactic HII regions. 3.6, 6 cm
AK509	Kulkarni, S. (Caltech) Fraill, D.A. (Caltech) 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
AK532	Kobulnicky, C. (Wisconsin) Martin, C. (Caltech)	NGC 1569, the nearest starburst with a galactic wind. 20, 90 cm
AK541	Keto, E. (CfA) Ho, P. T. P. (CfA)	Ammonia observations of hot core G10.6-04. 3.6 cm
AK542	Kharb, P. (IIA, Bangalore) Gabuzda, D. (NFRA) Shastri, P. (IIA, Bangalore)	Rotation measures for a sample of X-ray BL lac objects. 20 cm

AK543	Koopmans, L. (Caltech) de Bruyn, 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
AL554	Li, D. (Cornell) Dickey, J. (Minnesota) Goldsmith, P. (Cornell)	Deep imaging of HI narrow line absorption in dark clouds. 20 cm
AL556	Lazio, T. J. W. (NRL) Cordes, J. (Cornell)	Steep-spectrum sources toward the galactic center. 6 cm
AL557	Lovell, J. (CSIRO) Bignall, H. (Adelaide) 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
AL558	Lang, C. (Massachusetts) Goss, W. M. Rodriguez, L. (Mexico/UNAM)	New observations of the arches cluster: search for variability and low mass stars. 3.5 cm
AL559	Lacy, M. (UC, Davis) Gregg, M. (UC, Davis) Becker, R. (UC, Davis)	A lensed, FeLoBAL quasar from FIRST-2Mass matching. 2, 3.6, 6, 20 cm
AL561	Lim, J. (SA/IAA, Taiwan) Tung-Hui, L. (Calgary) Van-Trung, D. (SA/IAA, Taiwan) Kwok, S. (Calgary)	Search for ionized jets in narrow-waist bipolar nebulae. 0.7, 1.3 cm

AL563	Lu, F. (Massachusetts) Lang, C. (Massachusetts) Wang, D. (Massachusetts)	The Crab-like SNR G54.1+.3. 20 cm
AL564	Landt, H. (STScI) Perlman, E. (Maryland) Padovani, P. (STScI)	Faint sample of BL lacertae objects. 20 cm
AM684	Maccorone, T. (Yale) Nowak, M. (Yale) Bailyn, C. (Yale) Brisken, W. Jain, R. (Yale)	Searching for outflows in Aql X-1. 1.3, 3.6 cm
AM687	Monnier, J. (CfA) Greenhill, L. (CfA) Tuthill, P. (Sydney) Danchi, W. (NASA/GSFC)	Monitoring the WR 112 binary system. 0.7, 1.3, 2, 3.6, 6, 20 cm
AM702	Markovic, T. (NMIMT) Owen, F. Eilek, J. (NMIMT)	Radio halos in Abell Clusters of galaxies. 20 cm
AM708	Murgia, M. (Bologna) Parma, P. (Bologna) Mack, K. (NFRA) deRuiter, H. (Bologna)	Dying radio galaxy candidates. 20 cm
AM713	Mohan, R. N. (Raman Institute) Ulvestad, J.	Resolving the nucleus of NGC 253. 0.7 cm
AN104	Nagar, N. (Arcetri) Falcke, H. (MPIR, Bonn) Wilson, A. (Maryland)	Search for AGN in ultra luminous infra-red galaxies. 2 cm
AO163	Owen, F. Lonsdale, C. (Caltech) Morrison, G. (IPAC) Smith, G. (UC, San Diego) Xu, C. (IPAC)	Very deep radio SIRTF survey: faint source, radio FIR correlation. 20 cm

