Quarterly Report

September - December 2001

National Radio
Astronomy
Observatory

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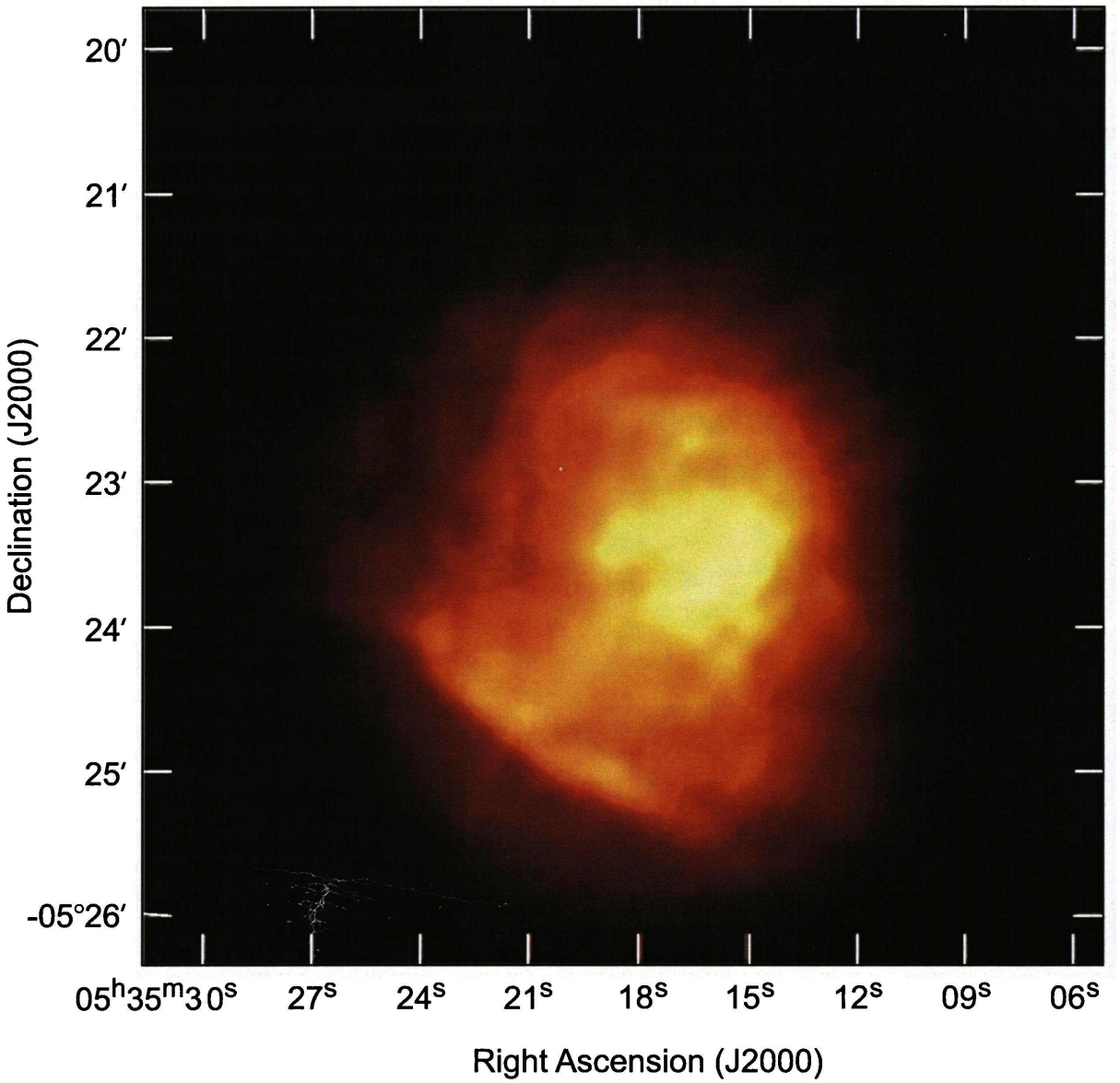

The Orion Nebula at 3.6 cm: First Combination of VLA and GBT Data.
Investigators: D. S. Shepherd, R. Maddalena, and J. P. McMullin

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Executive Summary

ALMA

Funds for the start of ALMA construction have been appropriated. The actual start of construction awaits action by the NSF Science Board. The Alma Executive Committee has begun an updating of the baseline cost model and the Work Breakdown Structure.

EVLA

The EVLA Project was approved for construction by the National Science Board. A Conceptual Design Review for the Correlator and Preliminary Design Reviews (PDR) for the EVLA System and Fiber Optics Subsystem were held. No major specification or design problems were identified by these reviews. PDR's for the remaining subsystems will be held in early 2002. Design and prototyping began on all EVLA subsystems.

Green Bank Telescope

The antenna is commissioned to frequencies up to 15 GHz and is performing at or above design specification. Good progress has been made in achieving observing capability in the basic spectral line modes. A trial participation of the GBT with the VLBA was made in December. Pulsar observing capability was enhanced.

The problem in the structure caused by a sudden "hard" stop has been fixed by a modification to the braking system. The azimuth track has been reviewed by a consultant and is satisfactory, although monitoring of the grout is required. Only one significant issue remains with the contractor (the HVAC system) and it is expected that final resolution will be made early in 2002.

Work continues on the samplers in the Spectrometer. The Spectral Processor and the Digital Continuum Receiver are ready for general use. The Berkeley-Caltech Pulsar Machine was used in the discovery of three new binary millisecond pulsars. Future instrumentation projects that are currently under way include a receiver for 68-92 GHz, a beam forming array at 18-21 cm, and the University of Pennsylvania Penn Array 3mm bolometer camera. A concentrated effort is being made on the Precision Telescope Control System which uses laser ranging to improve the accuracy of the pointing and surface.

Control of the first LO and a Doppler tracking algorithm were implemented. The GBT scan data FITS files have been defined and documented. The capabilities of the Observer's Interface are essentially complete, and progress is being made on making the configuration of a number of the modes automatic. Some simple high-level AIPS++ routines to analyze spectral line data are being tested.

Green Bank Site Engineering, Operations, & Projects

A visual inspection of the 20 members in the GBT having the highest stress revealed that all but one was in good condition. The member with a potential problem will be fixed during the first quarter of 2002. A

program of routine inspection is being developed. The OVLBI tracking station is scheduled to operate until March, 2002. The 20 meter antenna is being kept in operation until it use in future VLBI tests with the GBT is decided.

Progress on the construction of the Green Bank Astronomy Education Center has been good, and is approximately 10% complete.

Very Large Array & Very Long Baseline Array

The surfaces of three VLA antennas were adjusted based on 43 GHz holography, and the fifth antenna of the year was re-painted. New encoder electronics was installed on two VLA antennas, and a procedure is under development to modify encoder electronics in the field in order to reduce periodic pointing errors. A fall-arrest system has now been installed at the apexes of all VLA antennas. The first round of microwave holography of the Pie Town VLBA antenna has been completed, and analysis of the results is under way. Seven VLBA antennas now have 86 GHz receivers installed, providing a reasonable complement for a standalone high-frequency VLBI array.

A new frozen release (31DEC01) of the AIPS data-reduction software was created, and the move of the master copy of AIPS to Socorro has been completed. Capabilities of the AIPS task correcting for ionospheric effects in VLBA data have been improved. A new release of Jobserve incorporates new 1 milliarcsecond calibrator positions that also are included in the relevant calibrator data bases. Replacement Modcomp computers for the VLA have been tested, with some setbacks caused by faulty hardware; complete installation now is scheduled for the first quarter of 2002.

A large number of proposals (230) were received at the October 1 deadline for the VLBA and the VLA A configuration, including the second session in which the VLA-Pie Town link is to be used operationally. Numerous tests for the Pie Town link observing that begins in January 2002 have been conducted, with final system readiness tests to be conducted following the move to A configuration.

Central Development Laboratory

Significant progress was made in the study of two important problems in the design of millimeter-wave mixers—the saturation by thermal noise, and the suppression of undesirable Josephson currents. The investigation of the best devices for use in the ALMA bands at 211-274 GHz and 602-720 GHz continued. The construction of a second mixer measurement system continued with the work on the Dewar nearly complete.

The design of a new feed for the range 1.2-2.0 GHz, to be used in the EVLA project, was completed. Digital engineering involved aspects of the ALMA baseline correlator, and a logic card to support pulsar observations with the GBT spectrometer. The design effort on local oscillator sources and multipliers, especially for ALMA applications, continued.

A series of meetings was held this quarter to explore various design options and to begin the task of formulating a preliminary design of a fully-sampled focal plane array for use on the GBT.

Data Management

An external, AUI-sponsored review of Data Management (DM) activities was held in November. The report of the committee is being studied by NRAO.

The first version of the project book for the End-to-End Project (e2e) was completed this quarter. Work on one of the first stages, the archiving of data, has begun. The archiving system initially is for VLA data but will be extended to data from the GBT. This project, in coordination with other parts of DM and with ALMA, will look at pipeline issues of mutual interest.

Preparations were made for the release of version 1.6 of AIPS++ in January 2002, and planning was started for the next release in June. The AIPS++ group focused this quarter on user support and training, and leaders for the users group for synthesis and single-dish were appointed. Particular emphasis was placed on the continued development of AIPS++ application to GBT data.

The Central Computing Services have expended considerable effort in enhancing computer security. They have also improved web services this quarter.

During this quarter additional equipment has been installed which will provide enhanced video conferencing equipment. The installation is complete in Tucson, Green Bank, and Charlottesville, and will be finished in New Mexico during the first quarter of 2002.

Education and Public Outreach

NRAO hosted a workshop on Education and Public Outreach, in November. During the workshop the ongoing programs and plans for new initiatives were reviewed and a number of recommendations were made.

Progress on the construction of the Education Center in Green Bank was good, and the design of the associated Dormitory was nearly ready for a critical review.

Green Bank

New Binary Millisecond Pulsars - Three new binary millisecond pulsars have been discovered in the globular cluster M62 (NGC 6266) using the Green Bank Telescope. M62 was observed at a frequency of 1.4 GHz for four hours on August 16, 2001, with the GBT and Berkeley-Caltech Pulsar Machine (BCPM), a flexible 2 x 96-channel digital filterbank. Confirmation observations were carried out during the week of December 4, 2001. Pulsars were searched at the dispersion measure of the three previously known pulsars in the cluster (D'Amico et al. 2001, astro-ph/0105122). PSR J1701-3006D has a spin period of 3.418 ms, an orbital period of 1.118 days, and a minimum companion mass of 0.12 solar masses. PSR J1701-3006E has a 3.234 ms spin period and is orbited by a companion of at least 0.03 solar masses every 0.16 days. PSR J1701-3006F has a 2.295 ms spin period, an orbital period of 0.2 days, and a minimum companion mass of 0.02 solar masses. M62 is now the third globular cluster containing six or more known radio pulsars.

Investigators: *B. A. Jacoby, A. M. Chandler (Caltech); D. C. Backer, (UC, Berkeley); S. B. Anderson, and S. R. Kulkarni (Caltech)*

The Orion Nebula at 3.6 cm: First Combination of VLA and GBT Data - 3.6 cm continuum images of the Orion Nebula from the GBT and the VLA have been combined. This is the first such combination of images from the two telescopes and results in final image that is sensitive to emission on all angular scales down to an angular resolution of 8.4 arcsec. The GBT image was taken in "on-the-fly" mode on November 1, 2001, and covers a field of approximately 90 x 90 arcmin. The dynamic range of the image is 11,900:1, and is believed to be the highest dynamic range image ever achieved with a single dish telescope. All flux from the source within the observed bandwidth is retrieved by the GBT, and the image reveals the large scale structure of the nebula. The VLA image consists of a 3x3 mosaic taken in the "D Array" configuration on October 4, 2000. The mosaic covers about 7 x 7 arcmin, with a synthesized beam of 8.4 arcsec. The high resolution VLA image reveals numerous filaments and bright rims of emission. The combination of the two images, which was performed with AIPS++ software, provides a complete image for full scientific interpretation of both small and large scale features. This is a powerful new imaging capability and is expected to be the first of many combinations of GBT and VLA data.

Investigators: *D. S. Shepherd, R. Maddalena, J. P. McMullin*

Very Large Array

VLA Sees Star Turning into Planetary Nebula - Observations of the planetary nebula K3-35 with the VLA have revealed 22 GHz water-maser emission. Since the central star's intense ultraviolet radiation is expected

to quickly dissociate molecules, the period during which water-maser emission can be observed in a planetary nebula may last only about 100 years. These VLA observations thus represent the first example of this very brief initial stage in the life of a planetary nebula.

Investigators: Y. Gomez (Mexico/UNAM), L.F. Miranda (IAA/Andalucia), G. Anglada (IAA/Andalucia and CfA), and J. Torrelles (Barcelona).

VLA Confirms Interstellar Origin for Rapid Radio Variability - Simultaneous observations of rapid radio variability in the quasar J1819+3845, with the VLA and the Westerbork Synthesis Radio Telescope in the Netherlands, have confirmed that its variability on sub-hour time scales is caused by intervening gas in our own galaxy rather than in the quasar itself. The research, published in the January 3, 2002, issue of Nature, shows that flux maxima and minima seen by the VLA and Westerbork are offset in time, inconsistent with expectations for intrinsic variability in the quasar. Instead, the offsets imply that the different parts of the Earth move through a scintillation pattern generated by local gas within the Milky Way. The delays on successive days are all consistent with a plasma velocity of 36 km/s, and are interpreted to be caused by local plasma at a distance of about 20 pc (70 light years) from the Sun. Confirmation of the local nature of the scattering also obviates the need for extremely high (and possibly non-physical) brightness temperatures in this quasar and the entire class of intra-day variable sources.

Investigators: J. Dennett-Thorpe (Kapteyn Institute and University of Amsterdam, Netherlands) and A. G. de Bruyn (Kapteyn Institute and ASTRON, Netherlands)

Very Long Baseline Array

VLBA Finds Very Small Radio Sizes for Low-Luminosity Active Galaxies - Four-frequency imaging of three Low-Luminosity Active Galactic Nuclei (LLAGNs) has shown that they are completely unresolved, with size upper limits of 1,500-10,000 times the sizes of their central supermassive black holes. Previous research has implied that such objects have radio emission powered by low-efficiency accretion onto the central black holes. However, the X-ray/radio luminosity ratios of the three LLAGNs imaged by the VLBA are inconsistent with accretion models, implying that the radio emission actually is generated by a compact radio jet that is formed very close to the black holes. This research was published in the December 1 edition of Astrophysical Journal Letters.

Investigators: J. S. Ulvestad (NRAO) and Luis C. Ho (Carnegie Observatories)

On November 26, 2001, President George Bush signed the Fiscal Year 2002 appropriations bill for the Veteran's Administration, Housing and Urban Development, and Independent Agencies, including the National Science Foundation. The bill appropriates $12.5 million in funding for the start of ALMA construction. The actual start of construction in the U.S. awaits action by the National Science Board this spring. Funding for the European part of the ALMA project is expected to be considered by the ESO Council at its meeting in June. Unfortunately, funding for ALMA construction in Japan has been delayed until at least 2004.

Recognizing the course of recent events, the ALMA Coordinating Committee (ACC) directed the ALMA Executive Committee (AEC) to immediately defer any planning for a Trilateral project and complete the detailed planning for a bilateral ALMA with the original baseline scope of 64 12-m antennas and four receiver bands. To this end, the AEC has begun a complete review and updating of the baseline cost model and Work Breakdown Structure. A detailed plan will be delivered to the ACC in February.

Further information for the ALMA-U.S. project can be found at http://www.alma.nrao.edu/library/.

