NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

October – December 2003

Cover: The VLA image of Hydra A at 74 MHz.
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Executive Summary

ALMA

ALMA officially broke ground in Chile on November 6, 2003 with a ceremony at the Operations Support Facility near San Pedro de Atacama. The ceremony was attended by a number of dignitaries from North America, Europe and Chile. On December 25 it was announced by Dr. N. Kaifu, Director General of NAOJ, that the ALMA-J construction budget has been included in the Japanese FY2004 Government Budget plan.

Evaluation of the prototype antenna from VertexRSI continues at the Antenna Test Facility located at the VLA. The prototype Alcatel antenna has been fully erected and is undergoing commissioning. The Request for Proposals and Call for Tenders for the production antenna procurement has been released.

The Critical Design Review for the Correlator was successfully completed, and production of the first Correlator quadrant is now underway.

EVLA

Bench testing of prototype electronic modules continued and installation of modules into racks on antenna 13, the EVLA test antenna, was initiated. System integration tests went well, and first light at 8.6 GHz was achieved on the test antenna early in the quarter.

Installation of fiber optic cable on the VLA is complete to the halfway point on the North Arm, which means that this important activity is now more than 80% complete overall. A review of antenna fiber was held. Two Digital Transmission System/sampler modules have been assembled and bench tested, and are now being used on the test antenna to evaluate the fiber optic system. Phase stability tests of the fiber showed good results and data transmission tests between the antenna and the VLA Control Building have started. Use of the Monitor and Control software to control various electronic devices began.

The Request for Proposal for the correlator chip developed by the Canadian Partner was nearly finalized. Progress was made in the development of correlator components such as the delay module and the Long term Accumulator. A baseline plan for the interface between the EVLA monitor and control system and the correlator was agreed upon, and some details of the correlator software implementation were discussed.

Executive Summary

A design team consisting of representatives from the two divisions working on EVLA software (EVLA Computing Division and Interferometry Software Division) has been formed to produce a high level architecture design for the complete (End-to-End) EVLA computing system. The VLA Data Archive, which is a prototype for the EVLA Data Archive, was put into on-line service and is receiving wide use.

Green Bank Telescope

GBT observing capability for the 40-50 GHz band (Q-band) was achieved in the 4th Quarter. This required both the completion of the receiver and reaching the required telescope performance. The Q-band receiver, which had been on the telescope for initial engineering checks last spring, was reinstalled in December for astronomical commissioning. In November, the accuracy targets for initial Q-band observing were reached with respect to the pointing, tracking, focus, and surface rms. Q-band operation is a major milestone that provides significant, new scientific capability for the user community. First astronomical observing at Q-band will commence this winter

Tests of the trial modification of the GBT track continue. The joint has been stable, as indicated by wheel tilt measurements, but ultrasonic examination revealed some linear defects near the top surface of the plate to one side of the weld centerline. This area will be monitored for changes. Work continued on the azimuth track study. The critical effort is the dynamical analysis of the track with a moving wheel, a challenging piece of engineering being performed by the firm of Simpson, Gumpertz and Heger (SGH). The results are now expected in the first quarter of 2004, and will be reviewed at a meeting of the Track Panel.

The Precision Telescope Control System (PTCS) project is responsible for delivering the high frequency performance on the GBT. The work on correcting for thermal gradients in the antenna was continued in this quarter, and culminated in a successful real-time demonstration of the dynamic thermal corrections on November 20. All-sky pointing/focus data were combined with temperature sensor data to construct gravity pointing and focus models, as well as thermal pointing and focus correction predictors. Using the model a blind pointing accuracy of 5" is achieved under benign conditions (winds less than 2.5 m/s, and avoiding extreme solar loading). Tracking stability of 1" for up to 30 minutes has been demonstrated. At the PTCS In-Progress Review in December, the review panel was pleased with the progress achieved and endorsed the project plan for further work.

The Software Development Group achieved a number of milestones in the 4th Quarter, including the beta releases of the new GBT Configuration Tool and the Single-Dish Flexible Image Transport System SDFITS writer. The Configuration Tool is already in use by staff astronomers and visiting observers, and has made a considerable improvement in the speed and ease of setting up GBT observations. Work is continuing to expand the capabilities of this application, with planned completion in the 2nd Quarter of 2004. The SDFITS writer provides a well-known export format for GBT data that makes it much easier to reduce GBT data with software packages provided by users, other observatories, or commercially.

Executive Summary

The GBT spectrometer, a highly capable backend with up to 256,000 spectral channels and 6.4 GHz of analysis bandwidth, was used routinely during the 4th Quarter. Reliability of this instrument improved significantly in the past few months as a result of modifications and upgrades by the Digital Engineering Group. The backend is now a quite reliable and powerful astronomical instrument. Continued work to improve capabilities and reliability of the spectrometer is planned in 2004.

A significant development with the spectrometer was the release of "expert operation" of the pulsar spigot mode. This is a powerful capability that allows pulsar data to be dumped very rapidly—as often as every few microseconds—with observing bandwidths as high as 800 MHz. The digital hardware and observing systems were developed by NRAO engineers and scientists, and the data acquisition computer system was developed by David Kaplan, a Ph.D. student at Caltech.

A Critical Design Review of the Penn Array project was conducted in mid-October. Other milestones reached this quarter include the production of a mechanical prototype for the detector array at Goddard, the finalization of the optics design and prototyping of the anti-reflective coating, and the successful analysis of the simulated data in the software package created by W. Cotton. Goddard personnel have made good progress with a firmware upgrade which will make the multiplexed bolometer data much easier to handle.

The receiver engineering group was very successful this quarter. The receiver in the 18-26 GHz (K-band) was modified. The receiver at 40-50 GHz (Q-band) was reworked to eliminate an RFI leak in the mounting plate and to correct a problem which had caused failures in the Low Noise Amplifier. The receiver was ready for the performance tests at 7 mm described above. Construction of the 26-40 GHz (Ka-band) receiver continues, and it is expected to be ready at the end of the next quarter.

Very Large Array & Very Long Baseline Array

The 19th Annual New Mexico Symposium was held at the Array Operations Center (AOC) on October 3, 2003. The purpose of the Symposium is to support the network of scientific research in the Southwest and to encourage interdisciplinary discussions. Researchers from the University of New Mexico, the New Mexico Institute of Mining and Technology, Los Alamos National Laboratory, and NRAO made presentations at the Symposium. The Symposium was held in conjunction with the Jansky lectureship given by Professor Donald C. Backer of the University of California at Berkeley.

The new policy on Rapid Response Science for the VLA, VLBA, and GBT went into effect on October 1, 2003. The policy allocates up to five percent of the total observing time on the VLA and VLBA, and two percent of the total observing time on the GBT for observations of known transient phenomena, exploratory time, and targets of opportunity. The policy is designed to accommodate observations of unusual or rare events which cannot be supported by the routine proposal process in a timely manner.

Executive Summary

With the activation of the VLA on-line data archive in October 2003, VLA archive data are now readily accessible to many astronomers. The fraction of refereed VLA papers utilizing archive data should increase over the next few years. In 2002, approximately 15 percent of the VLA papers appearing in the refereed literature relied upon archive data.

His Royal Highness, the Duke of York, was given a tour of the AOC on October 20. Prince Andrew was visiting Socorro for the ground breaking ceremony of the Magdalena Ridge Observatory. Included in the AOC visit were demonstrations of EVLA electronics developments and a tour of the VLBA control center.

Annual maintenance visits to the VLBA antennas were completed for the 2003 calendar year on October 23 when an azimuth wheel assembly was replaced at the North Liberty antenna. Other maintenance activities completed during the quarter include the replacement of the hydrogen maser at the Brewster VLBA station and the installation of a prototype digital tachometer at Hancock.

Central Development Laboratory

During November and December 2003, the CDL and ALMA offices and laboratories were moved to the new NRAO Technology Center (NTC).

Development of amplifiers using InP transistors in the range 1-4 GHz for the EVLA reached prototyping stage.

The ALMA Band 6 SIS mixer-preamps were successfully tested in nearly-final configuration. The SIS Band 6 mixer-preamp and cartridge test dewars were completed and successfully used to test prototype systems. Improved methods of SIS mixer construction were implemented.

Electromagnetic work on feeds supporting 1-2 GHz observations on the GBT and EVLA made good progress.

The ALMA 2-antenna prototype correlator was completed and its operation verified. The ALMA 64-antenna correlator passed its Critical Design Review and detailed work began on implementing the recommendation of the CDR committee to carry out a multiple-output tunable filter bank to enhance significantly the performance of the correlator.

Production prototypes of several modules of the front end segment of the ALMA local oscillator system, including Active Multiplier Chains and Power Amplifiers, were fabricated and successfully tested.