AO164	Ogley, R. (Keele) Eyres, S. (Lancashire) Stirling, A. (Lancashire) Kenworthy, M. (Arizona)	Nebulosity around AG Dra. 6 cm
AP427	Prouton, O. (Padova) Bressan, A. (Padova) Franceschini, A. (Padova) Gruppioni, C. (Padova) Granato, G. (Padova) Silva, L. (Trieste Obs) Pratap, P. (Haystack)	Evolutionary properties of compact dusty starbursts. 1.3 cm
AP430	Pedlar, A. (Manchester) Muxlow, T. (Manchester) Wills, K. (Sheffield)	327 MHz observations of Messier 82 using the PT link. 90 cm
AP433	Pedelty, J. (NASA/GSFC) Hollis, J. (NASA/GSFC)	Q Band monitoring of the R Aquarii binary system. 0.7 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)	Sensitive search for radio emission from the highest redshift QSOs. 20 cm
AR458	Rupen, M. Mioduszewski, A. Dhawan, V.	Radio and X-ray activity in Galactic black hole X-ray transients. 0.7, 1.3, 2, 3.6, 6, 20 cm
AR464	Reynoso, E. (IAFE) Hughes, J. (Rutgers) Moffett, D. (Furman)	Expansion of Tycho's supernova remnant, 3C10. 20 cm

AR465	Reipurth, B. (Colorado/JILA) Rodriguez, L. (Mexico/UNAM) Anglada, G. (IAA, Andalucia) Bally, J. (Colorado/JILA) Zapata, L. (Mexico/UNAM)	Large survey of outflow regions. 3.5 cm
AR466	Ratay, D. (Florida) Gottesman, S. (Florida)	Global properties of barred and flocculent disk galaxies. 20 cm
AR473	Rodriguez, L. (Mexico/UNAM) Wilner, D. (CfA) Ho, P. T. P. (CfA) Loinard, L. (Mexico/UNAM)	The young source IRAS 04368+2557. 0.7, 3.6, 6 cm
AR475	Rodriguez, L.F. (Mexico/UNAM) Wilner, D. (CfA) Ho, P. T. P. (CfA) Claussen, M. Curiel, S. (Mexico/UNAM) Porras, A. (Mexico/UNAM)	The possibly binary jet in L1551. 3.6 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

AR480	Rupen, M. Mioduszewski, A. Dhawan, V.	High frequency observations of the black hole binary Cygnus X-3. 0.7, 1.3, 2, 3.6, 6 cm
AS717	Sjouwerman, L. Messineo, M. (Leiden) Habing, H. (Leiden)	43 GHz SiO maser emission in late-type bulge stars with 86 GHz SiO. 0.7 cm
AS718	Su, Y-N. (NCU, Taiwan) Lim, J. (SA/IAA, Taiwan) Ho, P. T. P. (CfA)	Molecular envelopes of high-mass protostars. 1.3 cm
AS719	Snellen, I. (Royal Obs) Best, P. (Royal Obs)	Distant FR I radio galaxies. 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
AS721	Schmitt, H. Calzetti, D. (STScI) Armus, L. (Caltech)	Star formation of local starbursts. 20 cm
AS723	Stockdale, C. (NRL) Cowan, J. (Oklahoma) Maddox, L. (Oklahoma) Prestwich, A. (CfA) Primmi, F. (CfA) Zezas, A. (CfA)	SNRs in nearby spiral galaxies. 20 cm
AS724	Sollins, P. (CfA) Ho, P. T. P. (CfA) Zhang, Q. (CfA) Keto, E. (CfA)	Detecting structure around massive young stars. 1.3 cm
AS727	Schmitt, H.	A complete sample of Seyfert galaxies. 3.6 cm