Milestones	Original Date	Revised Date	Date Completed
Complete Q-band build	12-31-02		
Complete K-band build	12-31-02		
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 construction of fiber room	06-01-02		
Start fiber installation	08-01-02		
Patch panel	09-01-02		
Trench fiber	09-01-04		
Installation of seven more K-band receivers (18-26.5 GHz) at VLA	01-31-01	01-30-03	
Demonstrate RFI from samplers and fiber optic transmitters can be reduced to acceptable levels	12-31-01	03-30-02	
Monitor RFI environment at VLA 1 - 18 GHz	12-31-01	03-30-02	
Develop block diagram for M&C, wye alarms, voice communication (DCS, LO/IF, Comp. Div. ES Div)	12-31-01	03-30-02	
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 computing engineering requirements	12-10-01		12-04-01

Milestones	Original Date	Revised Date	Date Completed
M/C computing operations requirements	12-10-01		12-04-01
M/C engineering requirements version 2	03-15-02		
M/C operations requirements version 2	03-15-02		
Prototype Displays	12-10-01	03-15-02	
EVLA Project Book	08-15-01	11-15-01	11-15-01
Next iteration project book chapter (formerly Software Design Document	08-31-01	03-31-02	
System PDR preparation	12-04-01		12-04-01
Revision labor requirements	02-01-02		12-04-01
Complete construction of Fiber Room	06-01-02	03-05-02	
Start fiber installation	08-01-02	06-03-02	
LO/IF PDR	01-22-02		
Feed/Rx PDR	02-12-02		
Software Top-level Architecture PDR	03-15-02		
M/C PDR	03-15-02		

Although the test equipment for the SOIDA test stand has been received, implementation is delayed to take advantage of a student co-op employment beginning in January.

The re-worked WVR prototype met requirements. Now two new production prototype models will be constructed and tested on-antenna.

Modification of helium lines and testing higher volume helium compressor is delayed until closer to the time of need.

The prototype displays, M/C software work, and Software Design Document have been delayed due to difficulty in recruiting qualified software engineers. An intensive effort is currently under way to correct this situation.

Management

NSF Form 1030, detailing the budget requirements for the Project over its 10-year duration, was submitted to the NSF in October. The National Science Board approved the Project for construction at its meeting on November 14.

Electronics

The System PDR, the Fiber Optic Subsystem PDR, and the Fiber Optic Subsystem Acquisition CDR were all conducted in Socorro this quarter. The Panel reports on the reviews are due early in January and the design team response in 30 days. Though excellent discussions and good ideas emerged from the presentations, there were no serious problems apparent. The other electronic subsystem PDRs are scheduled to be presented this quarter. Prototype designs are proceeding for a test antenna by April 2003.

Computing

A considerable effort took place gathering EVLA M/C Real-Time system requirements and Operations requirements. The EVLA Antenna M/C Preliminary Requirements Specification draft was completed and used as the basis for a presentation during the System Preliminary Design Review (PDR) December 4-5, 2001. A similar document was completed for the EVLA Operations requirements. New versions, incorporating comments from the review panel, are planned in time for the PDRs in the spring of 2002.

Strawman displays, implemented in Java, were developed while the initial release of the operations requirements was being prepared. It is likely that modified versions of these strawman displays will become the prototypical displays and that these prototypical displays will be released as a part of the second draft of the operations requirements document.

The software design document/project book has been replaced with work on the appropriate chapter in the project book. The previous version was released November 11; the next version is planned for late March 2002.

The EVLA System PDR was held on December 4, 2001. Initial versions of requirements for operations and engineering were released in mid November 2001 as partial preparation for the PDR. Comments on the initial versions of the requirements have been received. The comments will be analyzed and incorporated into the requirements documents. Release of a second version of these documents is expected in mid March, immediately before the M&C PDR.

A study group has been established for the purpose of examining candidate processors and Real Time Operating System kernels for 1) the antenna module interface board (MIB), 2) the correlator MIB, and 3) the antenna computer. The study group will hold its first meeting during the first week of January and has a deadline of late January 2002 or the first week of February 2002 for its recommendations. This study group will be a subgroup of a somewhat larger collection of people who will examine and discuss issues of MIB functionality, hardware, and software for the EVLA Monitor and Control system.

Engineering Services

The Engineering Services Division will now be installing the fiber on the array. Heavy equipment preparations are being made for this which will begin by the third quarter of 2002. The fiber optic patch

panel room and the RFI shielded rooms are ready to begin erection and should be complete by the end of the first quarter. Antenna feed and feed cone design continues and a vertex mockup is scheduled to be completed by the end of the second quarter. The hiring of personel for the Antenna Mechanical, Carpentry, and Machine shop groups is in progress.

Correlator

Recruitment for the key engineering positions began during the quarter and work on the detailed proposal to the Canadian Centre for Innovation for funding for the correlator began.

Antenna

Milestone	Original Deadline	Revised Deadline	Date Completed
Install lower feed arm lasers	09-15-00	06-03-02	
Complete Q-band tertiary	04-15-00	Postponed	
Measure az track profile	09-15-99	12-31-01	
Install optical guide scope	04-30-01	02-28-02	
Install new Az and El Brakes	11-30-01		11-07-01

GBT Mechanical Engineering and Central Instrument Shop Work

Milestone	Original Deadline	Revised Deadline	Date Completed
100 GHz MMIC Amps (10)	10-26-01		10-24-01
Design and fab. feedarm laser rangefinder cover	09-28-01	03-15-02	
Design & fab. feedarm laser rangefinder handling container	08-24-01	02-28-02	
Design & fab. quadrant detector mount	04-18-02		
PF2 Dewar mount & cart	11-09-01	01-30-02	
GBT Access Ladder Modification	01-30-02		
Servo RFI Box	02-28-02		

GBT Software and Computing

Milestone	Original Deadline	Revised Deadline	Date Completed
M&C / VLBA software integration	01-19-01	10-31-01	10-31-01
Observer (GO) interface completion	03-23-01	06-01-02	
Prepare for visiting observers	06-30-01	03-01-02	
Complete Doppler tracking capability	06-30-01	10-15-01	12-14-01
Unify GBT FITS file formats	06-30-01	11-30-01	12-14-01
Support for VLBI observations	08-15-01	10-31-01	12-22-01

GBT Operations

Milestone	Original Deadline	Revised Deadline	Date Completed
Use of MainSaver by Telescope Operations	06-01-01	10-22-01	11-01-01
Installation of GBT Hoist pads	10-30-01		10-05-01
Six-month structural inspection plan for GBT	07-30-01	03-30-02	
Operations of GBT from Jansky Lab	08-01-01	01-18-02	
Reduce maintenance days to 4 per week	01-07-02		
Decision on use of GBT Warehouse	02-15-02		
VLBI observing capability at L and S Bands	02-15-02		
Decision on date of 20 m mothball	03-30-02		
Six month Inspection of GBT welds /structure	06-30-02		
Reduce maintenance days to 3 per week	07-01-02		

GBT Project Summary

Scientific Commissioning Status

This quarter has seen considerable progress in achieving scientific observing capability with the GBT. The emphasis of the commissioning has been basic spectral line capability, which is required for a large fraction of observing programs. The facilities needed for spectral line observing are rather extensive and complicated, including not only operation of the antenna and front-end receivers, but local oscillator tracking of Doppler shifts, IF down-conversion, intensity calibration systems, spectrometer back-end systems, and extensive facilities within the new AIPS++ data reduction system. In early October, we assembled a "tiger team" made up of workers and managers in all the major areas listed above. This team worked steadily throughout the autumn, and by the end of the quarter had achieved scientific observing capability in the basic spectral line modes. An in-house survey program of 21 cm HI emission of galaxies was run throughout the month of December and the first trial run of a visitor spectral line observing program was made before Christmas. More capabilities will be tested and released early in the next quarter, including additional observing modes and additional GBT Spectrometer modes.

The antenna itself, in regard to pointing, focusing, etc., is now commissioned to ~15 GHz and is performing at or above design specification. RMS pointing accuracy is currently 6-7" and continues to be refined. Focus tracking curves have been established that will be adequate for operation through 26 GHz, and perhaps higher frequencies. Beam response is very clean, and is demonstrably better than any previous single dish telescope: images with the highest dynamic ranges ever obtained have already been achieved with the GBT.

Pulsar observing capability was enhanced during the last quarter and a number of scientific programs have been carried out, including the detection of three new millisecond pulsars (see the Science Highlights

section). The university-built Berkeley-Caltech Pulsar Machine (BCPM) was interfaced to the GBT Monitor and Control System, and the NRAO Spectral Processor was also released for pulsar-mode observations.

There was also progress in commissioning VLBI capability on the GBT. In November, the GBT and the Green Bank 20 Meter Telescope were used in a "Ties" experiment to determine the position of the GBT on the Earth's surface. This initial run determined the position to about 2 cm accuracy. A further run in December should confirm and refine this value. In late December, a trial participation of the GBT with the VLBA, using a VLBA observing file, was conducted. We anticipate that the GBT will be ready for routine participation in VLBA scientific projects in the first quarter of 2002.

Drive System Brakes

In the course of antenna evaluation and commissioning during the past two quarters, it was determined that the azimuth and elevation drive system brakes were stopping the antenna too quickly, resulting in too much energy being dissipated in the structure itself. With the antenna at full slew speed, a sudden, "hard" stop could potentially overstress some structural members. To protect the structure while a solution was found, the maximum slew speed was reduced to 25 percent of its design value. NRAO engineers, working in consultation with the contractor (Lockheed-Martin) and the brake manufacturer (Stearns) designed a solution to the problem that involved replacing about 75 percent of the brakes in azimuth and elevation with new models that apply their torque gradually over a 2-3 second interval. The remaining older brakes are used to slow the antenna, and the new brakes bring it to a stop and hold it in position. This modification was installed in mid November. Following a design tweak in early December, the solution was found to be successful in braking the antenna with acceptable acceleration, and the slew speeds in both azimuth and elevation drives were restored to their design specifications of 40 deg/min and 20 deg/min, respectively.

Azimuth Track

The modification to the azimuth track made in the summer of 2001 has been successful in stabilizing the track wear plates and retaining bolts. NRAO commissioned an engineering study of the track by an outside firm and received the report during the last quarter. The detailed study confirmed that the track modifications should allow operation of the GBT for the expected lifetime of the wear plates. The consultant advised that we monitor the condition of the grout that lies between the steel track plates and the concrete foundation. Indeed, some evidence for wear of the grout has been detected. To slow the rate of wear from water seeping between and under the plates, GBT mechanics have installed track covers to shield the track from rain water. We will continue to closely monitor the condition of both the track and grout.

Contract Close-Out Status

Most issues with the GBT construction contract have been resolved. A punch-list remains open, but the only item of significance on this list is the resolution of some issues with the HVAC system that cools the

Gregorian Receiver Room. Progress is being made on this issue, and final resolution should come early in the first quarter of 2002. At the successful resolution of this item, the final retainage payment will be made to the contractor, and the contractor will issue a release of claims. The warranty on GBT systems as a whole will expire on April 1, 2002. In the last quarter, the NRAO began a program to acquire a considerable number of critical spare parts that are needed to avoid lengthy down-times should failures in these components occur.

New Antenna Coordination Group

To ensure a strategic and practical overview of antenna engineering issues, and to effect a smooth transition of responsibility from the contractor to the NRAO, we have formed a new, cross-divisional coordination group for the GBT antenna. This group has broad responsibility for antenna engineering issues, defining inspection and maintenance procedures, with a particular emphasis on safe, long-term operation of the antenna. The group contains members from the Telescope Operations Group, the GBT Computing, Electronics, and Mechanical Engineering Groups, and the NRAO Structural Engineering Group. The group is coordinated by T. Weadon, and reports to the GBT Deputy Director for Technical Services, R. Prestage.

GBT Electronics Development

GBT Spectrometer Hardware

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 GBT Back-ends

The Spectral Processor was used this quarter for debugging and RFI measurements, and is ready for general use as a GBT back-end. Several modifications were undertaken to the spectral processor this quarter to improve reliability, and modifications to allow input of an RFI blanking signal were made. The Digital Continuum Receiver has also been in regular use by the GBT commissioners. Work on integrating the GBT VLBA terminal was completed, and several VLBI test runs were made.

GBT Cryogenics

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

GBT Computing and Software Development

The majority of effort over the last three months has been devoted to finishing the development of, and commissioning our spectral line observing capability, using the GBT Spectrometer. This includes providing rigorously correct calibration, completion of frequency-related items (frequency switching and Doppler tracking), rationalization and documentation of the scan data FITS files, provision of a real-time display of calibrated spectra, and simple and complete data analysis facilities within AIPS++.

The main items completed in the past quarter were as follows. The key Spectrometer modes were fully debugged by carefully inspecting the data at each stage, from raw lags through to calibrated spectra. A number of errors, both in the M&C Manager and AIPS++ filler processing stages were found and corrected. Automatic leveling by the adjustment of attenuators in the converter rack was implemented; this is on the basis of measurements of both the Analog Filter Rack power meters (for coarse adjustment) and the Spectrometer sampler duty-cycle ratios (for fine adjustment).

Control of the LO1, for both Doppler tracking and frequency switching was completed. Doppler tracking for position-switched observations required a new algorithm to allow for frequency updates in the absence of a Sig/Ref switching signal. Problems with the LO1 HP Frequency Synthesizer firmware were identified and circumvented. Numerous details relating to switching signal polarity and timing were identified and resolved. The LO1 power level is now set automatically on the basis of the chosen receiver and tuning frequency.

The content and structure of essentially all of the GBT scan data FITS files have been reviewed and rationalized, and the formats well documented in a series of notes. The resulting changes have been implemented in both the FITS writing (device managers) and reading (AIPS++ filler) software. The contents of the FITS files are now under formal change control; only the Spectral Processor and DCR FITS files have yet to be updated.

The capabilities of GO, the GBT Observer's Interface, to acquire data in a variety of observing modes is essentially complete. However, at the start of October, configuration of the rather complex IF/LO system was an entirely manual operation. As an interim solution, we have implemented a small number of glish scripts, which will automatically configure the system for the key supported observing modes. At the same time, we have designed a mechanism to allow GO to configure the system in a flexible and user-friendly manner, based on the specification of a small number of GO keywords. Implementation of this approach is ongoing.

We have worked closely with the AIPS++ group to specify, assist in the development of, and test simple high-level AIPS++ routines (referred to as "Uni-Jr") to allow simple and straightforward analysis of GBT spectral-line data. These routines are also used by the interim automated real-time display system.

In addition to the spectral line capability, work has proceeded in a number of other areas. A number of improvements have been made to the antenna control software. This includes a fix to a problem where the antenna FITS file would occasionally drop data; improvements to the stow and unstow commands; rate-limiting near travel limits; enabling of network controlled access to the antenna, and support of various antenna hardware tests and velocity limit changes.

The network communication problem described in the previous report is still believed to be the result of a bug in the VxWorks operating system. Correction of a semaphore locking bug in the LO1 and some other improvements have alleviated, but not eliminated the problem. Since we see no long-term future to the

continued use of VxWorks, we have started a pilot project to move the LO1 control software from a VxWorks/VME to an RT-Linux/Intel architecture. We are also exploring use of RT-Linux for the rangefinder control software (currently running under Windows). This work is greatly facilitated by the fact that, apart from the obvious OS-dependent layer (device-drivers), the GBT M&C system is already largely portable between VxWorks and Unix systems. If the port of the LO1 system is successful, we will plan to use Linux for all future GBT M&C systems.

Support for the metrology systems continues, as described in the PTCS project report below. Work has continued on support for VLBI, and both GBT Ties and VLBA test observations have been performed. The holography manager has been resurrected, and a variety of bugs fixed, in preparation for holography experiments in January. Continued support has been provided for pulsar observing, including use of the BCPM, which has now become relatively routine.

GBT Development Projects

Precision Telescope Control System (PTCS)

The PTCS is the advanced system of electronics and software that will allow the GBT to operate at frequencies of 100 GHz or above with good pointing and surface accuracy, while maintaining the best possible efficiency over all antenna elevation angles. The majority of the work on the PTCS in the last three months has focused on the complete instrumental characterization of the ground monuments and rangefinders, and development of a comprehensive XYZ trilateration analysis capability.

The metrology group has completed a precision calibration of the elevation (z coordinate) of each monument, using the model NPH6 custom built hydrostatic level instrument. The (x,y) coordinates will be bootstrapped using the laser instruments to measure distances between monuments—corrected for group index of refraction as a function of temperature, humidity, and pressure. The metrology group have also made precise measurements of the height of the azimuth track, at 45 degree intervals.