The initial version of a Solar Radio Burst spectrometer to be installed at Green Bank for monitoring solar activity was fabricated and successfully tested in Charlottesville.

Executive Summary

Computing and Information Services

As a result of Internet router filters, vigilant anti-virus maintenance, and focused patching efforts, the NRAO has been almost completely spared from major virus outbreaks. All sites are now cautious about verifying operating-system patches and anti-virus protection on non-NRAO systems (visitors' laptops, for example), and the automated patching processes established by the Common Computing Environment (CCE) group for both Windows and Linux are functioning well.

The CCE group has as its goal to ensure that all sites provide a standard configuration of operating systems, network services, applications software availability, and user interfaces. A target list of activities is used and refined in regular target-review and discussion meetings, and brief weekly reports describe the progress. Approximately 90% of the targets set in March 2003 by the project members were met by the end of the year, and the remainder should be completed before the project review meeting in March 2004.

A major effort this quarter was the completion of the networking and phone infrastructure to prepare for the migration of the Central Development Lab and the ALMA Electronics from the old Dynamics Building to the new NRAO Technology Center (NTC). Communication between the Edgemont Road Building and the NTC employs a DS43 (45 Mbps) link carrying both data and voice services. For network support within the NTC a backbone comprising Cisco Systems equipment for Ethernet switches and routers has been deployed. The Cisco equipment also provides the infrastructure for Voice-over-IP and IP telephony.

After some delay caused by limited resources, the current plan for upgrade of the network service to the VLBA Kitt Peak antenna envisions the deployment to be completed in the next quarter. As a result of lower costs for the new intranet contract it will be possible to upgrade the service at three other sites as well. When this is complete, five of the six VLBA stations that connect via frame relay intranet will have full T1 connections.

Education and Public Outreach

Attendance at both the Science Center at Green Bank and the Visitor Center at the VLA showed significant increases this quarter in comparison to the same period last year. Three new exhibits have been installed at the VLA Visitor Center. One is a gallery of VLA photos taken by the staff. However, it is hoped that the exhibit will eventually include photos taken by visitors to the Array. The new student bunkhouse in Green Bank built in conjunction with the Science Center is essentially complete, and will house visiting students and youths during visits to the Observatory. It is anticipated that the building will be ready for use in February 2004.

Executive Summary

The NRAO initiated, organized, and sponsored a successful conference on the topic of communicating astronomy to the public (CCAP). The conference was held in October at the National Academy's Keck Building in Washington, DC. One outcome was a statement on the importance of EPO for all astronomy institutions which will be forwarded to the AAS and other organizations to solicit their formal endorsement.

The CCAP was one of five EPO related meetings in October. The NSF highlighted its ground-based facilities in the meeting "The Universe from the Ground Up", which included an NRAO display and a presentation about ALMA by the NRAO Director. One of the NRAO's public information officers participated in the NSF Public Information workshop held at the NSF itself. Meanwhile, Albuquerque hosted the annual meeting of the Society for Advancement of Chicanos and Native Americans in Science at which NRAO had a display. Finally, NRAO participated in the meeting of the Southwest Consortium of Observatories for Public Education, held in Sunspot, New Mexico.

Environment, Safety and Security

NRAO revised the Emergency Preparedness Plan for the AOC and the VLA in Socorro. At the ALMA Test Facility in Socorro, the emphasis was in the development and implementation of the AEC contractor safety program. The Green Bank site was inspected for safety items and a concerted effort was placed on the installation of security surveillance cabling. In Charlottesville, the focus was on the preparation of the NTC building and the associated move of the chemistry lab and on the access control card system at the Edgemont Road site. With the office in Santiago, ES&S began meeting to resolve procedures for safe operations and medical surveillance protocols.

Science Highlights

Very Large Array

Cosmic Explosions Have Common Origin **-** Using data from VLA observations of GRB 030329 along with observations from other instruments, researchers have concluded that strong and weak Gamma-Ray Bursts and X-ray flashes, which emit almost no gamma rays, have a common origin—the explosive death of a massive star. Such explosions produce both narrow and wide polar beams and can distribute their energy quite differently between those beams. The narrow beam contains the gamma rays, and if it receives little energy, the explosion will appear as an X-ray flash rather than as a gamma-ray burst. Despite such differences, however, the explosions all produce about the same amount of total energy.

Investigators: E. Berger and S.R. Kulkarni (Caltech); G. Pooley (Mullard); D.A. Frail (NRAO); V. McIntyre and R.M. Wark (ATNF); R. Sari and A.M. Soderberg (Caltech) and P.A. Price (Mt. Stromlo).

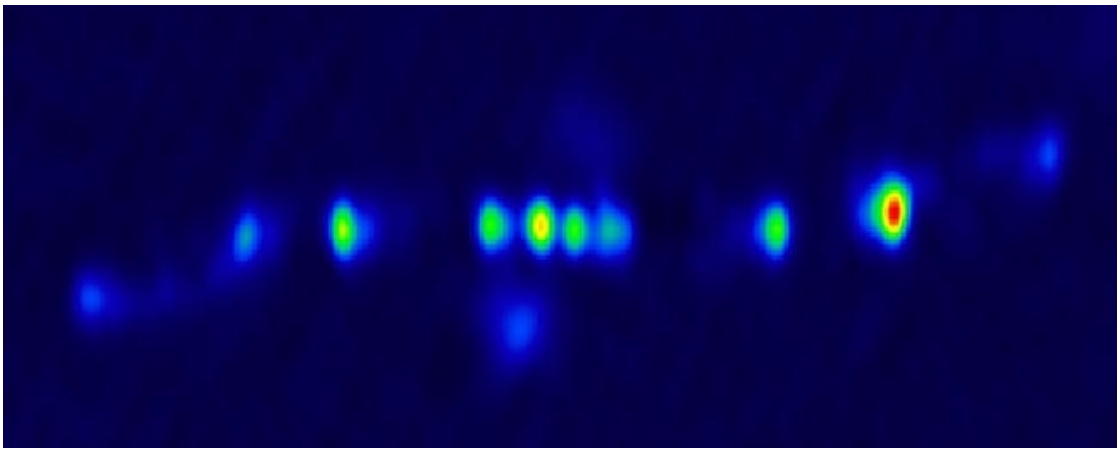
Artist's Conception of Twin Jets in Energetic Cosmic Explosion.

Science Highlights

Very Long Baseline Array

VLBA "Movie" Reveals Detail of Microquasar Jets **-** The VLBA was used to make a 42-day movie of the famous microquasar SS 433, showing unprecedented detail of the object's jets and other emission regions. The once-a-day observations allowed tracking of jet ejecta and their brightening at several points within the jet. The jet's precession also is clearly shown. The movie shows for the first time that previously-discovered anomalous emission, nearly perpendicular to the jets, is moving outward from the microquasar's core. Initial analysis suggests that both the anomalous emission and the brightening of jet ejecta may be the result of a broad wind from the accretion disk.

Investigators: A. Mioduszewski, M. Rupen, G. Taylor and C. Walker (all NRAO).



Frame from SS 433 Movie.

Green Bank

Binary Millisecond Pulsars in the Globular Cluster M30. Two binary millisecond pulsars have been detected in the globular cluster M30. One of the pulsars (M30A) is an 11 ms, eclipsing pulsar in a 4 hour circular orbit, and the other (M30B) is a 13 ms pulsar in what is likely an eccentric, relativistic orbit. Timing observations over a 20 month baseline have provided a precise determination of the M30A's position, which is within 4 arcseconds of the optical centroid of the cluster. The position of M30A is coincident with a possible thermal X-ray point source detected by Chandra and a faint star in archival HST data that is likely the pulsar's companion. It is anticipated that further, higher sensitivity observations with the GBT may allow the investigators to monitor M30A for long-term variations in its orbital parameters, allow consistent detection and timing of M30B, and perhaps the detection of additional pulsars in M30.

Investigators: S. Ransom (McGill, MIT), I. Stairs (UBC), D. Backer (UC-Berkeley), L. Greenhill (CfA), C. Bassa (Univ. Utrecht), J. Hessels and V. Kaspi (McGill).

ALMA

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

ALMA officially broke ground in Chile on November 6, 2003 with a ceremony at the OSF site near the town of San Pedro de Atacama. The ceremony was attended by dignitaries from North America, Europe, and Chile.

"The U.S. National Science Foundation joins today with our North American partner, Canada, and with the European Southern Observatory, Spain, and Chile to prepare for a spectacular new instrument," said Dr. Rita Colwell, Director of the U.S. National Science Foundation. "The Atacama Large Millimeter Array will expand our vision of the Universe with "eyes" that pierce the shrouded mantles of space through which light cannot penetrate." Wayne Van Citters, NSF's Division Director of Astronomical Sciences represented Dr. Colwell at this ceremony.