AS728	Schmitt, H.	Understanding the jet structure of MCG+8-11-11 and Mrk 6. 1.3 cm
AT263	Thuan, T. (Virginia) Ulvestad, J.	Deeply embedded starburst in the BCD galaxy SBS 0335-052. 3.6 cm
AT269	Takakuwa, S. (SA/IAA, Taiwan) Lim, J. (SA/IAA, Taiwan) Choi, M. (SA/IAA, Taiwan)	Binary protostellar system L1551 IRS 5. 0.7 cm
AT270	Tarchi, A. (MPIR, Bonn) Peck, A. (MPIR, Bonn) Greve, A. (IRAM)	Neutral hydrogen absorption in NGC 2146. 20 cm
AT271	Tsujimoto, M. (Kyoto) Koyama, K. (Kyoto) Kobayashi, N. (NAO) Goto, M. (NAO) Tsuboi, Y. (Penn State) Saito, M. (CfA)	A cluster of hard X-ray sources in a class 0 protostar core. 3.6 cm
AT272	Turner, J. (UCLA) Beck, S. (Tel-Aviv U.)	Supernebulae in NGC 5253 and II ZW 40. 1.3, 2 cm
AT273	van der Tak, F. (MPIR, Bonn) Menten, K. (MPIR, Bonn)	Small scale distribution of dust around high-mass protostars. 0.7 cm
AU090	Umana, G. (Bologna) Trigilio, C. (Bologna) Leone, F. (Catania)	Probing the inner regions of the B Lyrae radio nebula. 0.7, 1.3 cm
AV253	Trung, V. (SA/IAA, Taiwan) Lim, J. (SA/IAA, Taiwan)	Dust disks in IRC+10216 and the Egg Nebula. 0.7 cm
AW563	Williams, P. (Edinburgh) Dougherty, S. (DRAO)	Continuing monitoring of WR 125. 3.6, 6, 20 cm

AW568	Wilcots, E. (Wisconsin) van Gorkom, J. (Columbia) Zabludoff, A. (Wisconsin) Mulchaey, J. (Mt. Wilson) Williams, B. (Delaware)	Evolution of HI content of poor groups of galaxies. 20 cm
AW574	Wrobel, J. Taylor, G. Myers, S. Gregory, P. (British Columbia)	Phase calibration sources at low galactic latitudes. 3.6 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
AW578	Wilner, D. (CfA) Ho, P. T. P. (CfA) Rodriguez, L.F. (Mexico/UNAM) Mathieu, R. (Wisconsin)	Inner regions of disks around nearby T Tauri stars. 0.7, 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
AW580	Wilner, D. (CfA) De Pree, C. (Agnes Scott College) Zauderer, A. (Agnes Scott College)	Hyper compact HII regions in W51. 0.7 cm

AW582	Webster, Z. (UC, Berkeley) DiFranceso, J. (UC, Berkeley) Anglada, G. (IAA, Andalucia) Welch, W. (UC, Berkeley) Wilner, D. (CfA) Rodriguez, L.F. (Mexico/UNAM)	The embedded protostars in NGC 1333. 0.7 cm
AY128	Young, L. (NMIMT) van Gorkom, J. (Columbia)	Interacting HI in two elliptical galaxies. 20 cm
AZ136	Zhao, J-H. (CfA) McGary, R. (CfA) Goss, W. M. Bower, G. (UC, Berkeley)	VLA monitoring the 106-day cycle of Sgr A. 0.7, 1.3, 2 cm
AZ138	Zebker, H. (Stanford) Harcke, L. (Stanford) Butler, B. Slade, M. (JPL) Jurgens, R. (JPL)	Goldstone/VLA radar observation of Callisto. 3.6 cm
BB138	Bach, U. (MPIR, Bonn), et al. *See VLBA Program List*	Motion in the counter jet of Cygnus A. 2, 6 cm
BD079	Diamond, P. (Manchester), et al. *See VLBA Program List*	TX Cam returns. 0.7 cm
BF063	Fix, J. (Alabama), et al. *See VLBA Program List*	Hydroxyl masers in late type stars. 18 cm
BF066	Fomalont, E., et al. *See VLBA Program List*	VLBI Observations of SA 13 deep field. 18 cm
BG118	Greenhill, L. (CfA), et al. *See VLBA Program List*	SiO maser motions in Orion BN/KL. 0.7 cm
BG123	Giroletti, M. (Bologna), et al. *See VLBA Program List*	VLBA observations of a sample of nearby BL-Lacs. 6 cm