A number of extended measurement campaigns have been performed and archived. These include measurements between the monuments, as well as static measurements of the GBT cardinal points. Weather, configuration (which instrument is on which monument), calibration, and all other possibly needed parameters are recorded along with the data. A wealth of information about the properties of the GBT structure will be available from these measurements. So far, they have been used to investigated variations in the group index of refraction, especially across day/night boundaries, as well as providing input data for 2d closure and four-rangefinder trilateration measurements.

The 2d closure measurements will allow us to refine the (x,y) positions of the ground monuments. Considerable effort has been expended over the last three months to complete the software framework to allow routine analysis of trilateration experiments. Current results are producing rms residuals at the 300 micron level; this includes one remaining systematic error, believed to be due to the back-prism targets.

As noted in the software section, some investigations have been made into the feasibility of porting the rangefinder ZY software to Linux. At the same time, a number of bug-fixes and improvements have been

made, including development of a generic scheduler, which can schedule both ZY-to-ZY and non-ZY target measurements.

Work has proceeded to characterize the quadrant detector, and complete the mechanical mounting arrangements for the laser and detector. For now, these have taken second priority to mechanical work required for the RFI suppression project.

Finally, we have recruited a new engineer, Kim Constantikes, to work on the PTCS project. Kim has a strong background in electro-optical engineering and software development. Kim will initially work on continued development of the metrology trilateration capabilities, and characterization of the feedarm using the quadrant detector.

3 mm Receiver Module 1

One of the major instrument development projects for the GBT is the first receiver for the 3 mm wavelength band. This receiver will have two modules, the first covering the 68-92 GHz band, and the second the 90-116 GHz band. Module 1 will be a dual-beam, dual polarization, pseudo-correlation receiver and is specified to have excellent continuum and spectral line performance. Design work on Module 1 has been proceeding over the past year, culminating in a Preliminary Design Review held on October 2. The plans successfully passed review, although some scientific and technical details are still being considered, including the most appropriate method of performing the down-conversion. The intent is that this receiver will have a dedicated continuum back-end, built to a common design with the Ka-band receiver. Work will now proceed on the detailed design and prototyping of the RF section.

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. The first formal meeting of the Beam Forming Array Group was held in Green Bank during the second quarter. Details of current work are provided in the CDL section of this report.

Penn Array Bolometer Camera

The NRAO has initiated a program to sponsor university-built, advanced instrumentation development for the GBT. Following a call for and review of proposals in April 2001, the Observatory began negotiations the University of Pennsylvania to develop a 64-pixel, 3 mm band, bolometer camera for the GBT known as the Penn Array. The project successfully passed a Conceptual Design Review in early November, and a Memorandum of Agreement to begin the project formally is in final negotiation. 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 start 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 winter or spring. 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.

Miscellaneous RFI reduction projects completed this quarter include shielding the GBT weather stations and a new ultrasonic anemometer at the tip of the feedarm.

GBT Mechanical Engineering Development

During the fourth quarter, the Mechanical Engineering Division's outfitting support efforts had a strong RFI mitigation component in addition to the usual miscellaneous brackets, boxes, and frames. Modifications were developed for the GBT track covers to accommodate the more robust wear plate attachment. This modification was carried out and the covers mounted. A modification to the main telescope access ladder is now being designed and fabrication is expected to be completed early in the first quarter of 2002. Design continues as availability permits on the Quadrant Detector Mount and the Laser Rangefinder Covers. Work is nearly complete on a cart to ease the handling of the prime focus receiver Dewars.

GBT Operations Summary

Telescope Operations Personnel Changes

During the last quarter of 2001 the following positions were filled: GBT Operator to replace a retiring operator, Telescope Support Supervisor, and a part time OVLBI operator.

GBT Operations Documentation

Development and updating of operational procedures documentation continued into the last quarter of 2001. Areas of the documentation started or updated involve more than two dozen procedures and information specific to operations. Some of the new documentation includes: the beginning of an operator's trouble shooting guide which will most likely turn into a searchable database, telescope positioning guide, and celestial object positioning guide. An internal evaluation of a simplified operator logging tool was started late in 2001.

GBT Maintenance

The Telescope Mechanics group was augmented with personnel during the last quarter with the addition of the Telescope Support Supervisor and the transfer of an electrician and painter from Plant Maintenance. The reorganization of the group has increased the need for centralizing the Telescope Mechanics group to improve coordination of their activities. A decision on the location of their offices will be made during the first quarter of 2002.

The number of regular Preventative Maintenance duties continued to increase during the last quarter. Some of these activities include PM maintenance on many systems of the GBT, touch up and minor painting of the structure, installation of the new brake system, work on tachometers and repair of the subreflector servo seals.

A visual inspection of the top 20 high stress and fatigue members of the GBT structure was completed during the last quarter of 2001. All but one member passed the inspection. The one member with a detectable problem is being investigated and a fix will be implemented during the first quarter of 2002.

Construction of GBT hoist pads was completed during the last quarter of 2001. Also completed during the fourth quarter were installation and testing of the new azimuth and elevation brakes and installation of 75 percent of the GBT track covers. The GBT HVAC system was upgraded during the last quarter of 2001.

The responsibility of developing a detailed plan for the long and short term inspection of the GBT structure and welds was transferred to the Antenna Group. The current goal is to have a completed plan by the end of the next quarter and a contract issued for the six-month inspection by the end of the second quarter of 2002.

The number of scheduled maintenance days per week will be 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 last quarter. The training of one GBT operator was completed and the training of a new GBT

operator was started during the fourth quarter. An OVLBI operator started training during the last quarter of 2001. The telescope mechanics received training on the new articulated fork lift.

GB Maintenance Bookkeeping

The data entry of the Mainsaver inventory continued during the last quarter of 2001. The use of Mainsaver within the Operations division began during the quarter with entry of repair work orders. More extensive use of this system will occur during the first quarter of 2002 with the inclusion of preventative maintenance scheduling.

GBT Operations

The effort of converting the Operator Advancement Proposal into a plan continued during the last quarter. Work progresses towards duty descriptions and an operational employment concept for the new "Observing Assistant" position while awaiting input from the observatory wide personnel study (by an outside group).

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 has been delayed until the first quarter of 2001 due to limited resources. The first use of the Spectral Processor on the GBT for astronomical pulsar observations started during the last quarter of 2001. Astronomical VLBI observations using the GBT are planned to begin in the middle of the first quarter.

NRAO Central Instrument Shop

Milestone	Original Deadline	Revised Deadline	Date Completed
Fab. ten 510-690 MHz balanced amplifiers	04-30-01	09-12-01	10-15-01
Fab. Dewar Heat shields for ALMA	10-26-01		10-11-01
Fab. Dewar G-10 Supports for ALMA	12-21-01	Cancelled	
Fab. L-band OMT for Arecibo (contract)	11-15-01	01-18-01	
Fab. parts for ALMA Nutator	01-30-02		

Astronomy Education Center Project

Milestone	Original Deadline	Revised Deadline	Date Completed
AEC dormitory 90% design review	09-10-01	01-25-02	
AEC main building construction complete	10-15-02	12-15-02	

Electronics Engineering

OVLBI Tracking Station

This quarter we continued support of the OVLBI tracking station. We continue to work on increasing reliability and decreasing the time to repair the station. This process is helped along by the increasing experience of the OVLBI engineering and technician staff. The contract for operation of the station is scheduled to end on 28 February 2002.

Green Bank Computing

With the arrival of Wolfgang Baudler in September, our system administration staff is now up to full strength, although the Head of Computing Division vacancy remains unfilled. The majority of work in this quarter has consisted of the installation of a number of new staff desktop and visitor workstations, and the upgrade of the Linux systems to Red Hat 7.2

Six staff desktop PCs were purchased, as part of the regular replacement cycle, with Observatory-wide Computing funds. A similar number were purchased using fiscal and GBT specific funds, mainly for new staff. All of these machines have now been installed, and most of the replacement machines have also been "trickled down" to staff with less demanding requirements. In addition, three high-end PCs were purchased out of OWC funds for the use of visiting observers, as well as an eight processor Linux SMP system for the most intensive data analysis tasks. All of these have also been deployed.

All of the new GB Linux systems, and the majority of the existing systems, have been upgraded to Red Hat 7.2. This process included assisting a number of staff scientists to migrate from Solaris to Linux. With the purchase of the most recent Linux PCs, we have now replaced essentially all Sun equipment on individual's desktops.

We took advantage of a side-wide power shutdown to rearrange the new Server area in the shielded room. All of the Green Bank servers are now connected, via UPS's, to the GB emergency generator.

Upgrades to the network, including the installation of the new network switches purchased with infrastructure funds, continues. The fiber to the Residence Hall has now been activated, and a number of the dorm rooms connected.

Mechanical Engineering and the NRAO Central Instrument Shop

A number of items in support of the ALMA Nutator assembly are being fabricated and will be completed early in the first quarter of 2002. Other ALMA projects are expected in the new year. Work continues on the L-band orthomode transducer for Arecibo and will be completed early in the next quarter. The Shop also expects production of the K-band feeds and OMT's for the VLA to be reestablished in the coming quarter. The NRAO Central Instrument Shop has closed out the year 2001 with 144 identified projects.

Operations - Other Telescopes

20 Meter, GBI, 85-3, and OVLBI Tracking Station

The mothballing of the 20 Meter will be delayed until a decision is made regarding its use in future VLBI tests with the GBT. The 20 Meter receiver was removed for repairs and then reinstalled. The 45 Foot HALCA (OVLBI) tracking station continues operation in 2001. Routine preventative maintenance and general repair maintenance of the 20 Meter , 85-3 (Pulsar monitoring) and the 45 Foot continued as resources permitted. Inspection of the 140 Foot telescope continued during the fourth quarter.

Education and Public Outreach

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 "Catching 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 10 percent, with much of the lower level concrete work close to completion, and

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 late January 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.

Management and Scientific Services

Milestones	Original Date	Revised Date	Date Completed
Transition to new A.D.	12-17-01		12-17-01
Name new head of Scientific Services	01-15-02		12-17-01
VLA/VLBA Proposal Deadline	02-01-02		
Recommendations on Office Space Solutions	02-15-02		
Evaluate VLBA dynamic scheduling	03-08-02		
Release Jobserve Cookbook	09-30-01	03-29-02	
Complete Visiting Committee Report	03-29-02		
Revise VLA Proposal Form	04-19-02		
Complete VSOP Support	05-15-02		
Finalize Chandra Observing Agreement	06-14-02		
Hold Aperture Synthesis Workshop	06-24-02		

Electronics

Milestone	Original Deadline	Revised Deadline	Date Completed
VLA/VLBA Pie Town Link (LO/IF)			
Complete construction & checkout of spares	01-31-01	04-30-02	
Reduce temperature sensitivity	01-31-01	04-30-02	
Use spare VLA antennas in VLBI	06-30-02		
Receivers (FE)			
Build and install three more 86 GHz receivers	10-31-01		12-27-01
Replace Y-coupler on 86 GHz receivers #2 to #4	08-30-01	02-01-02	
Install new 1.4 GHz receiver windows as the old ones fail	Open ended		

Milestone	Original Deadline	Revised Deadline	Date Completed
Identify and correct moisture buildup problem in new VLA 22 GHz feeds (FE)	12-31-01	09-30-02	
Upgrade for Pulsar High Time Resolution Processor (DCS, NM Tech)			
Checkout of full FADC	09-30-01	11-15-01	12-15-01
VLBA Improvements			
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	
Change FE filters to 3 MHz for 74 MHz receivers	12-31-01		Cancelled

Spares were built and constructed for the PT Link, but not yet tested. They will be tested during observations beginning in January. HVAC modified, a new local oscillator module was installed at VLBA PT and will be tested for temperature stability during observations beginning in January.

Delays in receiving electroformed parts caused the delay in completion of the build and install of 86 GHz receivers. Receiver SN #4 remains to be completed; it was used for parts to complete SN #9 for VLBAPT. Again, the delay in completion is driven by the delay in receiving electroformed parts.

Test and replacement of new material for 1.4 GHz dewar windows is complete, assuming the new epoxy window passes polarization tests. New goal is to install new 1.4 GHz receiver windows as the old ones fail. The target date is open-ended.

Tests with desiccant and filters last summer did not prove satisfactory, so now O-rings will be installed to improve seals on the 22 GHz feeds. Since the problem is evident only during the August rainy season, further tests await the summer.

Tests on the VLA 3 MHz FE filters at 74 MHz showed RFI and calibration are too much of a problem with the wider bandwidth, and the work is cancelled.

The Iridium filters, intended to permit use of the hydroxyl line at 1612 MHz, have been received. The delay in installation results from delays in testing the prototype, a long order and ship time, and an overly optimistic initial target date.

A full complement of four FADC (Fast Analog to Digital Converter) boards became available December 15; the project is being called complete on that basis. Observational testing remains to be accomplished. In the interim, various observing modes are being tested in the laboratory. The current plan is to rebuild all four FADC boards after the design is tested in use for at least one year. The recent delay is largely due to the need to provide software testing after each hardware change.

Engineering Services

Milestones	Original Date	Revised Date	Date Completed
Pie Town maintenance visit	11-14-01		11-13-01
Complete D Array reconfiguration	10-12-01		10-11-01
Complete A Array reconfiguration	01-25-02		
Assemble three spare Dichroic panels for VLBA	05-31-01	09-30-01	11-30-01
Adjust VLBA Pie Town main reflector panels to achieve best efficiency at 86 GHz	01-31-01	12-31-02	
Develop a means of measuring & correcting VLBA subreflector surfaces	12-31-01	12-31-02	
Complete VLA fall arrest installation	08-31-01	11-30-01	12-17-01
Dish panel adjustments on Antenna 19, 26, 11	10-26-01		11-15-01
Prep and paint Antenna 25	10-18-01		10-22-01
Antenna #17 Azimuth Bearing repair/rebuild	03-01-02		
Dish panel adjustments on Antenna 24, 23	04-30-02		
Begin installation of new encoders	06-29-01	10-26-01	10-30-01
Cryo Air Conditioner installation	10-30-01	01-30-02	
Radio upgrade	12-28-01	06-30-02	
Install 5,000 crossties on East Arm	09-30-01	10-21-01	10-25-01
Crane inspection re-certifications	10-30-01		10-30-01

The new Cryo HVAC was delayed due to lack of electrical supply, parts needed to be ordered. The radio upgrade is delayed awaiting the license approval.

Computer Division

Milestones	Original Date	Revised Date	Date Completed
Video conferencing	01-31-01	01-31-02	
Web/ftp servers	08-31-01	02-28-02	
Replacement public machines	09-30-01	01-15-02	
Build 2+ Terabyte SAN	11-30-01	02-14-02	
Establish NRAO-NM laptop policy	02-28-02		
NRAO DNS/DDNS	02-28-02		
Release JObserve 1.6.4	12-31-01		10-10-01
Release JObserve 1.6.5	02-28-02		
Move AIPS to Socorro	12-31-01		12-31-01
Upgrade INGRES to Version 2.5	08-01-01	10-31-01	10-31-01
Streamline VLA observe file submission	12-31-01	03-01-02	
Investigate Mainsaver asset swap	02-01-02		
Correlator controller in continuum	05-31-01	03-01-02	
Modcomp replacement	10-31-01	03-15-02	
ASG recruitment	08-31-01	03-15-02	
VLBA station computer software upgrade	01-31-02		
VLBA Recorder test software	01-31-02		
View dynamic scheduling from OMS	01-15-02		
VLBA distribution system upgrade	02-28-02		

Video conferencing upgrade

All of the video conferencing equipment has been ordered but not all has arrived. We are currently waiting on six monitors and the installation of the new VLA router. When complete, the VLA will have one video conferencing system and the AOC will have two conference room systems as well as one in the auditorium with new projection equipment.

Web/ftp Servers

The servers have been ordered and delivered. They are currently in Charlottesville being installed. There is still no firm date as to when they will arrive in Socorro.

Replacement Public Machines

Installation of the new public systems was further delayed when it was found they had been shipped without external SCSI connectors (necessary for tape drives). New SCSI controllers were ordered and have arrived. Installation will have to wait until the first weeks of January, 2002.

Implement 2+ Terabyte SAN

The components for the Storage Area Network (SAN) have been ordered and some have arrived. The entire order probably won't arrive until early January. The system should be available for early use by late January or early February.