"ALMA will be a giant leap forward for our studies of this relatively little explored spectral window towards the Universe," said Dr. Catherine Cesarsky, Director General of ESO. "With ESO leading the European part of this ambitious and forward-looking project, the impact of ALMA will be felt in wide circles on our continent. Together with our partners in North America and Chile, we are all looking forward to the truly outstanding opportunities that will be offered by ALMA, also to young scientists and engineers."

"ALMA will push the limits of engineering to provide a telescope array at a fantastic site for astronomers to peer at the beginnings of the Universe, galaxies, stars and planets, and perhaps even life," said Dr. Fred K.Y. Lo, director of the National Radio Astronomy Observatory (NRAO).

On December 25, Dr. Norio Kaifu, Director General of NAOJ, sent the following message to the ALMA Board: "I am pleased to inform to the ALMA Board that the ALMA-J construction budget has been included in the FY2004 Government Budget plan announced on 24 December. The Ministry of Finance and the Cabinet approved 25.6 Billion Yen ($239M) for the ALMA-J budget in eight years and 1.0 Billion Yen ($9.35M) for the FY2004 budget. As I mentioned before, some other resources including personnel costs of ALMA-J staff will be provided separately through the NAOJ annual operation budget."

A meeting of the ALMA Board negotiating team will visit Tokyo next quarter to finalize the agreement between ALMA and Japan for the enhanced ALMA made possible by the inclusion of Japan in the ALMA project.

Evaluation of the prototype antenna from VertexRSI continues at the ATF site located at the VLA. Following correction by VertexRSI of the embedded control software reported last period, the antenna has been operated successfully.

ALMA

By the end of the period, the prototype antenna from Alcatel had been fully erected at the site and was undergoing servo and metrology commissioning and acceptance testing leading to provisional acceptance early in the next quarter.

A major milestone this period was the simultaneous release by NRAO and ESO of the Request for Proposals and Call for Tenders for the production antenna procurement. These parallel procurements utilize a common Technical Specification and Statement of Work and each request pricing for 32 production antennas delivered to the OSF.

The Critical Design Review for the Correlator was held during the period. Having successfully completed this milestone, production of the first Correlator quadrant is now underway. A major recommendation from the CDR was the adoption of an enhanced filter card that will significantly increase the spectral resolution of the Correlator. This enhanced filter card fits within the same form factor as the baseline design and is plug compatible. The modest additional cost of the card fits well within the original budget for the baseline Correlator.

In addition to breaking ground, the project also unveiled the newly adopted ALMA logo. The logo, shown below, includes elements that represent both radio astronomy (the antenna array) and the southern sky (the Southern Cross).

Expanded Very Large Array

Expanded Very Large Array Highlights

Installation of fiber optic cable on the VLA is complete to the halfway point on the North Arm, which means that this important activity is now more than 80% complete. Electronic outfitting of the EVLA test antenna is well into its testing phase, with first light being achieved on the antenna at 8.6 GHz early in the quarter. Phase stability tests of the fiber showed good results and data transmission tests between the test antenna and VLA Control Building have started. Use of Monitor and Control software to control various electronic devices began.

Expanded Very Large Array Progress

Milestones	Original Date	Revised Date	Date Completed
C-rack RFI cable modifications made	10/02/03		10/02/03
Test antenna MCB Ethernet operational	10/03/03		10/03/03
Start fiber cable trenching on north arm	10/06/03		10/06/03
P301 & P302 power supplies ready for MIB	10/09/03		10/09/03
Antenna fiber internal review	07/23/03	10/15/03	10/15/03
Master LO power supplies built and tested	10/13/03		10/17/03
1.4 GHz OMT prototype assembled and ready to test	10/17/03		10/17/03
Test antenna power supplies built and tested	10/14/03		10/20/03
Start new M&C system on test antenna	07/25/03	11/19/03	10/27/03
First light at 8.6 GHz	10/29/03		10/29/03
Review of overall computing design alternatives	11/01/03		11/01/03
L352 RTP module MIB provided	10/30/03		11/05/03
L305 reference gen/distr module ready for MIB	10/24/03		11/07/03
L350 reference generator ready for MIB	10/30/03		11/07/03
T304 downconverter module ready for MIB	10/31/03		11/07/03
L353 LO transmitter module ready for MIB	10/31/03		11/07/03
2nd DTS/Sampler power supply board assembled	10/15/03		11/10/03
L353 LO transmitter prototype assembled	10/15/03		11/11/03
L353 LO transmitter prototype assembled & tested	07/23/03	10/15/03	11/17/03
Level 2 schedule updates completed	11/21/03		11/21/03
F320 FE transition prototype assembled	10/24/03		11/23/03
e2e system requirement specifications under revision control	11/24/03		12/01/03
Antenna 48V DC power available	10/03/03		12/08/03
ACU/FR controller interface assembled and ready for MIB	10/08/03		12/15/03

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
RTP stability tests w/ antenna moving	10/24/03		12/16/03
K-band receiver ready for test antenna	11/20/03		12/22/03
L354 LO driver prototype assembled	12/18/03		12/29/03
First internal software design review	01/05/04		
Antenna vertex room HVAC system functioning	10/17/03	01/09/04	
F317 FE controller prototype design	11/17/03	01/12/04	
First digital transmission from antenna to Control Bldg	01/14/04		
Band switches design & development plan	08/20/03	01/15/04	
Software requirements for real-time system	08/29/03	01/20/04	
Q-band receiver ready for test antenna	12/01/03	01/20/04	
Establish NRAO-NM VPN capability	06/30/03	01/21/04	
M301 converter interface prototype assembled	10/24/03	01/22/04	
Bench test of samplers, DTS and D/As	11/03/03	01/22/04	
M301 converter module ready for MIB	11/14/03	01/22/04	
1.4 GHz transition receiver ready for test antenna	11/26/03	01/22/04	
MIB software installed on L302 synthesizer	10/03/03	01/26/04	
4/P-band converter module ready for test antenna	10/24/03	01/26/04	
Begin mechanical preparation for 2nd test antenna	01/26/04		
Antenna D/A tests of sampler/DTS	01/29/04		
Control of test antenna azimuth & elevation movement	01/30/04		
Electronic hardware functional design freeze	01/30/04		
GUI to correlator back-end	01/30/04		
Complete Part 1 hardware bench integration	03/03/03	01/30/04	
Test antenna module and rack assemblies complete	11/07/03	01/30/04	
e2e observing scripts for test antenna observations	12/12/03	01/30/04	
L302 synthesizer ready for test antenna	10/08/03	02/02/04	
30 GHz receiver design ready for drafting	11/14/03	02/09/04	
First release proposal tool	02/11/04		
U/X converter ready for test antenna	11/14/03	02/13/04	
Control of test antenna RA, Dec	02/13/04		
U/X converter MMIC prototype design complete	02/13/04		
1.4 GHz feed horn prototype assembled and ready for testing	12/04/03	02/22/04	
Check for interference and bandpass shapes: 328MHz, 8GHz, 22GHz and 45GHz	11/07/03	02/23/04	
Check for interference and bandpass shapes 8, 22 & 45 GHz	12/19/03	02/23/04	
Master LO functional	02/25/04		
Array fiber burial complete	05/31/04	02/26/04	

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
LO and Fiber Optic system CDR	03/03/04		
Develop production specifications document	03/11/04		
Bench integration test rack complete	03/12/04		
First fringes achieved at 8.6 GHz	03/15/04		
C-band OMT design/analysis	03/16/04		
1.4 GHz feed prototype tested	03/19/04		
Start 2nd test antenna outfitting	03/22/04		
IF and FE system CDR	03/24/04		
Receiver stability tests: 8, 22 and 45GHz	12/19/03	03/24/04	
Electronic hardware physical design freeze	03/31/04		
New Control Bldg chillers installed	04/30/04		
EVLA Computing Overall Design	03/01/04	06/01/04	
Functional and technical overall EVLA M&C architectural design	03/01/04	06/01/04	

Management

The project WBS schedule review was held and schedules brought up to date. The initial 2004 budget was issued and included a plan to begin production spending in the 2nd quarter of 2004. An initial attempt to spend some of the Mexican funds on an EVLA electronics module failed when responses to the Mexican CONACyT RFP came in 50% higher than bids to NRAO. This was in part because of unusual contractual conditions required by CONACyT.