BG124	Giovannini, G. (Rome Obs), et al. *See VLBA Program List*	VLBI observations of the giant super luminal source 1144+35. 4, 6 cm
BK076	Kurayama, T. (NAO), et al. *See VLBA Program List*	Parallax measurement of Miras for period luminosity relation. 1 cm
BP089	Piner, B. (Whittier College), et al. *See VLBA Program List*	Monitoring of ultra-fast blazars. 0.7, 1 cm
BP092	Polatidis, A. (MPIR, Bonn), et al. *See VLBA Program List*	Observations of flat spectrum weak line radio galaxies. 6 cm
BS102	Sahai, R. (JPL), et al. *See VLBA Program List*	The water masers in the "water-fountain" proto planetary IRAS 16342-3814. 1.3 cm
BW056	Winn, J. (MIT), et al. *See VLBA Program List*	An unusual gravitationally lensed quasar. 2 cm
BW060	Winn, J. (MIT), et al. *See VLBA Program List*	Possible third image in gravitational lens J1632-0033. 4, 20 cm
GL026	Lonsdale, C. (Haystack), et al. *See VLBA Program List*	High sensitivity imaging of supernovae and masers in Arp 220. 18 cm
GP030	Porcas, R. (MPIR, Bonn), et al. *See VLBA Program List*	Global VLBI study of gravitational lens 2016+112. 18 cm

VLBA Observing Programs

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

No.	Observer(s)	Programs
BA051	Aller, H. (Michigan) Aller, M. (Michigan) Homan, D. (Brandeis) Hughes, P. (Michigan) Roberts, D. (Brandeis) Wardle, J. (Brandeis)	Oblique shocks in jets: the evolution of Parsec-scale structures of sources with rapidly variable polarization. 0.7, 1, 2, 4 cm
BB123	Brotherton, M. (NOAO) Beasley, A. (OVRO) Becker, R. (UC, Davis) Gregg, M. (UC, Davis) Lacy, M. (UC, Davis) Laurent-Muehleisen, S. (UC, Davis)	Milliarcsecond structure of radio-bright broad absorption line quasars. 20 cm
BB136	Brisken, W. Golden, A. (Ireland) Goss, W. M. Thorsett, S. (UC, Santa Cruz)	Parallax for PSR B0656+14 and measuring the radius of a neutron star. 18 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
BB141	Biggs, A. (Manchester) Browne, I. (Manchester) Jackson, N. (Manchester) Norbury, M. (Manchester) Wilkinson, P. (Manchester) Wucknitz, O. (Hamburg U.)	The quadruple gravitational lens system B0128+437. 3.6 cm

BB142	Brunthaler, A. (CfA) Falcke, H. (MPIR, Bonn) Greenhill, L. (CfA) Henkel, C. (MPIR, Bonn) Reid, M. (CfA)	Second epoch observations for extragalactic proper motions in the local group with the VLBA. 1 cm
BB145	Biggs, A. (Manchester) Rusin, D. (Manchester)	Resolving the radio jets in CLASS B1152+199. 4 cm
BB146	Biggs, A. (Manchester) Augusto, P. (Madeira) Browne, I. (Manchester) Chae, K. (Manchester) Mao, S. (Manchester) Wilkinson, P. (Manchester)	High resolution observations of JVAS B2114+022. 4 cm
BB148	Baganoff, F. (MIT) Taylor, G. Morris, M. (UCLA)	Simultaneous Chandra/VLBA observations of Sagittarius A*. 0.7 cm
BC113	Chatterjee, S. (Cornell) Cordes, J. (Cornell) McLaughlin, M. (Cornell) Lazio, T. J. W. (NRL) Arzoumanian, Z. (NASA/GSFC)	A very high proper motion pulsar. 18 cm
BC116	Chatterjee, S. (Cornell) Cordes, J. (Cornell) Goss, W. M. Fomalont, E. Benson, J. Lazio, T. J. W. (NRL) Arzoumanian, Z. (NASA/GSFC)	High frequency VLBA astrometry of pulsars. 6 cm
BC117	Cotton, W. Saslaw, W. (Virginia)	Search for lensing by the star in front of 3C 435 B. 3.6 cm
BC121	Claussen, M. Brogan, C.	VLBA Proper Motion Study of Water Masers in the FU Orionis Object Z CMa. 1 cm