Establish NRAO-NM laptop policy

Support of laptop computers is consuming an ever increasing share of our resources. NRAO-NM will examine establishing an official laptop policy which will cover configuration and support issues. The policy will outline the level of support NRAO-NM computing can/will provide and the circumstances under which they can provide it.

NRAO DNS/DDNS

We intend to test and install the dynamic name service for host names, required to support the Windows 2000 domain as well as true mobile computing between sites. We plan to start testing this early 2002.

Jobserve

JObserve 1.6.4 was released. This version *only* updates calibrator positions. We plan JObserve 1.6.5, including fixes of a number of known bugs, to come out in February 2002.

AIPS support

The master installation of (classic) AIPS, and the basis for serving the AIPS midnight job, was moved from Charlottesville to Socorro.

Ingres Upgrade

Ingres is our database engine on which many vital applications are based (VLA archive, VLBA operations). Ingres was successfully upgraded to version 2.5 with no disruption in service. A side-effect of this upgrade is that some Ingres applications (OMS) are now running faster.

Streamline Observe File Submission

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

Mainsaver Asset Swap

Mainsaver has no easy way to relocate/swap assets within its asset hierarchy system. We are currently investigating the possibility of writing an in-house method to accomplish this. If this turns out not to be feasible, we will wait for Cayenta Software to add this functionality to Mainsaver (expected early 2003).

VLA Correlator Controller Upgrade

Schedule conflicts with the Modcomp replacements has halted testing. Several timing issues with the Xilinx chips in the serial I/O module have been identified which, when compensated for, produced reasonable integrator results. Work is expected to resume in early January 2002 after testing the new Modcomps is complete.

Modcomp Replacement

The Modcomp installation was delayed because of a malfunctioning board that required a field technician to fly in and replace it. Since then, the machines have been tested and were shown to work. Some remaining unexplainable behavior may cause us to further delay the installation until March, 2002.

Array Support Group Recruitment

Of our three vacancies, one has been filled. We have made a shortlist of our favorite candidates for the other two positions, and the people on the list have been contacted.

VLBA Station Computers

Software updates have finally been applied to all sites after several bugs were identified and fixed at Pie Town. Hardware modifications to transfer the MVME050 board to non-critical duties will now proceed as planned.

VLBA Recorder Test Software

Recorder testing software is being revised to allow tests to be run in a shorter period of time and to better help the recorder technicians collect and analyze recorder data in a more timely fashion. New test software is expected to be ready late January 2002.

View/Edit dynamic scheduling properties from OMS

This will allow the users to view and modify a project's dynamic scheduling attributes used by Barry Clark's scenario program.

VLBA Distribution System Upgrade

All drives on the correlator (archive) and distribution drives have been upgraded to DDS-4. The distribution user interface has been modified to run with the new drives and the Solaris 8 operating system. This user interface will be folded into OMS in early 2002. The archive information system (archinfo) has already been incorporated into OMS.

AIPS

Distribution and Versions

The 31DEC01 version of AIPS, updated daily, was distributed 556 times, to about 475 sites, after December 2000. This version has now been frozen, in preparation for release in January 2002. A new evolving version that is updated daily, called 31DEC02, has been initiated.

Key Developments

1. The move of the "midnight job" and the master version of AIPS to NRAO-Socorro is being done in conjunction with the initiation of the 31DEC02 version. This move was nearly complete at the end of December 2001, and is expected to be finished in January. At that time, the daily versions will be accessible by an ftp copy/update procedure that is run under the Unix "cvs" utility. This eliminates dependence on "secure shell" (ssh) copies, which appear to have been a significant impediment to some users in implementing the midnight job. In addition, it should eliminate the common failures of midnight jobs that have occurred when system managers on either end make modifications to ssh.

2. The TECOR task, which applies global ionospheric corrections to VLBA data, has been extended to cover data sets crossing UT midnight (actually, UT 2300). Users now can apply corrections for multiple dates merely by specifying (and making available) multiple "IONEX" format files.

3. Several modifications were made to FITLD in order to properly handle multiple frequency IDs (FQIDs) having the same frequency, frequency offsets from FQID number 1, and the proper comparison of tape bytes to AIPS bytes.

4. Exercising the VLBAUTIL procedures for simplified VLBA data reduction revealed errors and inconsistencies in the help files and default parameters for several AIPS tasks. In some cases, modifications were made to default parameters in VLBAUTIL, while in other cases, help files were modified to correctly represent what tasks were actually doing. The main tasks affected were SNSMO and FRING (help files clarified), while procedures that were modified included VLBACALA, VLBASUBA, and VLBAFQS..

5. IMAGR was modified to handle clean boxes from a BOXFILE more forgivingly, and to handle correctly a modification of flux limits with the TELL command during multi-field cleaning.

6. COMB, which combines images in various ways, has had the 'SUMM' option added in order to blank a pixel in the output image only if both input images are blank at that pixel; otherwise, it uses the value from the image whose pixel is not blanked, as in 'MEAN.'

7. A new procedure called FITDISK was added to enable AIPS files to be written out as disk files with default names, using appropriate interpretations of the file names inside AIPS. This enables multiple files to be written to disk using a simple "for" loop in POPS.

8. An investigation was made of possible options to separate primary and subreflector errors in VLBA holography results. Mathematically, additional information/assumptions beyond the holographic measurements are required to effect this separation.

Goals for Q1 2002

1. Continuing maintenance and user support.
2. Complete release of 31DEC01 version, and move of primary copy and midnight job to Socorro.
3. Complete comparison of FRING and KRING for fringe-fitting under various conditions.
4. Develop a data-editing task to use the VLA weather information now provided by FILLM.
5. Revise Cookbook Appendix C based on VLBAUTIL procedures and incorporating code changes.

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	03-31-02	
Demonstrate 211-275 GHz balanced SIS mixer with integrated 4-12 GHz IF preamp.	06-29-01	10-31-01	12-31-01
Demonstrate 211-275 GHz balanced sideband-separating SIS mixer with integrated 4-12 GHz IF preamps.	07-31-01	03-31-02	
Construct second test receiver	12-31-01	03-31-02	
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	
Finish detailed design of W-band feed.	12-31-01	03-31-02	
Evaluate performance and finalize design of L-band feed	12-31-01		12-31-01
G/T optimization of feed taper at 3,10 and 30 GHz	03-31-02		
Feed pointing optimization of the VLA antenna	06-30-02		
ALMA Correlator: 1) Write and release ALMA memo on the filter card testing. 2) Completion of the prototype filter card testing and release of ALMA memo on the filter design and performance.	 09-30-01 09-30-01	 01-31-02 01-31-02	
1) Start and complete design of FPGA chip for the ALMA correlator chip test fixture card. 2) Complete design of the station motherboard. 3) Start mechanical design of system bins and racks. 4) Start PCB layout of station power supply card. 5) Start design of the correlator motherboard. 6) Finish design of system interface paddle boards. 7) Finish correlator/LTA test fixture and begin testing correlator card. 8) Using correlator card/LTA test fixture to start developing control card software.	03-31-02		
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 was assigned to full-time support of the integrated SIS-IF amplifier project during the fourth quarter.

Amplifier Production

A total of 27 amplifiers was assembled during the quarter. Production included three 22 GHz amplifiers used for receiver construction at the VLA, eighteen 43 GHz amplifiers for use at various NRAO sites, and six 86 GHz amplifiers for VLBA use. Production of 22, 30 and 86 GHz LNAs is ongoing, and the machine shop completed a build of 20 chassis for 3-13 and 8-18 GHz amplifier production.

Superconducting (SIS) Millimeter-Wave Mixer Development

SIS Mixer Development

Saturation: In ALMA Memo 321, Plambeck pointed out that saturation (gain compression) by broadband thermal noise is likely to be a significant factor limiting the calibration accuracy of ALMA observations. Previous analyses of saturation in SIS mixers were limited to saturation by CW signals. We have developed a procedure for analyzing saturation by noise, and applied it to representative SIS receivers operating at different frequencies. Many SIS mixers in current use are expected to exhibit a significant degree of gain compression when connected to a room-temperature source. This work is reported in ALMA Memo 401.

Magnetic circuits: A magnetic circuit consisting of a superconducting coil and iron alloy pole-pieces is used with SIS mixers to suppress the undesirable Josephson currents in the junctions. Because of the limited space available in the ALMA cartridges, the magnetic circuits must be kept small. We found that the field produced in the vicinity of the SIS junctions by the present magnetic circuit was much smaller than expected from the size (amp-turns) of the coil. A study using the magnetic circuit analysis program, Maxwell, indicates that the magnetic circuit is saturating, especially in regions in which the iron cross section is reduced by screw holes. A new magnetic circuit is being made with larger iron components. This work will be reported in a future ALMA memo.

Band 3 (84-116 GHz) SIS mixer: The choice between SIS and HFET receivers for ALMA Band 3 is still open. To obtain a comparison between the two types of receiver, we have designed a tunerless SIS mixer for this band capable of operation with a 4-12 GHz IF. Funding to complete this work will be provided by the Herzberg Institute of Astrophysics as part of Canada's contribution to ALMA. The mask layout has now been completed, and the mixer block design will be completed in January 2002. The first wafer of mixer circuits will be fabricated at UVA as soon as the masks are delivered.

Band 6 (211-275 GHz) balanced single-chip SIS mixer: A balanced SIS mixer is the Band 6 fallback design if neither of the sideband-separating designs (described below) are found to be suitable for ALMA

production. There are two balanced mixer designs, one using the UVA single-chip balanced mixer described in ALMA Memo 308 but with a 4-12 GHz IF preamplifier, and the other using two single-ended SIS mixers of the type described in ALMA Memo 205, also with a 4-12 GHz IF preamplifier. Initial results for the single-chip mixer with 4-12 GHz IF gave receiver noise temperatures in the range 35-75 K DSB, but further testing has been delayed by a parasitic oscillation found in some of the IF preamps.

Band 6 (211-275 GHz) balanced sideband-separating SIS mixer — A. Single-Chip Design: This design has three RF quadrature hybrids, an in-phase power divider, four SIS mixers, and their RF tuning circuits on a single 2 x 1 mm quartz chip. The wafers were fabricated at UVA. The first mixer has been assembled and is awaiting a pair of 4-12 GHz IF preamplifiers and the magnetic circuit components.

Band 6 (211-275 GHz) balanced sideband-separating SIS mixer — B. Multi-Chip Design: This design uses 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 IF's. The mixer blocks are currently being fabricated in the CDL shop. We are also awaiting 4-12 GHz IF preamplifiers and the magnetic circuit components.

Band 6 redesigned single-ended building-block mixer: A new building-block 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 redesigned for the actual ALMA band (210-275 GHz) which is narrower than the original design band (200-300 GHz), and the RF choke is being redesigned to present less capacitance to the 4-12 GHz IF amplifier.

Band 9 (602-720 GHz) SIS mixer: After several equipment failures, SUNY/Stony Brook is still working on improving their junction process. They did not deliver any new wafers in this quarter.

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 then 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 we believe is due either to a change in the internal wiring and layout of the preamp or to a change in some components: capacitor physical size or resistor type (thin film *vs* thick film). This is under investigation.

Components for Band 6 Mixer Production Test Set

In preparation for building two mixer production test sets, we have been designing some of the component parts. These components may eventually be used in the ALMA Band 6 cartridges.

We have continued exploring the use of an overmoded stainless-steel waveguide between the LO multiplier on the 70 K stage and the SIS mixer at 4 K. Simulations are being done using CST Microwave Studio. In the absence of a vector network analyzer for Band 6, W-band scale models are being used.

Compact multi-conductor heatsinks are required for the many bias and monitor wires in the test receiver. We continue to evaluate a compact design using Nanonics miniature connectors. The goal is to derive a thermal π equivalent circuit of the heatsink which can be used in thermal analysis.

Receiver Optics

Band 6 cartridge optics: The Band 6 horn and optics designs (ALMA Memo 362) assume the successful development of an orthomode transducer for that band. In the event that an OMT turns out to be impractical, a new optics design will be required because the dimensions of the Band 6 cartridge will not accommodate the original optics with a quasi-optical (grid or cross-grid) polarization diplexer. We have designed such a modified configuration which will fit inside the cartridge, but it is asymmetrical and is not expected to be as efficient as the original design. A physical optics evaluation of the compromise design is needed.

Vacuum windows: We completed designs for vacuum windows for Bands 3-10. These are described in ALMA Memo 397.

Automatic SIS Mixer Testing

Construction of the Dewar for the second mixer measurement system is nearly complete. All internal Dewar components, including switches, heaters, temperature sensors, LO waveguide, connector mounting assemblies, control wiring, and IF cabling have been fabricated and installed. The only significant parts remaining to be installed are the newly designed heatsinks for the control wiring, which require minor modifications to eliminate shorts.

Gain compression due to noise was measured for the type of HFET amplifiers used as preamplifiers with the mixers, and the results have been documented in a memo.

Electrostatic protection for the mixer current and voltage monitor leads in the 6-wire bias system has previously consisted of 10 K ohm series resistors, but such a large value, in conjunction with the large capacitance of the in-line filters, reduces the bandwidth of the monitoring circuit and significantly slows measurements. The protection resistor for the mixer source bias line was already 1 k ohm, so it was decided to use 1 k ohm resistors for the other leads. The stability of the mixer bias circuit was analyzed with the new resistor values, and the results were documented in a memo.

The LO group has just supplied a prototype programmable LO source for ALMA Band 6, and we have begun configuring that source into the measurement system. This will significantly speed up mixer testing.

Publications and Memos

J. Effland, "NRAO HFET Amplifier Gain Compression Measured with Noise," NRAO CDL Internal Memo, 2 Nov. 2001.

D. Koller, A. R. Kerr and G. A. Ediss, "Proposed Quartz Vacuum Window Designs for ALMA Bands 3-10," ALMA Memo 397, 12 Nov. 2001.

G. A. Ediss and J. Effland, "Frequency Selective Surface (Dichroic) for use with the 211-275 GHz System,"
Electronics Division Technical Note No. 188, 14 Nov. 2001.

J. Effland, "Stability Analysis of SIS Mixer Bias Supply with 1 K Ohm Isolation Resistors," Electronics Division Technical Note No. 189, 29 Nov. 2001.

A. R. Kerr, "Saturation by Noise and CW Signals in SIS Mixers," ALMA Memo 401, 14 Dec. 2001.

Electromagnetic Support

EVLA

Design of a new L-band feed to cover the 1.2-2.0 GHz frequency range was completed. Efficiency and system temperatures of the VLA antenna with this feed were calculated. Using the measured patterns of the existing L-band feed (corrugated horn with lens), efficiency and system temperatures were calculated to compare with the new design. The existing feed yields approximately 15 percent higher Gain/System temperature (G/T) at 1.5 GHz at zenith and at 60 degrees elevation. At lower elevations, the new design has significantly better G/T. With the existing feed, the system temperature at 20 degrees elevation increases by 1.8 times as that at zenith. With the new design, the system temperature at 20 degrees elevation increases by <1.15 times as that at zenith.

Spectrometers/Correlators

Work on the baseline ALMA correlator during the last quarter concentrated on the design and testing of system logic cards. Some work was performed on mode definition and software support.

The correlator card prototype was received and assembled except for the correlator chips. A prototype run of the 4096-lag ALMA correlator chip was started. A logic card to test the correlator chip using the station test fixture was received and assembled. A test fixture to test the correlator and LTA cards is being assembled.

Testing of the prototype digital filter card continued with sufficient data accumulated to write a ALMA memo on filter performance.

Designs for both the correlator and station power supply cards were completed during the quarter, and design of the station bin motherboard continued. A prototype of the correlator power supply card was received and its assembly begun.

A logic card to support pulsar observations in the GBT spectrometer was assembled and tested, both on the bench and in the system. Some software support was written for the card. Occasional hardware support was rendered for the GBT spectrometer.

Work continued on a system to stream VLBA data from a VLBA playback unit onto high-density computer RAID disc. Preliminary design of a logic card was completed and software for a user interface was started.

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 both on demonstrating that current MMIC designs can adequately drive the high-frequency multipliers, and on bringing closer to production the already proven components and subsystems.