Systems Integration

Bench testing of prototype electronic modules continued and installation of modules into racks on antenna 13, the EVLA test antenna started. Assembly of the last prototype electronics modules started during the quarter. System integration testing of the round trip phase through fiber while slewing the antenna showed good results. First light at 8.6 GHz was achieved on the test antenna early in the quarter. Bench tests of the digital transmission module showed good results. The power supply units to drive the electronic hardware in the test antenna and the new Master LO system were assembled, tested and are ready for use. The build of module enclosures for the test antenna was completed and RFI testing of the electronics functioning inside the enclosures is well underway.

Expanded Very Large Array

Civil Construction

Installation of the fiber-optic cable along the arms of the VLA is nearing completion. By the end of the quarter installation on the North arm was complete through AN6. A planning session was held early in the quarter to organize the effort needed to prepare the VLA Control Building utilities for the new correlator shielded room. Vendor bids to replace the VLA Control Building chillers were received and a contract was awarded in December to have the installation done in April of 2004.

Antenna

The electrical distribution throughout the vertex room of antenna 13 is complete. The Heating, Ventilating, and Air Conditioning (HVAC) system for the vertex room has been wired and plumbed. Adjustments to the system are ongoing until all the electronic equipment is in place. The Antenna Control Unit & Focus Rotation Mount (ACU/FRM) interface control card, which ties the existing servo and focus rotation system to the EVLA design, has been assembled. The interface card was turned over to the software group to begin writing software for its Module Interface Board (MIB).

Front End

The 1.4 GHz Ortho Mode Transducer (OMT) quadridge sections were fabricated and assembled and the OMT is undergoing tests. The EVLA-modified 22 and 43 GHz receivers are ready for installation on the test antenna. The 1.4 GHz transition receiver to be mated with the new 1.4 GHz feed is almost complete. Card cage development continued and the 30 GHz receiver design started this quarter. The 1.4 GHz feed rings, aperture flanges and transition section were fabricated. The assembly of the 1.4 GHz feed was completed and fiberglassing has started. Design of the 30 GHz feed was completed and fabrication of the three initial prototypes has started. All of the test antenna cryogenic piping between the helium compressors and the vertex room is installed. On the antenna the third cryogenic compressor was installed and powered up and is being tested with the previously installed 8.6 GHz receiver.

Local Oscillator (LO)

The testing of the 10.8-14.8 GHz synthesizer running under MIB control continues. Additional copies of both Local Oscillator (LO) synthesizers were assembled and are being packaged to install into the test antenna. The LO antenna and central reference modules were assembled and bench tested. MIBs have been provided for each LO module. Two round trip phase (RTP) modules are in use to test the fiber on the test antenna. A third RTP module is being prepared for MIB software development.

Fiber Optics

A review of antenna fiber was held. Two Digital Transmission System (DTS)/sampler modules were assembled, bench tested and used on the EVLA test antenna for testing of the fiber optic system.

Expanded Very Large Array

Assembly of the LO transmitter prototype was completed. The transmitter is being used to run tests on the test antenna. A second LO transmitter module is close to being completed for developing its MIB software. Testing of the phase stability performance of the fiber, both under the ground and in the antenna, continued throughout the quarter. Inside the antenna vertex room, fiber cable was run between DTS racks and LO and F-rack where the LO/IF and front end controller module will reside. In the VLA Control Building, fiber was run between the IF equipment racks in the old correlator room and the Ethernet switches outside the room.

Intermediate Frequency System

The MMIC design and prototype assembly of the downconverter has commenced. This design is more cost effective for a production build. A second connectorized component downconverter is nearly ready for its MIB software development. Design and assembly of front end band converters was completed during the quarter. A plan for the development of all new band switches and housings is completed. To maintain schedule, mechanical band switches similar to the existing VLA design will be used until the new electronic versions become available.

Correlator

The correlator chip Request for Proposal (RFP), developed by the Canadian Partner was nearly finalized. It is expected that the bidding/tendering process will begin in January. The delay module design was finished and preliminary work is beginning on the Station Board printed circuit board design. The Finite Impulse Response (FIR) filter functional design is complete, and work has started on place-and-route of the design in the Field Programmable Gate Array (FPGA). The recirculation controller design was finished and the FPGA place-and-route at full speed was successful. The Long Term Accumulator (LTA) FPGA design started and all indications are that functional and performance goals will be met. This is particularly important for recirculation and pulsar phase binning capability. A face-to-face meeting held in Socorro in November primarily focused on correlator monitor and control software. A baseline plan for the interface between the EVLA monitor and control system and the correlator was agreed upon, and some details of the correlator software implementation were discussed. Finally, new ideas for the station-to-baseline cabling and cable routing are being discussed and investigated with the goal of simplifying some of the backplane hardware and reducing the correlator footprint by making the baseline racks smaller and allowing them to be placed side-by-side.

Monitor and Control (M/C)

A MIB for each EVLA electronic module type was completed. A contract to build 70 more MIBs was awarded. This small production quantity is to complete outfitting of two test antennas. The software group effort slowed when a key employee working on MIB software development resigned. Since then a temporary contracted position has been brought onboard, and MIB development of the individual electronic module types is moving forward and making good progress. The MIB framework software

was written. This software is the foundation from which to start module MIB development and will help make up the time lost in the schedule. An analog board to monitor voltage and temperature of various modules was designed. Its assembly is well underway. The front end transition module needed to run the existing VLA 1.4 and 8.6 GHz receivers is assembled and bench tested.

Data Management and Computing

A design team consisting of representatives from the two Divisions working on EVLA software (EVLA Computing Division and Interferometry Software Division) has been formed to produce a high level architecture design for the complete (End-to-End) EVLA computing system. The VLA Data Archive, which is a prototype for the EVLA Data Archive, was put into on-line service and is receiving wide use. A prototype of the Proposal Tool was completed and tested by the Proposal Tool project scientist. In the AIPS++ area significant progress was made in improving the performance of a number of calibration and imaging programs.

Green Bank Telescope

Green Bank Technical Highlights

GBT observing capability for the 40-50 GHz band (Q-band) was achieved in the 4th Quarter. This required both the completion of the receiver and reaching the required telescope performance. The Q-band receiver, which had been on the telescope for initial engineering checks last spring, was reinstalled in December for astronomical commissioning. In November, the accuracy targets for initial Q-band observing were reached with respect to pointing, tracking, focus, and surface rms. Q-band operation is a major milestone that provides significant, new scientific capability for the user community. First astronomical observing at Q-band will commence this winter

GBT Antenna & Operations

Milestone	Original Deadline	Revised Deadline	Date Completed
Complete Phase II of track finite element (FE) analysis	10/31/03	02/15/04	
Complete Retrofit trial period	12/31/03		12/31/03
Complete development of new rail concepts	12/31/03	02/15/04	
Hold panel review meeting	01/31/04	03/31/04	

GBT Electronics

Milestone	Original Deadline	Revised Deadline	Date Completed
Spectrometer Upgrades			
Spigot Card Expert Mode released	02/28/03	12/01/03	01/01/04
High Speed Sampler Upgrades	01/30/03		12/10/03
DMA error fixes	12/01/03		09/15/03
Cross-correlation/poln. test fixture designed	01/01/04	03/01/04	
Cross-correlation/poln. test fixture constructed	03/01/04	06/01/04	
Begin polarization mode checkouts	06/01/04		
LTA redesign (engineering only)	04/01/04	06/01/04	
Sampler distributor redesign (engineering)	08/01/04	12/01/04	
RFI Improvements			
Finish LO Receiver Module RFI retrofit	10/15/03		11/14/03
Complete anechoic chamber upgrades	01/01/04		12/31/03
Finish GBT receiver room HVAC suppression	12/01/03	On Hold	

GBT Mechanical Engineering & Central Shop

Milestone	Original Deadline	Revised Deadline	Date Completed
VLA K-band frontends (5)	07/25/03	10/15/03	10/22/03
Ku Circular - Rectangular transition	11/08/03		11/02/03
Penn Array Dewar	12/03/03		12/12/03
Outdoor range rotator	04/15/04		
Prime focus adaptors	03/15/04		

GBT Software & Computing

Milestone	Original Deadline	Revised Deadline	Date Completed
Visiting Observer infrastructure and facilities	06/30/01	08/31/03	10/01/03
M&C v3.18	11/17/03		11/18/03
M&C v3.19	12/31/03	01/12/04	
Configuration tool beta in use internally	10/31/03		11/18/03
Observing tool beta in use internally	12/31/03		12/19/03
Long-Term Data Strategy/Roadmap Complete	12/31/03		12/18/03
Complete Phase 1 Linux Migration	02/13/04		
Deprecate IARDS	03/31/04		
First Observing Scheduling Block Executed	03/31/04		