BD077	Dallacasa, D. (Bologna) Fanti, R. (Bologna) Stanghellini, C. (Rome Obs) Tinti, S. (Bologna)	High frequency peakers. 0.7, 1, 2, 4, 6 cm
BD079	Diamond, P. (Manchester) Kemball, A.	TX Cam returns. 0.7 cm
BE023	Edwards, P. (ISAS) Piner, B. (Whittier College)	Markarian 421 - Monitoring after a TeV outburst. 1 cm
BF063	Fix, J. (Alabama) Mutel, R. (Iowa) Gayley, K. (Iowa) Ignace, R. (Iowa)	Hydroxyl masers in late type stars. 18 cm
BF066	Fomalont, E. Kellermann, K. Richards, E. (Alabama) Garrett, M. (NFRA) Baan, W. (NFRA) Muxlow, T. (Manchester) Garrington, S. (Manchester) Alberdi, A. (IAA, Andalucia)	VLBI Observations of SA 13 deep field. 18 cm
BF069	Fish, V. (CfA) Argon, A. (CfA) Reid, M. (CfA)	Mapping magnetic fields in massive star-forming regions. 20 cm
BF071	Fomalont, E. Benson, J. Taylor, G. Walker, R. C. Wrobel, J. Beasley, A. (OVRO) Peck, A. (MPIR, Bonn) Ma, C. (NASA/GSFC) Gordon, D. (NASA/GSFC) Petrov, L. (NASA/GSFC)	VLBA calibrator survey: filling the holes. 3.6 cm

BG109	Girart, J. (Illinois) Curiel, S. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM)	Radio identification of the very strong X-ray source in YLW 15. 6 cm
BG118	Greenhill, L. (CfA) Chandler, C. Diamond, P. (Manchester) Moran, J. (CfA) Reid, M. (CfA)	SiO maser motions in Orion BN/KL. 0.7 cm
BG123	Giroletti, M. (Bologna) Dallacasa, D. (Bologna) Falomo, R. (Padova) Giovannini, G. (Bologna) Treves, A. (Como)	VLBA observations of a sample of nearby BL-Lacs. 6 cm
BG124	Giovannini, G. (Bologna) Cotton, W. Feretti, L. (Bologna) Lara, L. (IAA, Andalucia) Taylor, G. Venturi, T (Bologna).	VLBI observations of the giant super luminal source 1144+35. 4, 6 cm
BH069	Hachisuka, K. (Graduated Univ.) Fujisawa, K. (NAO) Honma, M. (NAO) Imai, H. (NAO) Kameya, O. (NAO) Kawaguchi, N. (NAO) Manabe, S. (NAO) Miyoshi, M. (NAO) Nishio, M. (Kagoshima) Omodaka, T. (Kagoshima) Sasao, T. (NAO) Sawada-Satoh, S (NAO).	Determination of the velocity of Galactic rotation at IRAS 21008+4700. 1 cm

BH077	Hachisuka, K. (Graduated Univ.) Fujisawa, K. (NAO) Honma, M. (NAO) Imai, H. (NAO) Kameya, K. (NAO) Manabe, S. (NAO) Miyoshi, M. (NAO) Mochizuki, N. (Graduated Univ.) Nisio, M. (Kagoshima) Omodaka, T. (Kagoshima) Sasao, T. (NAO) Sawada-Satoh, S (NAO).	Detection of an annual parallax of water masers in W3 (OH). 1 cm
BH080	Hough, D. (Trinity Univ.)	Variability in the nuclei of lobe-dominated quasars. 4 cm
BH081	Healy, K. (Arizona State Univ.) Claussen, M. Hester, J. (Arizona State Univ.)	Protostars and water masers in M16, the Eagle Nebula. 1 cm
BH084	Hirotani, K. (NAO) Kameno, S. (NAO) Marcaide, J. (Valencia) Perez-Torres, M. (Bologna)	Pair plasma dominance in the pc-scale jets of B1150+812. 1, 2, 4, 6, 13, 20 cm
BH087	Ho, P. T. P. (CfA) Anglada, G. (IAA, Andalucia) Canto, J. (Mexico/UNAM) Curiel, S. (Universidad de Chile) Garay, G. (Universidad de Chile) Gomez, J-L. (LAEFF) Greenhill, L. (CfA) Patel, N. (CfA) Rodriguez, L.F. (Mexico/UNAM) Sollins, P. (CfA) Torrelles, J. (CSIC)	Tracking a "Puff" of spherically symmetric ejection in Cepheus A. 1 cm