An InP MMIC power amplifier was packaged in a WR-10 mount and tested. This amplifier was then integrated with a YIG-tuned oscillator, active doubler, and tripler into a electronically tunable LO source from 66-100 GHz and delivered to the SIS group for Band 6 SIS mixer testing.

Another InP MMIC power amplifier was packaged in a WR-8 module and tested up to 145 GHz. Output power was measured from 600-720 GHz (ALMA Band 9) using this amplifier fed by a Gunn oscillator followed by a varistor quintupler borrowed from Virginia Diodes. This produced from 8-55 microwatts over the band. More power can be obtained by an improved multiplier design (this quintupler was designed to cover a different band), a power amplifier design optimized for this specific band (instead of the wideband design used here), or power combining two MMICs as described in last quarter's report. We have received quotes for the parts necessary to replace the Gunn oscillator with an electronically-tunable YTO-based LO source and talked to SRON about providing their SIS group with this LO for their Band 9 mixer tests.

Using the FTS board from Socorro, we tested the phase switching speed of the phase-locked YTO, finding that the phase settles to within a few degrees in 3-5 loop time constants. We have also worked on the digitally-controlled bias cards for the LO driver components. With the integration of these bias cards, the lock-loop board, and the AMBSI card, we continue to progress toward a pre-production model of the LO source.

We have received quotes from HRL for production of an InP MMIC power amplifier wafer run and from UMS for production of MMICs for the active multiplier block of the LO drivers.

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 are being developed.

80/240 GHz Frequency Tripler: The fabrication of the improved quartz-backed GaAs devices (chip with two anti-parallel diodes and idler arrangement) for the tripler was completed at the University of Virginia

(prior to the end of the contract period in September 2001). Subsequently, the tripler block was assembled, and developmental tests performed.

A peak output power of approximately 335 microwatts was measured at 228 GHz (with an input power of 65 milliwatts at 76 GHz). Output powers of 100 microwatts or more were measured for the frequency range of 216 GHz to 255 GHz.

The lower than expected performance was attributed mainly to the parasitic effects of the three-way junction between the input-output circuits and the diode chip, causing an unwanted interaction between the input and output circuits. The solution lies in controlling the junction geometry more closely by integrating the input and output sections into a single circuit. This should result in a behavior closer to simulated performance. This redesign effort is currently nearing conclusion. The tripler block will need to be redesigned to accommodate the new circuitry.

JPL/University of Michigan Collaboration: The Michigan group delivered a discrete diode array for use in the existing 110/220 GHz doubler block. This was done to develop a working knowledge of Michigan fabrication processes, and to set up design/data transfer protocols with the group. The devices were delivered as a 10-mil thick processed wafer that needed to be thinned and diced. This was done at the NRAO. Final devices were approximately 65 microns wide and 340 microns long. Backside thinning by mechanical lapping resulted in a thickness of 55 microns.

DC testing of the devices revealed that the junction capacitance was significantly less than the designed value. This was probably from etchants (used to form the air-bridge) stripping away part of the active epi-layer at the contacts. As a result, the reverse bias capacitance modulation was severely impaired as well. The reverse breakdown characteristics were as expected. Nevertheless, the thinned and separated devices were mounted in the110/220 GHz doubler block, originally designed and tuned for varactor operation. The best efficiency obtained was about 0.5% (in varistor mode of operation), but note that the block was not optimized for these devices, and was originally intended for matching into/from a varactor device. This poor impedance matching would seem to explain the significant "structure" in the measured results as well.

Nevertheless, the results are encouraging, and improved performance is expected once the devices are perfected. Efforts are under way at the University of Michigan to produce an improved device.

Progress was also made with the ongoing effort to fabricate "beam-lead" structures during this period. A successful waveguide probe on silicon substrate, which is mechanically very similar to the desired beam-lead structure, was reported.

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 instrument consists of a two-dimensional array of at least thirty-seven electromagnetic sampling elements located in the telescope's focal plane and is capable of synthesizing up to seven independent beams. Each element of the array consists of a dual-polarized antenna, low-noise electronics, analog downconverter, and digital sampler. The digital data streams are sent via optical fibers to a specially designed signal processor for beam-forming and spectral analysis. The physical size of the 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 of multiple beams and would represent a major breakthrough in technology applicable to all radio telescopes.

A series of meetings was held this quarter to explore various design options and begin the task of formulating a preliminary design for the array. Work continues on the six core technical documents. The Conceptual Design Review (CoDR) was rescheduled for May 2002 due to GBT commissioning activities.

Technical activities in Green Bank and Charlottesville include exploring various approaches to the signal processing flow and investigating several design options for the front-end cartridge. Preliminary designs for the antenna element, dewar configuration, refrigeration system, and low-noise amplifiers were studied. This work will continue through next quarter.

Meetings

THz Electronics Symposium, UVA, October 15-16, 2001 (CDL engineers)
LOFAR Meeting, Haystack Observatory, October 15-19, 2001 (Webber)
EVLA Design Review Meeting, Socorro, NM, November 1-2, 2001 (Webber, Escoffier)

An external, AUI-sponsored review of Data Management (DM) activities and management was held on November 14-15, 2001. The review committee was chaired by Ethan Schreier of STScI, and included experts on the main areas of DM activity: archiving, end-to-end processing, software development, computer system management, etc. The report is now available and a response directed to the NRAO Director is being prepared by DM management.

e2e Project

Milestone	Original Deadline	Revised Deadline	Date Completed
DM WBS out to 2006	02-01-01		12-01-01
First version e2e project book	08-01-01	11-01-01	12-01-01
DM review	09-17-01	11-14-01	11-14-01
Install interim VLA archive server	12-01-01	02-15-02	
Internal tests of VLA interim archive	01-15-02	04-01-02	
External tests of VLA interim archive	03-15-02	06-01-02	
Announce VLA interim archive server	06-01-02	08-01-02	
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		

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 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. In addition to the archive and pipeline development, e2e phase 1 also includes some exploratory development of observing scripts for NRAO telescopes. An improved approach to specifying observations on NRAO telescopes is required both for the pipeline and for improved usability.

The EVLA project is one of the customers of the e2e project, and is providing support via two positions. e2e staff participated in the system PDR of the EVLA project held in December 2001. At the PDR, e2e presented the overall architecture of the e2e system (as described in the current version of the project book).

Based on feedback from this review, it was decided to delay the EVLA PDR of e2e itself until the end of the first development cycle. This delay will allow the experience from the first cycle to be incorporated into the material presented at the PDR. The EVLA Monitor & Control PDR has also been delayed until May 2002. e2e is participating is discussions with EVLA M&C staff on the interfaces between the e2e package and the telescope M&C system. An initial split of responsibilities has been agreed. The details of this split will be elaborated over the next few months, prior to the two relevant PDRs.

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 have participated in the development of the management plan for the National Virtual Observatory (NVO), as funded by NSF ITR. NRAO is a partner in the collaboration, and work performed for NVO is complementary to that planned for e2e.

Technology Development

Milestone	Original Deadline	Revised Deadline	Date Completed
AIPS++ Developer's Pre-release	09-24-00	04-01-02	
ALMA AIPS++ test	08-15-01	04-01-02	
Prototype VLA pipeline	09-01-01	04-01-02	
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	
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		

During this quarter, effort in DM Technology Development has remained focused on AIPS++ development. AIPS++ is now in a regular release cycle of six-months duration, and this quarter fell in the last half of the v1.6 development cycle. The v1.6 release was finalized in December 2001, and will be distributed publicly at the 199th meeting of the AAS to be held in Washington D.C., on January 6-10, 2002. At the close of the quarter preparations were made for distributing the release to our current subscriber list of users in the community. In line with requests from advisory committees, we are also making the release available for network download at a number of additional high-bandwidth ftp sites. This includes the ftp site

maintained by the National Computational Science Alliance (NCSA) in Urbana-Champaign, IL, which is served by high speed network connections to the east and west coast.

Planning for the next public release (v1.7), which will be made available in June 2002, was started at the close of the v1.6 development cycle, in accord with project practices. The resulting WBS is heavily focused on continuing the current emphasis on scientific integration, which includes scientific completeness, usability and public outreach to the scientific user community. A scientific completeness audit was performed prior to the v1.7 planning phase, in order to identify observing modes at the individual consortium telescopes which required further development in particular. In addition, the scientific priorities expressed by the site user groups were fully incorporated into the planning process and the final WBS which was produced.

We completed a user interface survey during this quarter, in collaboration with the site user groups, in order to identify areas of future development in our user interface model. This particular survey concentrated on the automated graphical user interface and the image viewer. Subsequent surveys will focus on other areas of the user interface.

During this quarter we have maintained a strong focus on user support and training, consistent with the current operational phase of the project. The NRAO AIPS++ User Group (NAUG) was expanded during this quarter through the addition of new participating scientists, and a charter and structure for the group was finalized and agreed between AIPS++ and the participating scientific users. The scientists in the NAUG are led by Ed Fomalont (synthesis) and Phil Jewell (single-dish); the overall effort is coordinated by Joe McMullin as part of AIPS++ Operations. An AIPS++ Operations Division was formed during this quarter to collect together several related tasks in user outreach and support, defect correction and system administration within AIPS++; this effort is headed by Joe McMullin as AIPS++ Deputy Project Manager.
The NAUG has been active during this cycle in directed testing of AIPS++, and was an active participant in drafting release notes for v1.6 and in the planning for v1.7, as noted above.

The GBT has been a strong focus of the single-dish AIPS++ group during this quarter, both in supporting the commissioning work and in development of new single-dish analysis capabilities. Features have been added to the AIPS++ single-dish package to emulate the user interface that users may be familiar with from UNIPOPS. A dedicated two-week tiger-team meeting also took place at Green Bank during this quarter to coordinate GBT Operations work and AIPS++ single-dish development. Subsequent regular visits have been made to Green Bank to continue this close collaboration.

This quarter has also seen a continuation of our current participation in the AIPS++ evaluation and re-use analysis underway in partnership with ALMA. This effort involves participation by AIPS++ developers and several scientists and developers at IRAM, ESO, and the NRAO ALMA group. The goal of the test is to evaluate AIPS++ for end-to-end reduction of millimeter spectroscopic data from Plateau de Bure, and to train outside developers from ALMA in AIPS++ development. As part of this process we have undertaken reciprocal visits during this quarter, with Dominique Broguire (IRAM) visiting Socorro for two weeks in September, and Kumar Golap visiting IRAM for two weeks in December 2001. The test will run through April 2002.

DM Technology will assist the e2e Project primarily in the area of pipeline support. Efforts in this area are underway due to the overlap with high-level AIPS++ applications development. A coordination plan has been agreed with NRAO ALMA Computing to work jointly on pipeline issues of mutual interest. During this quarter a pipeline server system was purchased for the VLA and has arrived in Socorro. In personnel matters, Ralph Marson took a promotion transfer to ALMA, and this position was re-advertised. Jeff Uphoff was hired to complete part-time contract work in visualization.

In other developments during this quarter, AIPS++ staffed an exhibition booth at the annual ADASS conference in October 2001 (Victoria, BC) and distributed brochures and AIPS++ CDROM's at the meeting.

AIPS does not report to DM Technology. Further details on AIPS development can be found in the VLA/VLBA section of this report.

Central Computing Services

Milestone	Original Deadline	Revised Deadline	Date Completed
Revise Security Policy	02-15-01	01-31-02	
Testbed VPN	09-30-01	06-30-02	
Mail gateway and IDS purchases	12-31-01	02-28-02	
Turn off telnet/rlogin/rsh/rcp into NRAO	07-01-02		
Web-server deployment in GB, NM, TU	07-31-01	02-28-02	
Complete CCE-compliant UNIX OS upgrades	10-15-01	02-28-02	
CCE design (to infrastructure level)	10-31-01	03-31-02	
CCE design (core applications)	03-31-02	06-30-02	
DHCP/DDNS integration decision	11-30-01		10-26-01
Begin W2K Active Directory testing	08-15-01	11-30-01	11-30-01
Complete W2K Active Directory testing	03-31-02		
Final W2K domain design	09-01-01	03-31-02	
Begin W2K domain deployment	10-15-01	04-30-02	
Issue memo on Windows XP moratorium	02-28-02		

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 previous intrusions we have experienced. Despite frequent receipt of virus-carrying email attachments, viruses have rarely managed to infect NRAO systems, and have even more rarely been able to propagate. Our multi-faceted approach to security continues to prove its value.

In the last quarter, we examined techniques to make enhanced monitoring and intrusion detection manageable with the current staff. One-time supplemental funding resulting from the change in fiscal year-end will allow us to purchase software and hardware which, after initial deployment, should improve these capabilities and reduce the staff time that would otherwise be needed to perform them; purchases should be made early in this quarter. We will also be able to supplement desktop anti-virus detection, which relies on every single system to be effective, with software to detect and handle viruses and other malicious attachments at our email delivery gateways. Initial evaluation of NRAO requirements and of the products available for this purpose was completed in late 2001; a formal RFQ will be issued in early 2002 and should result in a purchase by the end of February.

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 who 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.

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, significant progress continued on several major projects involving NRAO computer systems support staff. These projects include:

- *Improving Web services*: Progress has been made in deploying a modern web serving infrastructure. The Charlottesville and ALMA web sites have been consolidated on the main NRAO web server in Charlottesville, and work is proceeding on creating and deploying a mirroring scheme for the primary NRAO web site among four machines. Once the mirroring is in place, three of these will be shipped to Green Bank, Socorro, and Tucson.
- *The Common Computing Environment project, or CCE (UNIX)*: CCE-compliant Solaris 8 upgrades are complete in Green Bank and Tucson, and are very close to completion in Socorro and Charlottesville. Due to the release last October of RedHat Linux 7.2, which incorporates a number of patches and is expected to be more stable than 7.1, the group decided to delay Linux upgrades until 7.2 was available. These upgrades began in November and most should be complete by the end of February. During this time, the group will also finish the definition of standards in the most important remaining infrastructure services. By 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. The week of NRAO-wide AD design testing was postponed pending the decision on integration of Dynamic DNS and DHCP, which control the assignment of network names and addresses to computers and other network devices, with the existing network infrastructure. A larger group including our senior UNIX, Windows, and network administrators was involved in this discussion, since it has implications for the long-term future of all NRAO networking, and there was a clear consensus that the use of these protocols is of widespread benefit across NRAO. DDNS tests were done in November, and NRAO-wide AD domain testing began at the end of that month. Tests should conclude during this quarter, allowing domain design completion soon thereafter, with production domain deployment beginning next quarter. There will be an NRAO-wide moratorium on Windows XP until Active Directory migration is well underway and testing on XP can be conducted.

Observatory-wide Communications

Milestone	Original Deadline	Revised Deadline	Date Completed
Chg long distance service in Green Bank	05-31-01	10-31-01	10-31-01
Chg long distance service in Tucson	05-31-01	10-31-01	10-31-01
Deploy most new video conferencing services	11-30-01		11-30-01
Decision on intranet contract for next years	12-31-01		12-31-01
Complete deployment of new video conference services	02-28-02		
Complete fiber re-wiring in Green Bank	02-28-02		
Upgrade GBT Lan to 1 Gbps	02-28-02		
Release RFP for new Intranet contract	02-28-02		

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. When all equipment is installed, we will be able to support three simultaneous video conferences. Since last quarter, we have been able to increase the scope to have permanently installed, and therefore immediately available, video conferencing equipment in ten different facilities. As previously planned, in Socorro, Green Bank, and Charlottesville we will have equipment in both the local auditorium and the main conference room; we will also have equipment in the conference rooms in Tucson and at the VLA site. In addition, we will also have two additional installations in smaller conference rooms in both Green Bank and Socorro. The third facility in Socorro will be especially useful for local communication with the VLA site, and also for conferencing between Tucson, Socorro, and the VLA site during the installation and testing of the ALMA Test Interferometer.

With the exception of the additional services in New Mexico, this was all installed and tested in the last quarter. The deployment of the video conferencing equipment in the two new conference rooms in Socorro and at the VLA site has been delayed substantially due to late delivery of some equipment. However, we expect to receive this equipment and to have the New Mexico facilities installed and operational in the first quarter of 2002.