GBT Projects

Milestone	Original Deadline	Revised Deadline	Date Completed
PTCS			
PTCS In-progress review	10/06/03	12/03/03	12/03/03
Ready for Q-band observing	09/30/03	11/12/03	11/20/03
Surface Efficiency Improvements	04/30/04		
Ease of Use			
Beta Release of Observing API	02/16/04		
Production Release of Configuration API	12/30/03	03/31/04	
Production Release of HLAPIs & Online Filler	03/31/04		
Beta Release of GO replacement	12/31/03	04/16/04	
Data Handling			
GBT/Class Interface	12/31/03	03/31/04	
Generate requirements for imaging	12/31/03	03/31/04	
Analysis Conceptual Design Review (In-	02/09/04	04/15/04	

Progress Software Review)			
Spectral Baselines			
Complete evaluation of Ku Thermal Transition	11/01/03		11/01/03
Install improved feed defroster	01/01/04		12/01/03
Begin installation of IF fixes	01/01/04	06/01/04	
Ka band (1cm Rx)			
Begin design of production system packaging, M&C, and begin fabrication of common MM converter.	11/01/03		12/01/03
Complete assembly of common MM converter prototype and evaluate performance. Refine design if necessary.	01/01/04	02/14/04	
Complete assembly of 1 cm receiver	11/01/03	03/01/04	
Test 1 cm receiver in laboratory, work out any problems	01/01/04	04/01/04	
Penn Array Receiver			
Hold CDR	10/18/03		10/18/03
Finish final dewar construction	12/03/03		12/05/03
Prototype new scan patterns	12/31/03		12/29/03
Hold CDR	10/18/03		10/18/03
Finish final dewar construction	12/03/03		12/05/03
Prototype new scan patterns	12/31/03		12/29/03
Analyze simulated data in Bill Cotton's OBIT	09/1/04	10/9/03	10/11/03
3mm Receiver (ON HOLD)			
Restart Project	11/15/03	On Hold	
Revise Project Plan	12/01/03	On Hold	
Prepare Budget request for FY2004	12/31/03	On Hold	
Caltech Continuum Backend			
Hold CDR in Green Bank	12/15/03	04/01/04	
Specify Data format and analysis procedures	12/31/03	TBD	

Green Bank Science Center Project

Milestone	Original Deadline	Revised Deadline	Date Completed
SC main building construction complete	10/15/02	10/28/03	10/28/03
SC dormitory construction complete	07/18/03	11/30/03	11/14/03

Green Bank Telescope

GBT and Green Bank Overview

The 4th Quarter of 2003 was a very productive period with regard to both GBT operations and long-term development. As noted in the Technical Highlights, observing capability was achieved in the 40-50 GHz (7 mm) band. This is a very significant achievement as the sensitivity and angular resolution of the GBT give it unique scientific potential in this band. The performance achievements at 7 mm leave us very optimistic that the ultimate goal of GBT operations at 3 mm can be reached within the next two years as planned.

The Precision Telescope Control System (PTCS) project is responsible for delivering high frequency performance on the GBT. At the April Conceptual Design Review, a number of goals were set including useable 45 GHz performance in the 4th Quarter. This target was met. At the PTCS In-Progress Review in December, the review panel was pleased with the progress achieved and endorsed the project plan for further work.

The receiver engineering group was also very successful in the last quarter. Achievements included completion of modifications to the 18-26 GHz (K-band) receiver and completion of work on the 40-50 GHz (Q-band) receiver. In addition, work on the 26-40 GHz (Ka-band) receiver and associated Millimeter-wave Down-converter module proceeded well.

The Software Development Group achieved a number of milestones in the 4th Quarter, including the beta releases of the new GBT Configuration Tool and the SDFITS writer. The Configuration Tool is already in use by staff astronomers and visiting observers, and has made a considerable improvement in the speed and ease of setting up GBT observations. Work is continuing to expand the capabilities of this application, with planned completion in the 2nd Quarter of 2004. The SDFITS writer provides a well-known export format for GBT data that makes it much easier to reduce these data with software packages provided by users, other observatories, or commercially.

The GBT spectrometer, a highly capable backend with up to 256,000 spectral channels and 6.4 GHz of analysis bandwidth, was used routinely during the 4th Quarter. Reliability of this instrument improved significantly in the past few months as a result of modifications and upgrades by the Digital Engineering Group. The backend is now a quite reliable and powerful astronomical instrument. Continued work to improve capabilities and reliability of the spectrometer is planned in 2004.

A significant development with the spectrometer was the release of "expert operation" of the pulsar spigot mode. This is a powerful capability that allows pulsar data to be dumped very rapidly – as often as every few microseconds – with observing bandwidths as high as 800 MHz. The digital hardware and observing systems were developed by NRAO engineers and scientists, and the data acquisition computer system was developed by David Kaplan, a Ph.D. student at Caltech.

Green Bank Telescope

The Penn Array Camera project, a 64-pixel bolometer camera sponsored by NRAO's University-built instrumentation initiative, held its Critical Design Review in mid-October. The project is a collaboration of the University of Pennsylvania, NASA-Goddard, NIST, Cardiff University, and NRAO. The review was very successful and the camera appears on track for delivery in 2005.

Work continued on the azimuth track study. The critical effort is the dynamical finite element (FE) analysis of the track with a moving wheel. This analysis is being performed by the firm of Simpson, Gumpertz, and Heger (SGH). The analysis has proved to be extremely challenging, and is running somewhat behind schedule, but results are being produced. We expect to have all the information necessary for a decision about the track in hand during the 1st Quarter of 2004, and plan to hold another review meeting toward the end of the quarter. More detailed information on this and other activities follows.

Azimuth Track

The test period for the trial modification continues. The joint has been stable, as indicated by wheel tilt measurements. The weld was re-inspected by ultrasonic methods on December 16th, after 6 months of operation. The weld itself was defect-free. The wear plate still showed shadow type impressions on the surface, with the appearance lines directly above the weld, as well as offset from it on either side. We took the opportunity to examine this area by ultrasonic methods as well, and found some linear defects near the top surface of the plate, about 5 to 7 inches to one side of the weld centerline. Neither we nor the company doing the track analysis can explain a mechanism for this. We will continue to monitor this area for changes. The Teflon-bronze shimming material continues to perform well, although some joints have required reshimming.

One of the remaining wear plate cracks detected last January became worse, and the plate was replaced. Three spare plates are on hand if any other plates do experience a significant crack, and we have ordered two additional spares. We are also evaluating another material for trial.

Simpson, Gumpertz, and Heger continues to work on the three-dimensional, quasi-dynamic model. This effort has proven more difficult than expected, as well as requiring very long computing run times for each trial. We have preliminary results from some cases, but expect that the full effort will not be completed until late January.

We have also asked for input from SG&H regarding an effort for a new track design, and it will involve a significant effort by our project team during the next quarter. We also expect to hold an in-house review of the azimuth track as well as the follow-up outside panel review toward the end of the quarter.

GBT Operations and Maintenance

Telescope Operations Activities

The preliminary recommendation of Modjeski and Masters and Dr. Peter Keating for the defects found in the elevation shaft assemblies is to not repair them at this time, but to continue to monitor them periodically. Formal recommendations are expected in January. Nearly all of the other defects found during the inspection including those on the walkway at the elevation bearing level, have been repaired. Methods to improve joint caulking and internal protection are in progress.

The trial for changing the azimuth wheel bearing lubricant from oil to grease is showing favorable results. The trial seals were installed in two bearings, and the oil in use now in three bearings shows significantly less wear product. If this continues, we will move to oil in all of the bearings when warmer weather arrives. The grease is too thick when it is cold to be removed satisfactorily.

Instead of waiting until spring to begin the 2004 painting season, we continued this effort into November. Significant progress was made on the access stairways, walkways, and telescope equipment, as well as some painting on other telescope structures. Painting will resume in mid-May, weather permitting. Trial modifications were also made to the rolling track covers. The covers are attached to the wheel trucks by springs, and bounce back and forth when movement starts or changes direction. Two different designs utilizing gas shock absorbers were installed to reduce the unwanted oscillations.

Other modifications were made to eliminate or reduce safety hazards, or to improve maintenance productivity. These include hand railing and safety chain installations, a stairway down into the area inside the azimuth track, installation of an air accumulator on the air compressor, enclosing of the air compressor to improve winter operation, and a better filter media on the azimuth drive motor cooling fans.

The Operations group also conducted a review of wind speed history and the current operating limits. The guidelines have been revised to better define continuous winds and implement limits for gusts. The new guidelines were implemented at the end of the quarter, and performance will be evaluated during the coming months.

New standards for conducting and documenting work activities were also implemented. The goal is to reduce failures related to work execution, as well as to improve communication between work groups. The standards apply to all GBT antenna systems, back-end equipment, and software for any of these systems. All divisions are required to follow them.