BH091	Henkel, C. (MPIR, Bonn) Braatz, J. Patnaik, A (MPIR, Bonn). Peck, A. (MPIR, Bonn) Wilson, A. (Maryland)	Circumnuclear disk in the spiral galaxy IC 2560? 1 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.	VLBA 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
BK081	Kemball, A. Diamond, P. (Manchester)	TX Cam and S Per: complementary observations of the 3 mm. 0.7, 3 cm
BK082	Klare, J. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Lobanov, A. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	Absolute kinematics of the innermost jet region in 3C345. 0.7, 3 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

BK089	Kanekar, N. (NCRA) Briggs, F. (Kapteyn) Chengalur, J. (NCRA) Lane, W. (NRL)	Compact structure of QSOs behind damped Lyman-α systems. 9, 20 cm
BK090	Krichbaum, T. (MPIR, Bonn) Bach, U. (MPIR, Bonn) Terasranta, H. (Metsahovi) Ungerechts, H. (IRAM) Witzel, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	TOO VLBA monitoring of 1633+382 after a major millimeter-flare. 0.3, 0.7, 1 cm
BK091	Kovalev, Y. (ASC, Lebedev)	Dual frequency sub-mass structure in the highly variable source 0524+034. 2 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 Ho measured from the gravitational lens 1830-211. 1, 2, 4 cm
BL104	Lobanov, A. (MPIR, Bonn) Roland, J. (IAP, Paris) Ros, E. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	Cross-band monitoring of a flare in the VLBI core of 3C345. 0.7, 1, 2 cm
BM154	Marvel, K. (AAS) Alcolea, J. (OAN) Boboltz, D. (USNO) Bujarrabal, V. (OAN) Colomer, F. (OAN) Desmurs, J. (OAN) Diamond, P. (Manchester) Kemball, A.	Spatial distribution of SiO masers in AGB stars at 43 and 86 GHz. 0.3, 0.7 cm
BM155	Mutel, R. (Iowa) Helton, A. (Iowa) Su, B. (Yuman Observatory)	Structure of magnetic fields in AGN jets: Testing the Shock Model. 0.7, 1, 2 cm

BM162	Marscher, A. (Boston University) Aller, M. (Michigan) Jorstad, S. (Boston University) McHardy, I. (Southampton)	Relationship between X-ray flares and super luminal ejections in blazars. 0.7, 1 cm
BM167	Mioduszewski, A. Dhawan, V. Rupen, M.	High resource observation of X-ray binary Cygnus X-3 in quiescence. 0.7, 2 cm
BM173	Momjian, E. Carilli, C. Romney, J. Troland, T. (Kentucky)	VLBA observations on two possible in-beam calibrators for low frequency observations on the target source IRAS 17208-0014. 90 cm
BN014	Nagar, N. (Maryland) Falcke, H. (MPIR, Bonn) Wilson, A. (Maryland)	Accretion and obscuration in LINERs: What can we learn from the AGN core and twin pc-scale jets in M89? 2, 4, 6, 20 cm
BP080	Porcas, R. (MPIR, Bonn) Rioja, M. (OAN)	Investigation of the quasar pair 1308+326/1308+326/ 1308+328 GHz. 0.3, 0.7 cm
BP084	Porcas, R. (MPIR, Bonn) Browne, I. (Manchester) Wucknotz, O. (Hamburg U.) Biggs, A. (Manchester)	Astrometrically registered, multi-frequency imaging of B0218+357. 2, 3.6, 6, 18 cm
BP089	Piner, B. (Whittier College) Edwards, P. (ISAS) Jones, D. (JPL)	Monitoring of ultra-fast blazars. 0.7, 1 cm
BP090	Perez-Torres, M. (Bologna) Alberdi, A. (IAA, Andalucia) Guirado, J. (Valencia) Marcaide, J. (Valencia) Ros, E. (MPIR, Bonn)	M81* at 43 GHz. 0.7 cm