We have changed to cheaper long distance phone service in both Green Bank and Tucson. Tucson and Charlottesville now use the same service, which has the best combined rates when including the substantial international traffic. Green Bank, where the international traffic is much lower, now uses FTS2001, which has the best purely domestic rates.

We have decided on our strategy for the renewal of our inter-site communications (intranet) contract, which expires at the end of February 2002. First, we will extend our present contract for a few months. Second, we will prepare a Request For Proposals for a possible replacement of the service later in the year. Although the present service is based on frame relay technology, it is possible that other cheaper options exist.

We are 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, most of the site Local Area Network (LAN) has been wired for fiber connectivity. In the main laboratories, older computers are being migrated to use 10 Mbps connections directly to the Ethernet switches. This provides much superior service than sharing a 10 Mbps coax connection with other machines. Newer computers are being given 100 Mbps service to the switches. These changes will be done gradually throughout the year on an as-needed basis. Fiber connections in the individual rooms of the residence hall should be complete in the first quarter of 2002. Initial tests of the connection to the main site LAN were successful. There has been some delay in progress due to the discovery of a possible hardware or firmware error in the Ethernet switch providing the service. The connection between the GBT alidade and the GBT control room in the Jansky Addition is connected by 100 Mbps Ethernet service. It will be upgraded to 1 Gbps when new router interface cards are delivered.

Education and Public Outreach

Overview

The NRAO has carried out a sustained program of Education and Public Outreach (EPO) for the last several decades. The primary goal of EPO activities at the NRAO is to support the development of a society that is both scientifically and technically literate. To learn science, individuals (students and the general public) must understand the unifying concepts and processes in science, and understand that science is based on inquiry. To teach science, teachers must have theoretical and practical knowledge of science, learning, and science teaching. The NRAO is in an excellent position to encourage scientific and technical literacy by bringing science discoveries and an understanding of the scientific process to teachers, students, and the general public. To accomplish this, the NRAO is expanding its comprehensive outreach program in which 1) public information about radio astronomy is made available via the web and media; 2) NRAO visitor centers provide an educational experience to the many visitors the telescopes attract; and 3) educational programs are developed in partnership with other institutions to help teachers and their students gain an appreciation for science and improve their understanding of the scientific process.

The Observatory held an Education and Public Outreach Workshop November 12-13, 2001, which reviewed the ongoing programs and proposals for new programs and made a number of recommendations. The highest recommendation was to conclude the current search for a Head of Observatory Education and Public Outreach as soon as possible. During this quarter candidates for this position have been interviewed.

Media & Public Outreach

The NRAO has succeeded in bringing more newsworthy results to a wide segment of the population. Media coverage has steadily increased over the past five years from six press releases in 1995 to 16 in 2001. To improve our media outreach, the NRAO is in the process of defining an outreach strategy that includes a consistency of look and design elements in all NRAO outreach products. The NRAO Web-site for the public will be restructured and redesigned. This is a top priority because it is such a cost-effective means for reaching the public.

Informal Education

As was described in the Green Bank Site report, construction for a new Astronomy Education Center in Green Bank began in September 2001. The funding for the building is from NASA while the displays are being funded by NSF Informal Education. The Green Bank Center is expected to be complete, staffed, and ready for visitors in late 2002. The VLA Visitor Center in New Mexico is being updated, with a gift shop, new displays, designed in coordination with Green Bank, and full time staff. Together, the new Centers will provide visitors attracted to the VLA and GBT with a quality experience that promotes excitement and appreciation for science.

The new Education Centers will also provide a community focus on science discovery. Exhibits and information presented in the Centers will remain fresh and contain state-of-the-art scientific and technical details. The Centers will be able to host numerous programs, including after school clubs, amateur radio and astronomy group talks, Summer Space Camps for kids, and programs for youth groups. In developing appropriate programs for the centers AUI/NRAO will pursue partnership opportunities with established and successful planetaria and science museums.

Programs for Teachers and Students

The NRAO has sponsored a summer student program for undergraduates and graduates since 1959. For a decade, the funding for this program has come from the NSF Research Experience for Undergraduates (REU) program. REU students are paired with scientists and engineers at all sites. In 2001, there were 15 RE students working on both scientific and technical projects. There were an additional 12 students, primarily graduates, who were supported under other programs.

Programs for teachers have increased within the past few years. The NRAO hosts Chautauqua Short Courses each summer at the Socorro and Green Bank sites. These are three-day workshops teaching the principles of radio astronomy to college and high school teachers. Directed-study summer courses for secondary teachers occur in Green Bank and Socorro with funding from the NSF Research Experience for Teachers (RET) program. NSF-funded RARECATS is a secondary science teacher training program at NRAO-Green Bank that gives teachers a three-week research experience and training they can bring back to their classrooms. The NRAO also participates in the NSF-funded Project ASTRO, linking astronomers with local teachers in Virginia, West Virginia, New Mexico, and Arizona to provide educational materials, information, and class tours of the NRAO facilities. Further outreach efforts focus on supporting local Science Fairs, giving classroom presentations, organizing "Ask the Astronomer" events, and providing students with information for science/astronomy projects.

Telescope Usage

The following telescopes have been scheduled for research and maintenance in the following manner during the fourth quarter of 2001.

	VLA	VLBA	GBT
Scheduled Observing (hrs)	1624.9	1263.2	140.5
Scheduled Maintenance and Equipment Changes	229.6	196.0	470.0
Scheduled Tests and Calibration	297.2	333.7	1230.0
Time Lost	70.4	38.0	13.3
Actual Observing	1554.5	1225.2	168.5

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

No.	Observer(s)	Programs
GBT01A-069A	Jacoby, B. (Caltech) Anderson, S. (Caltech) Kulkarni, S. (Caltech) Prince, T. (Caltech) Backer, D. (UC, Berkeley)	Galactic bulge globular cluster pulsar search. 21, 50 cm
GBT01A-075	Stairs, I. Manchester, R. (Australia Telescope) Lyne, A. (NRAL)	Multifrequency monitoring of a massive pulsar. 14, 21, 50 cm
GBT01A-078	Stairs, I. Kaspi, V. (McGill Univ)	A search for pulsars in globular clusters. 21 cm
GBT01A-079	Thorsett, S. (Lick Obs) Stairs, I. Arzoumanian, Z. (NASA/GSFC)	Timing fast pulsars at the GBT. 21 cm
GBT02A-010S-band	Black, G. Campbell, D. (Cornell) Ostro, S. (JPL)	Radar observations of Titan in 2001. 14 cm

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

No.	Observer(s)	Programs
AA264	Andre, P. (CNRS, France) Bontemps, S. (Bordeaux) Siebenmorgen, R. (ESO) Belloche, A. (CNRS, France) Motte, F. (Caltech)	Characterizing the evolutionary status of Mid-IR dark globules. 3.6 cm
AB0957	Bastian, T. Vilmer, N. (Paris Obs) Gary, D. (New Jersey Tech) Benz, A. (SFIT, ETH)	Joint microwave and hard X-ray imaging of solar flares. 0.7, 1.3, 2, 3.6, 6 cm
AB0982	Blundell, K. (Oxford) Dubner, G. (IAFE) Mioduszewski, A. Kassim, N. (NRL)	Imaging the W50-SS433 system at 74 MHz. 400 cm
AB0999	Beck, R. (MPIR, Bonn) Berkhuijsen, E. (MPIR, Bonn) Horellou, C. (Chalmers, Onsala) Fletcher, A. (New Castle) Shukurov, A. (New Castle)	Coupling of gas and magnetic fields in M51. 3.6 cm
AB1004	Blundell, K. (Oxford) Perley, R. Rawlings, S. (Oxford) Kassim, N. (NRL) Lazio, T. J. W.(NRL) Owen, F.	The very large, steep spectrum outer structure of a FR II radio galaxy. 20, 90 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

AB1007	Bureau, M. (Columbia) van Gorkom, J. (Columbia) Walter, F. (Caltech) Carignan, C. (Montreal) Walter, F. (Caltech)	An HI mosaic of HOII-U4438-M81dwA. 20 cm
AB1008	Bruns, C. (Bonn U.) Kerp, J. (Bonn U.)	HI small scale structure in the northern Magellanic Stream. 20 cm
AB1009	Beltran, M. (CfA) Estalella, R. (Barcelona) Ho, P. (CfA) Anglada, G. (IAA/Andalucia)	Continuum survey of very young thermal radio jets. 0.7 cm
AC591	Curiel, S. (Mexico/UNAM) Girart, J. (Illinois) Raga, A. (Mexico/UNAM)	First epoch for proper motions of the SiO emission in L1488. 0.7 cm
AC600	Clarke, T.	Faraday study of galaxy cluster core sources. 3.6 cm
AC602	Cesaroni, R. (Arcetri) Furuya, R. (Arcetri) Testi, L. (Arcetri) Codella, C. (Rome Obs)	Twin high mass YSOs in G24.78+0.08. 0.7 cm
AC605	Claussen, M. Wilner, D. (CfA)	Monitoring continuum emission from TW Hya. 2, 3.6, 6, 20 cm
AC606	Cappa, C. (IAR) Bonn, W. M. (Bonn) van der Hucht, K. (Utrecht)	Survey of radio continuum emission from Wolf-Rayet stars. 3.6 cm
AC608	Choi, M. (SA/IAA, Taiwan) Lim, J. (SA/IAA, Taiwan) Takakuwa, S. (SA/IAA, Taiwan)	Structure of Class O proto stars. 0.7 cm
AC610	Ceccarelli, C. (Bordeaux) Brouillet, N. (Bordeaux) Castets, A. (Bordeaux) Jacq, T. (Bordeaux)	Ammonia in the hot core of proto star IRAS 16293-2422. 1.3 cm
AC611	Choi, M. (SA/IAA, Taiwan) Lim, J. (SA/IAA, Taiwan)	Wiggling molecular outflow of NGC 1333 IRAS 4A. 0.7 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 red-shift QSOs. 0.7 cm
AC614	Cotter, G. (Cambridge) Bolton, R. (Cambridge) Jones, M. (Cambridge) Grainge, K. (Cambridge) Pooley, G. (Cambridge) Waldran, E. (Cambridge) Taylor, A. R. (Cambridge) Saunders, R. (Cambridge)	Followup of the Cambridge 15 GHz survey. 0.7, 1.3, 6, 20 cm
AC622	Carilli, C. Beelen, A. (IAP) Bertoldi, F. (MPIR, Bonn) Cox, P. (IAP) Isaak, K. (Cambridge) McMahon, R. (Cambridge) Menten, K. (MPIR, Bonn) Omont, A. (IAP) Petric, A. (Columbia) Priddey, R. (Cambridge)	Sensitive radio imaging of far-IR luminous QSOs at z~2. 20 cm

AD453	Disney, M. (Wales) de Blok, W. (CSIRO) Dalcanton, J. (Washington) Minchin, R. (Wales) Grossi, M. (Wales) Vlahakis, C. (Wales) Garcia, D. (Wales) Kilborn, V. (Manchester) Boyce, P. (Bristol, UK) Ryder, S. (AAO) Staveley-Smith, L. (CSIRO) Ekers, R. (CSIRO) Knezek, P. (Johns Hopkins) Eales, S. (Wales)	Hydrogen rich giant galaxies found in the HIPASS blind HI survey. 20 cm
AD454	Disney, M. (Wales) de Blok, W. (CSIRO) Dalcanton, J. (Washington) Minchin, R. (Wales) Grossi, M. (Wales) Garcia, D. (Wales) Vlahakis, C. (Wales) Linder, S. (Wales) Kilborn, V. (Manchester) Boyce, P. (Bristol, UK) Staveley-Smith, L. (CSIRO) Ekers, R. (CSIRO) Knezek, P. (Johns Hopkins)	Enigmatic HI sources from the HIPASS blind equatorial survey. 20 cm
AD455	Dettmar, R-J. (Bochum) Tullmann, R. (Bochum) Soida, M. (Jagellonian) Urbanik, M. (Jagellonian)	Role of magnetic fields in the halo dynamics of NGC 5775. 3.6 cm
AF383	Fomalont, E. Kellermann, K. Rossi, P. (MPIfEP, Garching) Shaver, P. (ESO)	Chandra Deep Field South. 6 cm

AG604	Giovannini, G. (Bologna) Brunetti, G. (Bologna) Feretti, L. (Bologna) Govoni, F. (Bologna) Setti, G. (Bologna)	A665 and A2163 halo sources. 90 cm
AG616	van Gorkom, J. (Columbia) van der Hulst, T. (Kapteyn) Schiminovich, D. (Caltech) Horellou, C. (Chalmers, Onsala) Black, J. (Chalmers, Onsala)	HI imaging of the radio galaxy Fornax A. 20 cm
AH717	Hardcastle, M. (Bristol, UK) Sakelliou, I. (Mullard)	Jets and their termination in wide angle tail radio galaxies. 3.6 cm
AH744	Harris, D. (CfA) Krawczynski, H. (Yale) Kassim, N. (NRL) Katz-Stone, D. (USNA) Lane, W. (NRL)	Jet-intra cluster medium interactions of radio galaxy 3C 129. 20 cm
AH748	Holzapfel, W. (Chicago) Carlstrom, J. (Chicago) Dawson, K. (UC, Berkeley)	Identification of point source contaminants in anisotrophy fields. 3.6, 6 cm
AH751	Hollis, J. (NASA/GSFC) Jewell, P. Palmer, P. (Chicago) Pedelty, J. (NASA/GSFC) Snyder, L. (Illinois) Lovas, F. (Illinois)	Search for interstellar glycine. 0.7 cm
AH752	Hunter, D. (Lowell Obs) Hunsberger, S. (Lowell Obs) Wilcots, E. (Wisconsin) Simpson, C. (Florida Int) Elmegreen, B. (IBM)	Origin of dwarf galaxies. 20 cm

AH753	Hunter, D. (Lowell Obs) Elmegreen, B. (IBM) Brinks, E. (Guanajuato U.) Westpfahl, D. (NMIMT) Nordgren, T. (Lowell Obs) Wilcots, E. (Wisconsin)	Clouds, porosity, and star formation in normal irregular galaxies. 20 cm
AH754	Henkel, C. (MPIR, Bonn) Peck, A. (MPIR, Bonn) Menten, K. (MPIR, Bonn) Neininger, N. (Bonn U.) Weiss, A. (Bonn U.) Mauersberger, R. (IRAM) Hagiwara, Y. (MPIR, Bonn)	Ammonia in nearby galaxies. 1.3 cm
AH755	Hameed, S. (New Mexico State) Young, L. (NMIMT)	HI imaging of early-type spirals. 20 cm
AH756	Hyman, S. (Sweet Briar) Lazio, T. J. W. (NRL) Kassim, N. (NRL)	New galactic center composite supernova remnant? 6 cm
AH757	Hofner, P. (Puerto Rico) Kurtz, S. (Mexico/UNAM) Araya, E. (Puerto Rico) Linz, H. (Puerto Rico) Cesaroni, R. (Arcetri) Molinari, S. (IFSI)	Accretion disks around massive proto-stars. 0.7 cm
AH758	Helfand, D. (Columbia) Halpern, J. (Columbia)	HI absorption distance to the new gamma-ray pulsar PSR J2229+6114. 20 cm line
AH759	Hagiwara, Y. (MPIR, Bonn) Diamond, P. (Manchester)	Water maser in NGC 6240. 1.3 cm
AH779	Hogg, D. Roberts, M.	HI companion to UGC 3384. 20 cm
AI088	Ivison, R. (U. College London) Papadopoulos, P. (Leiden) Carilli, C. Barvainis, R. (NSF) Lewis, G. (AAO)	CO J=1-0 and J=2-1 mapping of the z=3.9 quasar APM 08279+5255. 0.7, 1.3 cm