Inspections and assessments of some of the other telescopes were made during this period, including the 140 Foot, the 45 Foot, and the 20 Meter Telescopes. Touch-up painting of corroded areas was also done on these telescopes.

Green Bank Telescope

Green Bank Electronics

The Green Bank Electronics Division provides support for all electronic systems at Green Bank, including telescope controls, observing backends, receivers and RF equipment, audio-visual equipment, computing network installation and maintenance, radio communication system work, and machine shop electronic repair. Specific activities of the three groups are reported below

Digital Group Activities

Most of the digital group's time was spent on PTCS activities, GBT servo support, spectrometer support, and the Caltech Continuum Backend project.

About 4 FTE's were supplied to the PTCS project. This consisted of Quadrant Detector construction, calibration, and installation, and Air Temperature Sensor construction, installation, and calibration work.

The GBT servo system work for this quarter consisted of repairs to the contractor-supplied fault monitoring circuitry, wiring, and tachs. The fault monitoring circuitry consists of large wire-wrapped boards of logic chips, which have unconventional input and output. Some of the CMOS chips on these boards are being driven outside their recommended ranges. This is causing slow degradations and outright failures of the logic chips. Another problem with this system was a spurious azimuth transducer fault that is remedied after system restart. Calculations for determining servo system loads in various environmental conditions, such as wind, and ice were performed in support of an effort to liberalize the operating conditions of the telescope to reduce unnecessary wind shutdowns. This has culminated in the fact that the servo system is not a limiting factor in GBT wind performance.

Much of the spectrometer support rendered this quarter was for the purpose of developing and testing the pulsar spigot cards and associated modes. Other activities included filtering the power supplies entering the sampler modules, experimenting with the PLL inside the samplers, supporting baseline experiments, and a small amount of repair work on the spectrometer itself. The spectrometer is fairly reliable, and except for producing bad data occasionally, behaving well. We continue to work on an LTA card replacement to solve the data integrity problems, and the occasional DMA error problems. About 2 FTE's are provided to the spectrometer.

The Digital Group is supplying engineering effort to assist the Caltech Continuum Backend Project. We are designing the analog front end, including the receiver detector preamp, and consulting on the design of the digital sections of the backend. About 1 FTE is assigned to this task.

Other items that the Digital Group is involved in are reviving the 45 Foot telescope for use by the solar observing Major Research Instrumentation (MRI) project, repairing and maintaining printers, network cabling, and communications hardware on the GBT.

Microwave Group Activities

The Microwave Group provides support for the GBT receivers, IF/LO systems, the site radio, intercom, and GBT phone systems.

This quarter there was considerable activity for the high-frequency receivers. The Q-band receiver was reworked to eliminate an RFI leak in the mounting plate. The receiver also suffered some LNA failures while in the lab. This was traced to a faulty protection diode setup that was corrected. The system underwent thermal calibration and is installed on the telescope for commissioning and first science observations. The K-band receiver was also worked on this quarter. Refrigerator modulation in one channel was repaired. Thermal calibration was performed, and the receiver was reinstalled on the GBT for observations. The Ka band receiver construction is on-going. It should be ready for use near the end of the next quarter. The Ku band receiver received a new thermal transition for the purposes of helping the baselines, but, this did not have much of an effect.

The PF1 receiver was removed from the telescope for some repairs. During testing, it was discovered that there was a failed filter and amplifier. These parts were not able to be repaired in time to put the receiver back on the GBT, so an additional repair session was scheduled for early January.

The IF system also received some attention this quarter. The RFI-screened LO Receiver module was installed. One of the new fiber modulators failed, and the repaired unit failed incoming inspection. New IF amplifiers are being designed and tested. Various module instabilities and failures were repaired.

The indoor antenna range was completed this quarter. We now have capability to do antenna and feed measurements in our anechoic chamber at frequencies up to 115 GHz. Work has begun to outfit the indoor/outdoor building with mounts and hoists to allow us to test our GBT Gregorian receivers there.

Work on the site radio system continues. We are in the process of adding channels to our system so that we can effectively communicate all around the site, while keeping the RFI environment as quiet as possible. To do this, we are adding repeaters around the site.

More Microwave group activity is noted under the baseline investigation project.

RFI Group Activities

Direct Observer Support and Spectrum Monitoring

Two major PF1 450 MHz GBT RFI scans were conducted. As a result of these scans, some follow up RFI suppression was done. The data from the scans was summarized and added to the RFI management website for easy Observer access.

Allocation data was provided for the lower part of the Ku band and the PF1 800 band per separate observer requests. Some spectrum monitoring was also conducted.

Some IPG members met with observer Scott Ransom to discuss the 28.75 Hz RFI that has been showing up in BCPM pulsar data. Some possible testing and quick fixes to facilitate an upcoming pulsar observation were also discussed. John Ford, Rick Fisher and other members of the Electronics Division staff are following up on this.

National Radio Quiet Zone (NRQZ) Administration

- 19 requests for preliminary evaluation on 105 transmitter sites were completed.
- 50 regular applications for 115 sites were completed.
- ERPd restrictions were requested on 8 sites and one objection was filed.
- 1 site inspection was conducted.
- 5 applications from the Nextel Partners backlog were approved.
- The review of some 608 - 614 MHz medical telemetry devices, to be used at Davis Memorial Hospital in Elkins, WV, was completed and approval was granted.

Public Relations and Awareness

Understanding that Milestone Cable Television has been very supportive of the Observatory, the RFI group provided some assistance in an investigation of possible ways to improve their reception of local network affiliate stations. We also provided some construction details on our new cable TV RFI sniffer.

Several members of the RFI group spent time with a PCHS student in support of the PCHS Engineering Mentorship program.

Six different groups were hosted for site visits. A group from Wired Magazine was among them. The Wired visit was pursuant to finishing an upcoming article.

Instrumentation Repair and Improvements

Two pieces of our SE test setup were shipped out for repair, and some dedicated cables for the SE test setup were identified.

An additional cutout and cable entry panel was added to our RFI quiet box.

In order to expedite Cable TV and other RFI tracking, our spectrum monitoring truck was outfitted with an integrated wideband receiver system. The system includes a high-look angle antenna,

low noise amplifier, and a broadband communications receiver that is easily accessible to the driver. The system definitely works!

A new bulkhead assembly was installed on the anechoic chamber. This will provide more real estate for cable entry and make it much easier to switch between emissions measurement and indoor antenna range mode. A new antenna support and EUT mast were also fabricated.

Other

Jeff Acree led the GB effort to provide review and comment on the FCC's November 19, 2003 draft R&O regarding application processing in Quiet Zones.

GBT horizon data was provided to Charlottesville to facilitate NSF's coordination agreement with Boeing Connexion regarding the use of broadband on aircraft in the 14.47 - 14.50 GHz RA band.

Acrylite covers were installed on the windows in the Jansky Lab shielded rooms. Natrasorb desiccant was installed to absorb moisture between the covers and the exterior windows.

Cable TV and power line RFI suppression efforts continued, but requirements were minimal during the quarter.

Mechanical Engineering and the NRAO Central Instrument Shop

The Mechanical Division's collaboration with the Operations Division and the new Structural Engineer continued an interim review of the numerical analysis being performed by Simpson Gumpertz & Heger. In addition, this quarter will see the Mechanical Division complete work started in the 4th quarter of 2003 on the new rotator for the outdoor receiver test range. Work will also begin on fitting out the Prime Focus receiver test building for testing of some of the smaller receivers prior to installation on the telescope.

In the Central Instrument Shop, 4th quarter accomplishments included completion of the Penn Array dewar, continued work on the Ka band receiver, the fabrication of additional GBT temperature sensor units, and completion of the new GBT feed defroster. The shop participated in some minor outdoor repairs as the result of the GBT structural inspection and performed some field machining on the track that were required for measurements to check Simpson Gumpertz & Heger's numerical model of the track.

Software Development

Software Continuing Maintenance and Enhancement

The SDD produced two regular releases of its key product, M&C, with v3.18 on November 18, 2003, and v3.19 that was completed on December 19, 2003 and was released in early January. The focus of the additions was on the antenna and temperature sensor managers, support for Q-band commissioning, and incremental spectrometer work.

Progress towards 2003 goals in software operations were furthered during Q4 2003. Building upon the framework that was established last year at this time, the SDD expanded its unit tests over the quarter for the M&C product from 317 to 401. One key continuous improvement effort initiated at the beginning of 2003 came to successful completion in early December, as all build warnings were eliminated for the M&C system, yielding zero errors and zero warnings for all in-house control system software modules.