BP092	Polatidis, A. (MPIR, Bonn) Anton, S. (OAL) Bondi, M. (IRA) Caccianiga, A. (Brera) Marcha, M. (OAL)	VLBA observations of flat spectrum weak line radio galaxies. 6 cm
BP094	Phillips, R. (Haystack) Attridge, J. (Haystack) Doeleman, S. (Haystack) Lonsdale, C. (Haystack) Straughn, A. (Arkansas)	Registration of the 86 and 43 GHz transitions of SiO: the followup. 0.3, 0.7 cm
BR073	Roy, A. (MPIR, Bonn) Falcke, H. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Middleberg, E. (MPIR, Bonn) Walker, R. C.	Toward fainter sources: test of fast frequency switching for phase calibration at 3 mm. 0.3, 0.7, 2 cm
BR075	Roshi, D. Goss, W. M. Subrahmanyan, R. (ATNF)	Study of scatter broadening of the compact radio source in the direction of NGC 1977. 4, 20 cm
BR077	Ros, E. (MPIR, Bonn) Cohen, M. (Caltech) Kadler, M. (MPIR, Bonn) Kellermann, K. Lister, M. Vermeulen, R. (Dwingeloo) Zensus, J. A. (MPIR, Bonn)	Kinematics of parsec-scale structure in AGN: a survey. 2 cm
BS079	Stocke, J. (Colorado) Carilli, C. Taylor, G. Tumlunson, J. (Colorado)	HI Absorption structures of a galaxy halo cloud. 20 cm
BS087	Sudou, H. (Tohoku University) Iguchi, S. (NAO) Murata, Y. (ISAS) Taniguchi, Y. (Tahoku University)	Phase referencing VLBI observations of 3C 66B. 4, 13 cm

BS096	Suda, H. (University 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
BS101	Sato, N. (Nobeyama) Diamond, P. (Manchester) Ishihara, Y. (Nobeyama) Nakai, N. (Nobeyama) Yamauchi, A. (Nobeyama)	High velocity features of water maser in the Seyfert IC 2560. 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
BS103	Schmitt, H. Antonucci, R. (UC, Santa Barbara) Kinney, A. (NASA) Pringle, J. (IoA) Ulvestad, J.	Orientation of jets relative to dust disks in radio galaxies. 13 cm
BS104	Schmitt, H. Antonucci, R. (UC, Santa Barbara) Kinney, A. (NASA) Pringle, J. (IoA) Ulvestad, J.	Parsec-scale jets and the inner structure of Seyfert galaxies. 6 cm
BT060	Trinidad, M. (Mexico/UNAM) Anglada, G. (CSIC) Canto, J. (Mexico/UNAM) Curiel, S. (Mexico/UNAM) Garay, G. (Universidad de Chile) Gomez, J-L. (LAEFF) Frail, D. (Caltech) Patel, N. (CfA) Rodriguez, L. (Mexico/UNAM) Torrelles, J. (CSIC)	Proper motions studies of circumstellar water masers in AFGL 2591 and Lkha 234. 1 cm
BT061	Tarchi, A. (MPIR, Bonn) Greve, A. (IRAM)	Does the starburst galaxy NGC 2146 contain an AGN? 6 cm