AI093	Ivison, R. (Royal Obs) Greve, T. (Edinburgh) Carilli, C. Papadopoulos, P. (Leiden) Lewis, G. (AAO)	Mapping high z gas rich mergers via CO J=1-0. 0.7, 1.3 cm
AI096	Ivison, R. (Royal Obs) Townsend, R. (U. College London) Blain, A. (Caltech) Smail, I. (Durham) Frayer, D. (Caltech)	Search for water and OH masers in BAL quasar APM 08279+5255. 6, 90 cm
AJ283	Johnston-Hollitt, M. (CSIRO) Clarke, T.	High resolution observations of the radio relic in 0917+75. 6, 20 cm
AJ284	Jura, M. (UCLA) Reid, M. (CfA)	Dust around VY CMa. 0.7 cm
AK509	Kulkarni, S. (Caltech) Frail, D. Galama, T. (Caltech) Bloom, J. (Caltech) Berger, E. (Caltech) Harrison, F. (Caltech)	Radio afterglows from gamma-ray bursts. 3.5, 6, 20 cm
AK532	Kobulnicky, C. (Wisconsin) Martin, C. (Caltech)	NGC 1569, the nearest starburst with a galactic wind. 2, 6 cm
AK537	Koo, B-C. (Seoul National U.) Lee, J-J. (Seoul National U.)	HI line study of the supernova remnant IC 443. 20 cm
AK540	Kliem, B. (Potsdam)	VLA, HESSI, and SUMER observations of solar flares. 2, 6 cm
AL515	Ledlow, M. (KPNO-NOAO) Owen, F.	Search for giant, low-power FRI radio galaxies. 20 cm
AL549	Lim, J. (SA/IAA, Taiwan) Liang, M-C. (SA/IAA, Taiwan) Choi, M. (SA/IAA, Taiwan) Su, Y-N. (NCU)	Imaging the dust disks of Vega type stars. 0.7 cm
AL551	Lim, J. (SA/IAA, Taiwan) Ho, P. (CfA)	HI imaging of Seyfert galaxies: search for tidal interactions. 20 cm

AL552	Lang, C. (Massachusetts) Goss, W. M. Yusef-Zadeh, F. (Northwestern)	Galactic center snake filament (G359.1-0.2). 3.6, 6 cm
AL554	Li, D. (Cornell) Dickey, J. (Minnesota) Goldsmith, P. (Cornell)	Deep imaging of HI narrow line absorption in dark clouds. 20 cm
AM674	Mohan, R. N. (Raman Institute) Kurtz, S. (Mexico/UNAM)	Extended emission around ultra compact HII regions. 2, 3.6, 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
AM697	Minier, V. (Wales) Cesaroni, R. (Arcetri) Pestalozzi, M. (Chalmers, Onsala) Booth, R. (Chalmers, Onsala)	Search for embedded massive YSOs toward 6.7 GHz methanol masers. 0.7, 1.3, 2 cm
AM698	Murgia, M. (Bologna) Parma, P. (Bologna) Mack, K. (NFRA) de Ruiter, H. (Bologna)	Dying radio galaxy candidates. 6 cm
AM699	McGary, R. (CfA) Ho, P. (CfA) Coil, A. (UC, Berkeley)	Mapping hot gas near the galactic center. 1.3 cm
AM701	McKean, J. (Manchester) Browne, I. (Manchester) Jackson, N. (Manchester) Rusin, D. (CfA)	Spectral energy distributions of faint flat-spectrum radio galaxies. 1.3, 2, 3.6, 6 cm
AM702	Markovic, T. (NMIMT) Owen, F. Eilek, J. (NMIMT)	Radio halos in Abell Clusters of galaxies. 20 cm
AM704	Mathieu, R. (Wisconsin) Wilner, D. (CfA) Jensen, E. (Swarthmore) Koerner, D. (Pennsylvania)	Protostellar disks in the pre-main sequence binary environment. 0.7, 3.6 cm

AM705	Moran, J. (CfA) Greenhill, L. (CfA) Kondratko, P. (CfA) Herrnstein, J. (Renaissance Tech)	VLA polarimetry of the masers in NGC 4258. 1.3 cm
AM706	Mirabel, I. F. (CNRS, France) Dhawan, V. Duc, P. (CNRS, France) Rodrigues, I. (CNRS, France)	A probable halo compact binary. 3.6 cm
AN100	Nindos, A. (Athens) Alissandrakis, C. (Athens)	Mapping energetic electrons in solar flares. 2, 6 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
AP425	Phillips, C. (NFRA) Minier, V. (Wales) van Langevelde, H. (NFRA)	Methanol masers: tracers of hot cores and discs? 1.3 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
AR462	Roberts, M. (McGill University) Gaensler, B. (MIT) Romani, R. (Stanford)	Two potential pulsar wind nebulae associated with gamma-ray sources. 6, 20 cm
AR467	Ratay, D. (Florida) Gottesman, S. (Florida)	High sensitivity observations of the barred spiral NGC 1784. 20 cm
AR469	Reid, M. (CfA) Fish, V. (CfA) Ho, P. (CfA)	DR21: a dual cometary HII region. 0.7, 1.3 cm
AR470	Rodriguez, L. (Mexico/UNAM) Anglada, G. (IAA, Andalucia) Torrelles, J. (IAA, Andalucia)	Incidence of disks in young binary systems. 0.7 cm
AR472	Roshi, D. Goss, W. M.	W48A: are there compact CII and SII regions? 2, 3.6, 6 cm

AS716	Shinnaga, H. (SA/IAA, Taiwan) Choi, M. (SA/IAA, Taiwan)	Ammonia in late-stage starless cores. 1.3 cm
AS718	Su, Y-N (NCU) Lim, J. (SA/IAA, Taiwan) Ho, P. (CfA)	Molecular envelopes of high-mass proto stars. 1.3 cm
AT258	Thilker, D. Elmegreen, B. (IBM) Efremov, Y. (Moscow/SSAI) Larsen, S. (Copenhagen)	HI imaging of giant bubbles and arcs in NGC 6946. 20 cm
AT263	Thuan, T. (Virginia) Ulvestad, J.	Deeply embedded starburst in the BCD galaxy SBS 0335-052. 3.6 cm
AT265	Testi, L. (Arcetri) Natta, A. (Arcetri) Wilner, D. (CfA) Shepherd, D.	Search for evolved disks in pre-main sequence stars of intermediate mass. 0.7, 3.6 cm
AT268	Thilker, D. Braun, R. (NFRA)	HI observations of a possible companion to M33. 20 cm
AU088	Urbanik, M. (Jagellonian) Chyzy, K. (Jagellonian) Bomans, D. (Ruhr U.) Klein, U. (Bonn U.)	Blue compact galaxies: IC 10. 3.6, 6 cm
AV250	Vollmer, B. (MPIR, Bonn) Kenney, J. (Yale) van Gorkom, J. (Columbia) Beck, R. (MPIR, Bonn)	Active stripping of the Virgo spiral galaxy NGC 4522. 6, 20 cm
AV251	Vollmer, B. (MPIR, Bonn) Balkowski, C. (Paris Obs) Cayatte, V. (Paris Obs)	Anemic galaxies in the Virgo cluster. 20 cm
AV252	Trung, V. (SA/IAA, Taiwan) Lim, J. (SA/IAA, Taiwan) Shinnaga, H. (SA/IAA, Taiwan)	Wind sources IK Tau and IRC+10216. 0.7 cm
AV253	Trung, V. (SA/IAA, Taiwan) Lim, J. (SA/IAA, Taiwan)	Dust disks in IRC+10216 and the Egg Nebula. 0.7 cm

AW559	White, S. (Maryland) Kundu, M. (Maryland) Garaimov, V. (Maryland)	Microwave, millimeter and hard X-ray observations of solar flares. 2, 6 cm
AW563	Williams, P. (Edinburgh) Dougherty, S. (DRAO)	Continuing monitoring of WR 125. 3.6, 6, 20 cm
AW564	Willson, R. (Tufts)	Solar flares. 1.3, 2, 3.6 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
AW569	Wall, J. (Oxford) Perley, R. Silk, J. (Oxford) Laing, R. (Oxford) Taylor, A. R. (Cambridge)	43 GHz survey of two fields. 0.7 cm
AW571	Wyrowski, F. (Maryland) Carey, S. (Boston) Egan, M. (AFRL) Feldman, P. (NRC, Herzberg)	Temperature structure of infrared dark clouds. 1.3 cm
AW572	Wyrowski, F. (Maryland) Gibb, A. (Maryland) Mundy, L. (Maryland)	Temperature structure of high mass protostellar candidates. 1.3 cm
AW579	Weiler, K. (NRL) Panagia, N. (STScI) Sramek, R. Stockdale, C. (NRL) Van Dyk, S. (Caltech)	Properties of radio supernovae. 1.3, 2, 3.5, 6, 20, 90 cm
AY124	Young Owl, R. (UCLA)	Circumstellar environment of Herbig Ae Stars. 0.7, 3.6 cm
AY125	Yusef-Zadeh, F. (Northwestern) Roberts, D. (Northwestern) Wardle, M. (Sydney)	OH maser emission and OH absorption toward W28. 20 cm

AY127	Yusef-Zadeh, F. (Northwestern) Reid, M. (CfA) Roberts, D. (Northwestern)	Search for SiO masers in the arches and the quintuplet clusters. 0.7 cm
AZ133	van Zee, L. (Indiana) Schade, D. (DAO) Cote, S. (NRC, Herzberg)	HI in galaxies with deep H imaging. 20 cm
AZ134	van Zee, L. (Indiana) Salzer, J. (Wesleyan U.) Skillman, E. (Minnesota)	Kinematics of gas rich blue compact dwarf 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
BB143	Braatz, J., et al *See VLBA Program List*	Imaging the nuclear water maser in Mrk 1419. 1.3 cm
BC111	Cotton, W., et al. *See VLBA Program List*	Bright O-rich Mira stars. 7 cm
BD079	Diamond, P. (Manchester), et al. *See VLBA Program List*	TX Cam returns. 0.7 cm
BG113	Gomez, J-L. (IAA, Andalucia), et al. *See VLBA Program List*	Monitoring superluminal components in 3C120. 0.7, 1.3, 2 cm
BG118	Greenhill, L. (CfA), et al. *See VLBA Program List*	SiO maser motions in Orion BN/KL. 0.7 cm
BH085	Hoffman, I. , et al. *See VLBA Program List*	1720 MHz OH masers in SNR IC 443. 20 cm
BM157	Mantovani, F. (Bologna), et al. *See VLBA Program List*	Polarization and rotation measure in CSS QSOs. 3.6, 6 cm
BN018	Nakai, N. (NAO), et al. *See VLBA Program List*	New water maser features in NGC 3079. 1.3 cm
BR071	Ranter, M.I. (CfA), et al. *See VLBA Program List*	Astrometry of HR 8703 in 2001 for the gravity probe-b mission. 2, 3.6, 6 cm

BT058	Tinti, S. (Bologna), et al. *See VLBA Program List*	Morphological/spectral study of B3-VLA CSSs 3.6, 6 cm
GB042	Bartel, N. (York), et al. *See VLBA Program List*	SN 1993J and the core jet counterjet in M81. 3.6, 6, 20
GM045	Morganti, R. (NFRA), et al. *See VLBA Program List*	Thin disks in FRI radio galaxies? 18, 20 cm
GM046	Marcaide, J.M. (Valencia), et al. *See VLBA Program List*	Monitoring the expansion of SN 1993J. 6, 18, 20 cm
GP030	Porcas, R. (MPIR, Bonn), et al. *See VLBA Program List*	Global VLBI study of gravitational lens 2016+112. 20 cm
W305	Gabuzda, D. (JIVE), et al. *See VLBA Program List*	Toroidal B fields in BL Lac objects. 6 cm
W323	Jones, D.L. (JPL), et al. *See VLBA Program List*	Cores of compact sources AO 0235+164 and 0735+178. 6, 20 cm
W405	Argon, A.L. (CfA), et al. *See VLBA Program List*	Nuclear jet in M87. 6, 20 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. Hughes, P. (Brandeis) 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
BA054	Alberdi, A. (IAA, Andalucia) Colina, L. (IFCA) Panagia, N. (CSIC) Torrelles, J. (STScI) Wilson, A. (Maryland)	VLBI observations of the radio supernova RSN J230315+0852.4 in the circumnuclear starburst of the Seyfert 1 Galaxy NGC 7469. 6, 20 cm
BB123	Brotherton, M. (NOA) 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
BB137	Baudry, A. (Bordeaux) Desmurs, J-F. (OAN) Diamond, P. (Manchester)	Observations of the recently discovered 13.4 GHz OH maser in ON1. 2 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

BB143	Braatz, J. Greenhill, L. (CfA) Henkel, C. (MPIR, Bonn) Moran, J. (CfA) Wilson, A. (Maryland)	Imaging the nuclear water maser in Mrk 1419. 1.3 cm
BC111	Cotton, W. Mennesson, B. (Leiden) Vlemmings, W. (Leiden) Perrin, G. (Paris Obs) Coude du Foresto, V. (Paris Obs) Chagnon, G. (Paris Obs) Diamond, P. (Manchester) van Langevelde, H. (NFRA) Ridgway, S. (KPNO-NOAO) Morel, S. (CfA) Traub, W. (CfA) Carleton, N. (CfA) Lacasse, M. (CfA) Waters, R. (Amsterdam)	Bright O-rich Mira stars. 0.7 cm
BC113	Chatterjee, S. (Cornell) Arzoumanian, Z. (NASA) Cordes, J. (Cornell) Lazio, T. J. W. (NRL) McLaughlin, M. (Cornell)	Preliminary VLB observations of a Hyper-fast pulsar. 20 cm
BC114	Clark, T. (NASA/GSFC) Ma, C. (NASA/GSFC) Johnston, K. (USNO) Fey, A. (USNO) Gordon, D. (NASA/GSFC) Gaume, R. (USNO) Boboltz, D. (USNO) Kingham, K. (USNO) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) Shaffer, D. (Radiometrics) Fomalont, E. Walker, R. C.	Geodesy/astrometry observations for 2001. 3.6 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
BD073	Doeleman, S. (Haystack) Attridge, J. (Haystack) Lonsdale, C. (Haystack)	Magnetic fields in environments of SiO masers. 3, 7 cm
BD075	Darling, J. (Cornell) Menten, K. (MPIR, Bonn) Peck, A. (MPIR, Bonn)	Imaging OH mega maser emission at z >0.1. 20 cm
BD079	Diamond, P. (Manchester) Kemball, A.	TX Cam returns. 0.7 cm
BE023	Edwards, P. (ISAS) Piner, G. (Whittier)	Markarian 421 - monitoring after a TeV outburst. 1 cm
BF066	Fomalont, E. Alberdi, A. (LAEFF) Baan, W. (JIVE) Garrett, M. (JIVE) Garrington, S. (Manchester) Kellermann, K. Muxlow, T. (Manchester) Richards, E. (Alabama)	Observations of the SA 13 Deep field. 20 cm
BF068	Filho, M. (Kapteyn) Barthel, P. Kapteyn) Ho, L. (OCIW) Nagar, N. (Arcetri)	Parsec Scale Radio cores in "Transition" LINERs. Part II. 6 cm
BG103	Gabuzda, D. (JIVE) Pushkarev, A. (ASC)	Unique parsec-scale properties of the BL Lac object 0820+225. 2, 4, 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