A substantial investment of time was made at the beginning of the quarter to improve balancing of the spectrometer, when it was discovered that enhancements to the spectrometer code at the beginning of the summer had compromised the ability of observers to balance when using more than 4 IFs. After three weeks of investigations, a solution was identified and patched into the M&C system, thus decreasing latency and increasing accuracy. Other larger operational support items throughout the quarter included enabling the Archivist to log active surface LVDT position sensor temperatures and quadrant detector data, and patching several managers to allow zero length scans (a technique used to run VLBI scripts).

The production version of AIPS++ was also updated to the most current version in mid-November, and throughout the quarter, several fixes were put in place for AIPS++ and its related applications. For example, for spectrometer data, the filler was modified to place data from all data banks into one measurement set. Incremental improvements were also made to pgplotter and the DISH plotter in response to user requests, and the interim data display was changed to allow an IF selection for spectral window display. The dependency of the GBT control system on AIPS++ was also minimized, representing an improvement in overall systems reliability. For years, the telescope control system has been built against a full implementation of AIPS++, when in fact, only three libraries were required. At the end of November, in conjunction with the move to the Linux Red Hat 9 operating system, the build process was modified to access only these required libraries, and not the full AIPS++ implementation. Additionally, documentation for the DISH offline data analysis application was overhauled and is now accurate.

The Computing Division initiated the upgrade of all machines to the Linux Red Hat 9 operating system at the end of November, and this required significant software operational support. For example, the spectrometer had never been tested on the new version, and several very old libraries used by the IF

manager could not be recompiled at all. The initial build yielded 472 errors, which had to be worked through quickly. The change in development affected anyone running python modules in the test environment, or tcl modules (including CLEO) in the production environment, so rapid response was required to prevent downtime for observers.

Observing was also plagued by more frequent failures of single board computers running the VxWorks operating system, due to the addition of new receivers which overloaded the system. Though the Linux Migration work package had been initiated a few weeks prior, the situation became so severe that the Electronics Division suggested a new single board should be put up temporarily to offload the connections to the machine with the most significant bottleneck. Software support was provided to reconfigure the new machine, which took effect late in December. Results have been positive, reducing operational support on the single boards sufficient to provide an interim solution which will be in place until software on three of the old machines is ported to a PC running Linux. This is scheduled for completion in mid-February 2004. M&Cv3.19, released at the beginning of January, is the first version of the telescope control system running on the new version of Linux.

Software Contributions to the PTCS Project

Software work for this project focused mainly on implementing changes to accommodate the requirements of Q-band observing, and support new dynamic pointing and focus corrections. This involved several upgrades to the antenna manager, the development of a new coordinating manager, and the development of a new interface with far-reaching implications. In order to support new needs for the Engineering Management System (EMS), this new generic interface built on the Simple Object Access Protocol (SOAP) was created. It provides a common brokerage of transactions to and from the telescope control system, and in addition to being used for EMS, it is also used for the Configuration and Observation APIs.

The principal changes related to the antenna were performed to:

- Allow the specification of a dynamic correction to radial focus
- Allow the specification of a dynamic correction to azimuth and elevation local pointing corrections
- Rationalize the origin (a MySQL database) and recording of all relevant quantities in a PFM (Pointing and Focus Model) database

As a result of the improvements, the antenna manager now directly controls the subreflector in "actuator" coordinates, whereas previously, the servo system performed conversions to operate in this manner. This change is required to allow calibration corrections which only make sense in actuator coordinates. A new database was created as well. In November, managers for structural temperature and air temperature monitoring were refactored under the single coordinating manager for antenna

characterization. Individual temperature sensors can be dynamically enabled or disabled, and the FITS files produced are self-documenting.

Other Software Projects

Work on the Ease Of Use Initiative and Data Handling Improvements is described in the "GBT Development Projects" section of this report.

Computing Infrastructure

Workstations

The last ten of the new PC's from this year's round of upgrades were rolled out to staff and the old machines are currently being removed from service prior to donation to the local elementary school.

AD Testing

Testing for the new Windows Active Directory domain is continuing and all services required to support this are now in place at Green Bank. A few brave users are helping with the testing process.

RIS Server

As part of the Common Computing Environment (CCE) project a Remote Installation Services (RIS) server has been configured and put into operation. This is pretty much the equivalent of the Linux kickstart mechanism and allows installation of new machines to be standardized.

A Software Update Services (SUS) server has also been configured and deployed. This has largely automated the process of applying security patches to the windows workstations.

Autocad Inventor

The network license for Inventor finally arrived this quarter and this is now in use.

Star Award

This past year has seen a rash of highly destructive viruses, worms and trojans. The sobig-f virus was particularly obnoxious and fast spreading. Happily Green Bank was entirely unaffected by this. Charlie Myers' fast and effective reaction to this (along with all the other NRAO windows administrators) has been recognized with a well deserved Star Award.

Green Bank Telescope

RedHat 9 Upgrades

During this quarter most of the Linux workstations were upgraded to Redhat 9 using the configuration agreed upon by the CCE working group. This program should be completed early in Q1 2004 when the last 3 machines are upgraded. These last few machines are all servers of one sort or another and the upgrades to them will need to be coordinated observatory, wide to avoid inconsistencies in software versions.

Server Upgrades

Early in the quarter, after a routine kernel upgrade, some problems with our main server's disk became apparent. The problems resulted in a kernel race condition and severe memory problems that led to brief slow downs and freezes on all machines that relied on it. Various kernel patches were tried with differing degrees of success. Eventually BIOS upgrades became available to fix the problem, these have now been applied and with the appropriate kernel patches the problem seems to have been solved. The disk is undergoing rigorous testing prior to its return to service early in Q1 2004.

Timekeeping

The Network Time Protocol (NTP) configuration at all sites was overhauled this quarter after a few years of neglect. Earlier in the year the sites H-maser was interfaced to several solaris machines to provide accurate time. This has now been leverage to provide accurate time to all unix workstations across the observatory. Typically there is less than 10 ms difference between the sites timeservers.

Documentation Improvements

Various new documents concerning Green Bank specific procedures have been added to the computing web and users are encouraged to check these pages regularly. Some pages have also disappeared from the division web as the topics they cover are now common to all sites. These pages can now be found in the Gold Book. Again users are strongly encouraged to check this regularly.

Spigot Support

Some effort this quarter has gone towards supporting the operation of the new Spigot backend. The huge datasets (> terabyte) generated by the Spigot present difficulties in terms of transporting the data to an observer's home institution. The cost of tapes and their relatively low reliability make external hard disks an attractive option for data transport. The disks also have the advantage over tapes of random access to the data at generally higher speeds than tape allows.

A number of large external disks are now available for this purpose and have been successfully used by a few external observers. An advantage to this method is that the disks are returned by the

observers and this should prove somewhat cheaper in the long run. Currently the disks are available with either USB or firewire (or both) interfaces and testing is underway of the new SATA interface which offers a huge increase in speed.

User Cleanup

With some external volunteer help most of the inactive users have been cleaned out and large amounts of disk space reclaimed. As part of this exercise, working email addresses were tracked down for the active observer accounts and mail forwarding set up. The coverage is not 100% but "fingering" an observer's NRAO username will now reveal where his email is going.

Projects

PTCS

The PTCS project continues to make excellent progress. We have released a significantly improved "static" pointing/focus model, and have implemented a mechanism for correcting in real time for pointing and focus offsets caused by thermal gradients in the antenna. Together, these have allowed us to achieve Q-band performance, for both surface accuracy and pointing, under benign conditions. A very successful In-Progress Review was held in early December.

Antenna Performance: The work described in the previous quarterly report on correcting for thermal gradients in the antenna was continued in this quarter, culminating in a successful real-time demonstration of the dynamic thermal corrections on November 20. Additional all-sky pointing/focus data were acquired in October. These, together with the September data, were combined with the temperature sensor data to construct both significantly improved gravity (traditional) pointing and focus models, as well as thermal pointing and focus correction predictors. The predictors were single-blind tested against additional data taken in benign conditions with extremely good results, and a successful prototype of their real-time application tested. The full system will be released in January 2004. In the process of developing the improved traditional models, we also found and fixed a systematic error in the pointing model over and above those caused by thermal effects. Full details of this work are described in PTCS/PN/25.

Using the new "thermally neutral" pointing/focus model, we now achieve a blind pointing accuracy of 5" under benign conditions (winds less than 2.5m/s, and avoiding extremes of solar loading). Offset pointing accuracy is 2.7" for timescales up to ninety minutes, and we have demonstrated tracking stability of better than 1" for up to 30 minutes. Using the dynamic corrections, we can reduce focus offsets of up to ~ 30mm to less than ~ 3mm (apart from around mid-day). The dynamic pointing corrections show residuals of less than ~ 3" in up to 30" of pointing error, and reduce the thermally induced pointing gradients to less than 1" per hour (again apart from around mid-day). As noted, the combination of the

improved static models and thermal compensation allow the antenna to meet the Q-band pointing requirement; the existing surface accuracy already meets the requirement.