BU021	Ulvestad, J. Ho, L. (Carnegie Obs)	ADAFs or jets in low-luminosity active galaxies? 0.7, 1, 2, 4 cm
BU023	Ulvestad, J. Falcke, H. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Peck, A. (MPIR, Bonn)	Emerging jet component in Mrk 348. 1, 2, 4 cm
BV043	Vlemmings, W. (Leiden) Diamond, P. (Manchester) Habing, H. (Leiden) van Langevelde, H. (Dwingeloo)	Monitoring the stellar image of enshrouded AGB stars. 20 cm
BW054	Walker, R. C. Wrobel, J.	Jet collimation regions. 0.7 cm
BW056	Winn, J. (MIT) Lovell, J. (ATNF)	An unusual gravitationally lensed quasar. 2 cm
BW060	Winn, J. (MIT) Kochanek, C. (CfA) Rusin, D. (NAO)	Possible third image in gravitational lens J1632-0033. 4, 20 cm
GK022	Kharb, P. (IIA, Bangalore) Shastri, P. (IIA, Bangalore) Gabuzda, D. (NFRA)	Polarization of four FR I radio galaxies. 3.6 cm
GL026	Lonsdale, C. (Haystack) Lonsdale, C. (IPAC) Smith, H. (UC, San Diego) Diamond, P. (Manchester)	High sensitivity imaging of supernovae and masers in Arp 220. 18 cm
GP030	Porcas, R. (MPIR, Bonn) Patnaik, A. (MPIR, Bonn) Garrett, M. (NFRA) Nair, S. (Raman Institute)	Global VLBI study of gravitational lens 2016+112. 18 cm
GP032	Polatidis, A. (MPIR, Bonn) Conway, J. (Chalmers, Onsala) Owsianik-Rottman, I. (MPIR, Bonn)	Estimating kinematical ages of compact symmetric objects. 3.6 cm

V047	Gurvits, L. (NFRA)	Structure of extremely high redshift quasars at 1.6 and 5 GHz. 6 cm
W330	Kameno, S. (NAO) Wajima, K. (ISAS, Japan) Zhi-Qiang, S. (ISAS, Japan) Inoue, M. (NAO) Sawada-Satoh, S. (ISAS, Japan)	Complementary multi-frequency GPS survey. 18 cm
W401	Frey, S. (FOMISGO) Gurvits, L. (JIVE) Gabuzda, D. (NFRA) Altschuler, D. (NAIC) Salter, C. (NAIC) Perillat, P. (NAIC) Aller, H. (Michigan) Aller, M. (Michigan) Hirabayashi, H. (ISAS, Japan) Davis, M. (SETI)	Structural variability in the brightest AGN: AO 0235+164. 6 cm

New Hires

Acree, Jeffrey	Electronics Engineer I	01/07/02
Beaudet, Carla	Electronics Engineer III	01/02/02
Bhatnagar, Sanjay	Assistant Scientist	01/23/02
Boyden, Christopher	Junior Engineering Associate	01/07/02
Cutshall, Ryan	Junior Engineering Associate	01/01/02
Holmstedt, Christian	Electronics Engineer III	01/15/02
Ingate, Pamela	AUI Administrative Assistant	02/01/02
Jenkins, Sherrie	Electronics Engineer III	01/01/02
Kohring, Megan	Public Education Specialist	02/19/02
Marquez, Ivan	Junior Engineering Associate	02/04/02
Miller, Theodore	Deputy Associate Director	02/20/02
Morgan, Thomas	Senior Scientific Programmer Analyst	01/07/02
Radziwill, Nicole	Division Head, GB Computing	03/25/02
Walsh, Dennis	Systems Analyst	03/11/02
Ye, Honglin	Senior Scientific Programmer Analyst	02/11/02

Terminations

Cutshall, Ryan	Junior Engineering Associate	01/01/02

Promotions

Lucero, Selfa	Executive Secretary, Data Mgmt	01/28/02
Marson, Ralph	Deputy Division Head, ALMA	03/01/02
Pokorny, Martin	Senior Systems Analyst	03/01/02
Taylor, Gregory	Division Head, Socorro Ops	01/01/02

Other Changes

Roberts, Morton	Retired, Emeritus Scientist	02/02/02

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CHUNG, A.; VAN GORKOM, J.H.; O'NEIL, K.; BOTHUN, G.D. LSB Galaxies and the Tully-Fisher Relation.

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