BG113	Gomez, J-L. (IAA, Andalucia) Marscher, A. (Boston) Marchenko-Jorstad, S. (Boston) Alberdi, A. (IAA, Andalucia) Agudo, I. (IAA, Andalucia) Marti, J. (Jaen) Aloy, M. (Valencia) Ibanez, J. (Valencia)	Monitoring superluminal components in 3C120. 0.7, 1.3, 2 cm
BG116	Geldzahler, B. (George Mason) Bradshaw, C. (George Mason) Fomalont, E.	Astrometric observations of the compact radio source G127.11+0.54. 4 cm
BG117	Gabuzda, D. (JIVE) Agudo, I. (IAA, Andalucia) Cawthorne, T. (Central Lancashire) Gomez, J-L. (IAA/Andalucia)	Clues to unusual bending in 0735+178. 0.7, 1, 2, 4 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
BG122	Goedhart, S. (HartRAO) Gaylard, M. (HartRAO) Minier, V. (Wales) Quick, J. (HartRAO) van der Walt, J. (Potchesfstroom)	Progression of a flare in the methanol maser source G9.62+20E. 2 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	Omodaka, T. (Kagoshima) Hachisuka, K. (Graduated Univ) Sasao, T. (NAO) Honma, M. (NAO) Imai, H. (NAO) Kameya, K. (NAO) Manabe, S. (NAO) Miyoshi, M. (NAO) Mochizuki, N. (Graduated Univ.) Nisio, M. (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)	Variability in the nuclei of lobe-dominated quasars. 4 cm
BH085	Hoffman, I. Goss, W. M. Brogan, C. Claussen, M.	1720 MHz OH masers in SNR IC 443. 18 cm
BH088	Diamond, P. (Manchester) Miyoshi, M. (NAO)	Single black hole formation in an on-going merger? 1 cm
BH092	Hough, D. (Trinity)	Second epoch imaging of five faint nuclei in lobe-dominated quasars. 4 cm
BI024	Imai, H. (NAO) Diamond, P. (Manchester)	Collimated molecular jet in W 43A traced by water maser emission. 20 cm
BK076	Kurayama, T. (NAO) Sasao, T. (NAO)	Parallax measurement of Miras for Period-luminosity relation. 1 cm
BK080	Krichbaum, T. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Romney, J. Witzel, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	Precession or helical instabilities in 3C273? 0.3, 0.7 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
BK090	Krichbaum, T. (MPIR, Bonn) Bach, U. (MPIR, Bonn) Terasranta, H. (Metsahovi) Ungerechts, H. (IRAM) Witzel, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	VLBA monitoring of 1633+382 after a major millimeter-flare. 1.3, 7 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) 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
BM146	Miyoshi, M. (NAO) Deguchi, S. (Nobeyama) Imai, H. (NAO) Nakashima, J. (Graduate Univ.)	Precise proper-motion measurement of the SiO maser sources at the Galactic Center Relative to Sgr A*. 0. 7 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. 3, 7 cm

BM157	Mantovani, F. (Bologna) Junor, W. (New Mexico) Saikia, D. (TIFR) Salter, C. (NAIC)	Polarization and rotation measure in CSS QSOs. 3.6, 6 cm
BM162	Marscher, A. (Boston) Aller, M. (Michigan) Jorstad, S. (Boston) McHardy, I. (Michigan)	Relationship between X-ray flares and superluminal ejections in blazars. 0.7, cm
BM164	Middelberg, E. (MPIR, Bonn) Gabuzda, D. (JIVE) Kadler, M. (MPIR, Bonn) Roy, A. (MPIR, Bonn)	Polarimetry of NGC 1052. 2 cm
BN018	Nakai, N. (NAO, Japan) Ishihara, Y. (NAO, Japan) Sato, N. (NAO, Japan) Diamond, P. (Manchester)	New water maser features in NGC 3079. 1.3 cm
BN019	Nagar, N. (Arcetri) Falcke, H. (MPIR, Bonn) Wilson, A. (Maryland)	Parsec-scale radio cores in low-luminosity AGN. 6 cm
BR071	Ratner, M. (CfA) Bartel, N. (York U.) Bietenholz, M. (York U.) Lebach, D. (CfA) Lestrade, J-F. (Paris Obs) Ransom, R. (York U.) Ransom, R. (York U.) Shapiro, I. (CfA)	Astrometry of HR 8703 in 2001 for the gravity probe-b mission. 2, 3.6, 6 cm
BR072	Reynolds, C. (JIVE) Cawthorne, T. (Central Lancashire) Gabuzda, D. (JIVE) Pushkarev, A. (ASC)	Non-uniform Faraday rotation in BL Lac objects. 1, 2, 4, 6 cm
BR074	Romney, J. Kellermann, K. Walker, R. C. Zensus, J. A. (MPIR, Bonn)	VLBA 3 mm commissioning observations of four bright sources. 0.3, 0.7 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. 6, 13 cm
BR077	Ros, E. (MPIR, Bonn) Lister, M. Cohen, M. (Caltech) Kadler, M. (MPIR, Bonn) Kellermann, K. Vermeulen, R. (Dwingeloo) Zensus, J. A. (MPIR, Bonn)	Kinematics of parsec-scale structure in AGN: a survey. 2 cm
BR078	Rupen, M. Dhawan, V.	V445 Pup - Target of Opportunity. 4, 13 cm
BS087	Sudou, H. (Tohoku Univ.) Iguchi, S. (NAO) Murata, Y. (ISAS) Taniguchi, Y. (Tohoku Univ.)	Phase-referencing VLBI observations of 3C 66B. 4, 13 cm
BS090	Shepherd, D. Claussen, M. Kurtz, S. (Mexico/UNAM)	Water masers in the massive accretion disk of G192.16. 6 cm
BS096	Suda, H. (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
BS103	Schmitt, H. Antonucci, R. (UC,Santa Barbara) Kinney, A. (NASA) Pringle, J. (Cambridge) Ulvestad, J.	Orientation of jets relative to dust disks in radio galaxies. 1.3 cm
BS104	Schmitt, H. Antonucci, R. (UC, Santa Barbara) Kinney, A. (NASA) Pringle, J. (Cambridge) Ulvestad, J.	Parsec-scale jets and the inner structure of Seyfert galaxies. 6 cm

BS110	Spencer, R. (Manchester) Dhawan, V. McCormick, D. (Manchester) Mioduszewski, A. Pooley, G. (MRAO) Rupen, M. Stirling, A. (Central Lancashire)	Target of Opportunity Cygnus X-1. 2 , 4, 13 cm
BT058	Tinti, S. (Bologna) Dallacasa, D. (Bologna) Fanti, R. (Bologna) Fanti, C. (Bologna) Gregorini, L. (Bologna) Vigotti, M. (Bologna) Stanghellini, C. (Bologna)	Morphological/spectral study of B3-VLA CSSs. 3.6, 6 cm
BT060	Trinidad, M. (Mexico/UNAM) Anglada, G. (CSIC) Canto, J. (Mexico/UNAM) Curiel, S. (Mexico/UNAM) Garay, G. (Chile) Gomez, J-L. (LAEFF) Ho, P. (CfA) Patel, N. (CfA) Rodriguez, L. (Mexico/UNAM) Torrelles, J. (CSIC)	Proper motion studies of circumstellar water masers in AFGL 2591 and Lkh 234. 1 cm
BT062	Taylor, G. Harris, D. (CfA)	Constraining the jet orientation in the radio galaxy 3C129. 6 cm
BW054	Walker, R. C. Wrobel, J.	Jet collimation regions. 7 cm
BW056	Winn, J. (MIT) Lovell, J. (ATNF)	An unusual gravitationally-lensed quasar. 1.3, 20, 90 cm
BW057	Winn, J. (MIT) Lovell, J. (ATNF)	Completion of southern gravitational lens survey. 6 cm

GB042	Bartel, N. (York U.) Rupen, M. Bietenholz, M. (York U.) Beasley, A. (Caltech) Graham, D. (MPIR, Bonn) Altunin, V. (JPL) Venturi, T. (Bologna) Umana, G. (Bologna) Cannon, W. (York U.) Conway, J. (Chalmers, Onsala)	SN 1993J and the core jet counterjet in M81. 18 cm
GM045	Morganti, R. (NFRA) Oosterloo, T. (NFRA) Peck, A. (MPIR, Bonn) Sandro, C. (Torino) Parma, P. (Bologna) de Ruiter, H. (Bologna) Fanti, R. (Bologna) van Moorsel, G.	Thin disks in FRI radio galaxies? 18 cm
GM046	Marcaide, J. (Valencia) Guirado, J. (Valencia) Alberdi, A. (IAA, Andalucia) Lara, L. (IAA, Andalucia) Ros, E. (MPIR, Bonn) Diamond, P. (Manchester) Shapiro, I. (CfA) Preston, R. (JPL) Schilizzi, R. (NFRA) Mantovani, F. (Bologna) Perez-Torres, M. (Bologna) Trigilio, C. (Bologna) Van Dyk, S. (IPAC) Weiler, K. (NRL) Sramek, R. Whitney, A. (Haystack)	Monitoring the expansion of SN 1993J. 6, 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

W059	Kedziora-Chudczer, L. (CSIRO) Jauncey, D. (CSIRO) Reynolds, J. (CSIRO) Tzioumis, A. (CSIRO) Wieringa, M. (CSIRO) Nicolson, G. (HartRAO) Quick, J. (HartRAO) Walker, M. (Sydney) McCulloch, P. (Tasmania)	Complete sample of intra-day variables. 6 cm
W302	Giovannini, G. (Bologna) Lara, L. (IAA, Andalucia) Venturi, T. (Bologna)	BL Lac type objects Mkn 501, Mkn 421. 6, 18 cm
W305	Gabuzda, D. (NFRA) Pushkarev, A. (Lebedev) Garnich, N. (Moscow/SSAI)	Toroidal B fields in BL Lac objects. 6 cm
W315	Murphy, D. (JPL) Marshall, H. (MIT) Canizares, C. (MIT) Coppi, P. (Yale) Preston, R. (JPL) Piner, G. (Whittier College) Lister, M. Edwards, P. (ISAS, Japan) Hirabayashi, H. (ISAS, Japan)	3C273 and 1156+295. 6 cm
W323	Jones, D. (JPL) Preston, R. (JPL) Meier, D. (JPL) Murphy, D. (JPL) Lister, M. Piner, B. (JPL)	Cores of compact sources AO 0235+164 and 0735+178. 6, 18 cm
W330	Kameno, S. (NAO, Japan) Wajima, K. (ISAS, Japan) Zhi-Qiang, S. (ISAS, Japan) Inoue, M. (NAO, Japan) Sawada-Satoh, S. (ISAS, Japan)	Complementary multi-frequency GPS survey. 18 cm

W404	Hough, D. (Trinity U.) Murphy, D. (JPL) Readhead, A. (Caltech) Vermeulen, R. (NFRA) Wood, D. (NM Highlands)	Sub-mas structure and motion in lobe-dominated quasars. 6 cm
W405	Argon, A. (CfA) Reid, M. (CfA) Greenhill, L. (CfA) Moran, J. (CfA)	Nuclear jet in M87. 6, 18 cm
W421	Lobanov, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn) Abraham, Z. (Sao Paulo) Carrara, E. (Sao Paulo)	Parsec scale jet in superluminal quasar 3C 273. 6 cm
W503	Britzen, S. (NFRA) Krichbaum, T. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn) Strom, R. (Amsterdam)	BL Lac object S5 1803+784. 18 cm
W605	Mutoh, M. (NAO, Japan) Inoue, M. (NAO, Japan) Kameno, S. (NAO, Japan) Asada, K. (NAO, Japan) Fujisawa, K. (NAO, Japan)	A test of the 90d jump of position angle in GPS sources. 6, 18 cm

New Hires

Chang, Jack	Electronics Engineer I	12/01/01
Constantikes, Kim	Electronics Engineer I	12/17/01
Gray, Peter	Project Engineer (ALMA)	12/01/01
Johnson, Kelsey	Research Associate	10/01/01
Markovic, Tomislav	Jr Research Associate	10/01/01
Newton, Travis	Electronics Engineer I	10/29/01
Pihlstrom, Ylva	Research Associate	10/30/01
Rector, Travis	Research Associate	11/05/01
Sjouwerman, Lorant	Assistant Scientist	10/30/01
Uphoff, Jeffrey	Sci Programming Analyst*	11/12/01

Terminations

Hankins, Timothy	Visiting Scientist	11/20/01
Patt, Ferdinand	Electronics Engineer II	10/01/01

Promotions

Long, Robert	to Elec Eng III	11/20/01
Ulvestad, James	to Assistant Director (SO)	12/15/01

Other Changes

Goss, Miller	return to Scientist (Tenure)	12/15/01

* Part-time

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

PREPRINTS RECEIVED, OCTOBER - DECEMBER 2001

BAUMANN, D.; LEONG, B.; SASLAW, W.C. Universes that Change Their Global Symmetry.

BELTRAN, M.T.; ESTALELLA, R.; HO, P.T.P.; CALVET, N.; ANGLADA, G.; SEPULVEDA, I. Multiwavelength Study of the Powering Sources of the Double H2 Bipolar Jet in L1634.

BERGER, E. Flaring Up All Over - Magnetic Activity in Rapidly-Rotating Late-Type M and L Dwarfs.

BOLTON, S.J.; JANSSEN, M.; THORNE, R.; LEVIN, S.; KLEIN, M.; GULKIS, S.; BASTIAN, T.; SAULT, R.; ELACHI, C.; HOFSTADER, M.; BUNKER, A.; DULK, G.; GUDIM, E.; HAMILTON, G.; JOHNSON, W.T.K.; LEBLANC, Y.; LIEPACK, O.; MCLEOD, R.; ROLLER, J.; ROTH, L.; WEST, R. Cassini and Ground-Based Observations of Jupiter's High Energy Radiation Belts.

BRUNTHALER, A.; BOWER, G.C.; FALCKE, H.; MELLON, R.R. Detection of Circular Polarization in M81*

BUREAU, M.; CARIGNAN, C. Environment, Ram Pressure, and Shell Formation in Holl.

CARILLI, C.L.; BERTOLDI, F.; OMONT, A.; COX, P.; MCMAHON, R.G.; ISAAK, K.G. Radio Observations of Infrared-Luminous High-Redshift Quasi-stellar Objects.

CHEN, J.; LO, K.Y.; GRUENDL, R.A.; PENG, M.-L. Distorted H I Gas in the Widely Separated LIRG Arp 256.

DENNETT-THORPE, J.; SCHEUER, P.A.G.; LAING, R.A.; BRIDLE, A.H.; POOLEY, G.G.; REICH, W. Jet Reorientation in AGN: Two Winged Radio Galaxies.

DUBNER, G.M.; GAENSLER, B.M.; GIACANI, E.B.; GOSS, W.M.; GREEN, A.J. The Interstellar Medium Around the Supernova Remnant G320.4-1.2.

DWARAKANATH, K.S.; CARILLI, C.L.; GOSS, W.M. Detection of H I 21 cm-Line Absorption in the Warm Neutral Medium and in the Outer Arm of the Galaxy.

EMERSON, D.T. The Stage Is Set: Developments Before 1900 Leading to Practical Wireless Communication.

FOMALONT, E.B.; KELLERMANN, K.I.; PARTRIDGE, R.B.; WINDHORST, R.A.; RICHARDS, E.A. The Micro-Jansky Sky at 8.4 GHz.

FRAIL, D.A.; BERTOLDI, F.; MORIARTY-SCHIEVEN, G.H.; BERGER, E.; PRICE, P.A.; BLOOM, J.S.; SARI, R.; KULKARNI, S.R.; GERARDY, C.L.; REICHART, D.E.; DJORGOVSKI, S.G.; GALAMA, T.J.; HARRISON, F.A.; WALTER, F.; SHEPHERD, D.S.; HALPERN, J.; PECK, A.B.; MENTEN, K.M.; YOST, S.A.; FOX, D.W. GRB 010222: A Burst within a Starburst.

FRAIL, D.A.; KULKARNI, S.R.; SARI, R.; DJORGOVSKI, S.G.; BLOOM, J.S.; GALAMA, T.J.; REICHART, D.E.; BERGER, E.; HARRISON, F.A.; PRICE, P.A.; YOST, S.A.; DIERCKS, A.; GOODRICH, R.W.; CHAFFEE, F. Beaming in Gamma-Ray Bursts: Evidence for a Standard Energy Reservoir.

GOMEZ, J.-L.; MARSCHER, A.P.; ALBERDI, A.; JORSTAD, S.G.; AGUDO, I. Monthly 43 GHz VLBA Polarimetric Monitoring of 3C 120 Over 16 Epochs: Evidence for Trailing Shocks in a Relativistic Jet.

HIBBARD, J.E.; VAN DER HULST, J.M.; BARNES, J.E.; RICH, R.M. High-Resolution H I Mapping of NGC 4038/39 ('The Antennae') and Its Tidal Dwarf Galaxy Candidates.

HOMAN, D.C.; OJHA, R.; WARDLE, J.F.C.; ROBERTS, D.H.; ALLER, M.F.; ALLER, H.D.; HUGHES, P.A. Parsec-Scale Blazar Monitoring: Flux and Polarization Variability.

KAPLAN, D.L.; KULKARNI, S.R.; FRAIL, D.A.; KERKWIJK, M.H. Deep Radio, Optical, and Infrared Observations of SGR 1900+14.

KELLERMANN, K.I. Brightness Temperature Constraints to Compact Synchrotron Source Radiation Obtained from IDV and VLBI Observations.

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