In Progress Review: A very successful In Progress Review was held in Green Bank on 3/4th December. As for the Conceptual Design Review, the review panel consisted of David Woody (Chair), Peter Napier, and Patrick Wallace. All of the review material, as well as the panel report, is available from the PTCS web pages. The review panel were impressed by the progress made since the CoDR, and fully endorsed the approaches adopted by the project.

Future Work: The prototype dynamic thermal corrections demonstrated in November will be converted to a production system and released in January 2004. The next major push for pointing will be to install a system of inclinometers on the GBT, which will allow us to investigate the effects of azimuth track irregularities on pointing, independently confirm the alidade thermal effects, and potentially compensate for wind effects on timescales of ~ 10 seconds or longer. We will also be improving the GBT refraction corrections. Finally, we are also starting work analyzing traditional holography results obtained during the quarter, and expect to have a major campaign to improve the surface accuracy during the first quarter of 2004.

Ease of Use Initiative

The purpose of the Ease of Use project is to make it simpler for observers to configure the telescope and perform observations with the GBT. It includes the ability to define observations in advance of observing, the ability to execute those observations, improved monitor and status information while observations are executed, and an improved real-time display. Feedback must also be solicited from external observers to ensure that the learning curve for observing is appreciably shortened as a result of this project.

Ease of Use is segmented into three work packages: Configure, Observe/Status and Customer Satisfaction. Efforts this period were focused on developing application programming interfaces (APIs) for the first two. The Configuration API was released for beta testing in November, and is now being used routinely and reliably by NRAO astronomers as well as visiting observers. In addition to configuring the telescope for all 42 supported GBT observing modes, the configuration utility now also provides feedback to the observer, who can check the quality of the configuration, or queue up a configuration for the next observation. Telescope setup now requires 5-10 minutes even in the most complex cases, where in the past, setup took between 30 minutes to an hour. The introduction of a robust configuration utility has resulted in a direct improvement in the site's utilization of telescope time for testing and astronomical observations.

As stated in the previous quarterly report, the focus of work during Q4 was to 1) complete the configuration capability for all active GBT observing cases, and release this for production use; and 2) generate a replacement for GO, the observation execution program, which can be used and tested

internally by the beginning of 2004. The first goal was achieved on November 18, as stated above, with the beta release of the Configuration API. The second goal was met on December 18, with the first tests of the Observing API with the antenna simulator as well as the live antenna. The Observing API encapsulates "building blocks" which can be used by observers who wish to write their own procedures, by the SDD preparing pre-packaged observing procedures, and also by any graphical interface. By successfully slewing to a position in the sky, and tracking, the team was able to validate its approach in December. Observational control of the antenna in Python was a significant milestone for the Ease of Use project.

The single goal for the Ease of Use project in Q1 2004 is to release the production package of APIs for configuration and observing, with unified user preferences and an online filler. The project will be completed in Q2 2004 with the addition of functionality to automate balancing from the observer's perspective and user interfaces to guide the observing process.

Data Handling Improvements Project

This project covers all aspects of observer-facing software that are encountered after a successful observation from data quality assessment and quick look capabilities through imaging. The decision was made by the Green Bank Project Planning Committee in mid-November that dedicated resources would not be provided to this project for the second half of Q4 2003, and instead, the focus would be on the Ease of Use project which can be completed early in 2004.

However, work on a data display completed to support the emerging requirements for the PTCS project as well as the second phase of development for generating SDFITS files for IDL users, prior to this decision. Work during Q4 included:

- Beta Release of SDFITS generator based on user comments (11/24)
- Beta Release of Real-Time FITS Monitor for online and offline data processing (12/18)
- Generating a technology-independent specification of current offline data processing needs (12/31)

In the first few months of 2004, work will continue on the data display, culminating in its production release for data reduction of all standard observing procedures by the end of Q1. Also, analysis sessions will be held by astronomers to finalize the specifications for automated balancing and calibration algorithms. Enhancements to AIPS++ calibration algorithms and related modules will be scheduled during this time.

Penn Array

Preparations for the Critical Design Review, held 17 and 18 October, were a major focus of work early in the fourth quarter of this year. The panel members were Drs. William Duncan (chair; formerly of

UKATC, recently of NIST), Dale Fixsen (NASA, GSFC and SSAI), and Chris Carilli (NRAO). The panel was enthusiastic about the project and made a number of valuable recommendations that should prove helpful.

Other milestones reached this quarter were: production of a mechanical prototype for the detector array at Goddard; finalization of the optics design and prototyping of anti-reflective coating; completion of cable orders by Penn and GSFC; improvements to the Penn Array simulation software, and successful analysis of the simulated data in Bill Cotton's software package; and tests of new scan modes and observing procedures that are needed with the GBT. Goddard personnel have also made good progress with a firmware upgrade (now ~ 75% complete) which will make the Multiplexed bolometer data much easier to handle.

New Receivers Backends

In Q4 it became apparent that the departure of Caltech's project engineer earlier in 2003 was going to make it difficult to finish the project on time and under budget. To alleviate the situation the Green Bank Electronics Division has stepped in with significantly increased effort focused on the design of the analog section of the backend. Martin Shepherd and Randy McCullough, with consultation from Rich Lacasse and the rest of the team, have delivered a design for the detector amplifier circuit and conducted detailed noise calculations showing that its performance should be acceptable. A project meeting has been scheduled in Green Bank for January 15 – 16, 2004, and work will continue at high priority. Meanwhile Caltech has improved the power control circuit and updated interface documentation, and is proceeding with FPGA work.

Spectrometer Upgrades and Pulsar Backends

The work on the GBT backends focused on the autocorrelation spectrometer. To increase reliability of this backend, we upgraded all 10 LTA boards (both the eight being used and the two spares) to 32 MHz. This, combined with improvements in the system software, has resulted in increased reliability of the system, with no hardware failures requiring component replacement in the four months since the upgrades were completed. Nevertheless, we are still plagued with intermittent and unresolved problems associated with 'drop-outs' in the LTA boards being used.

Considerable effort has been spent over the year to study the problem, and a new FPGA design for the boards is now complete and is being tested. We have also implemented a new hardware reset and self tests for the spectrometer to enable ready diagnosis of any future problems.

The autocorrelation spectrometer also has a new piece of hardware attached to it - the GBT Spectrometer Spigot card. This is two custom digital logic cards designed by Ray Escoffier (NRAO) that can rapidly accumulate and sort the data coming into the spectrometer, allowing it to be used for pulsar searches. The spigot card has the same bandwidths as the spectrometer (12.5, 50, 200, 800 MHz) and can

dump data at rates of 2 - 80 microseconds, providing both much wider bandwidths and higher time resolution data than has previously been available with the GBT. The card has been opened for limited general use on the GBT, and work is continuing to allow the card to be used in all 128 of its possible observing modes.

Limited work on the GBT's other backends also occurred during the quarter. As the autocorrelation spectrometer is considered the primary backend for the GBT, work on the Spectral Processor, an FFT spectrometer used for both spectral line and pulsar work, was limited to maintenance. The Berkeley-Caltech Pulsar Machine (BCPM) received a software upgrade to remove many of the problems that previously had been limiting the number of observing modes available on the backends. Finally, we have begun preparations for installing the Caltech-Parkes-Swinburne Recorder II (CPSR2), a fast base-band recorder that performs online, real-time coherent de-dispersion of pulsars and will be used as a semi-public pulsar timing machine on the GBT.

New Science Center and Dormitory

The new NRAO Science Center construction in Green Bank is complete and the center is operating full-time. The center is enjoying great success as a tourist destination and as an educational facility.

The associated dormitory construction is also complete. A final inspection has been completed and minor punch list work is being finished. Furnishings have been ordered and will be installed by the beginning of February 2004.

Very Large Array and Very Long Baseline Array

VLA Highlights

The 19th Annual New Mexico Symposium was held at the Array Operations Center (AOC) on October 3, 2003. The purpose of the Symposium is to support the network of scientific research in the Southwest and to encourage interdisciplinary discussions. Researchers from the University of New Mexico, the New Mexico Institute of Mining and Technology, Los Alamos National Laboratory, and NRAO made presentations at the Symposium. The Symposium was held in conjunction with the Jansky lectureship given by Professor Donald C. Backer of the University of California at Berkeley.

The new policy on Rapid Response Science for the VLA, VLBA, and GBT went into effect on October 1, 2003. The policy allocates up to 5 percent of the total observing time on the VLA and VLBA, and 2 percent of the total observing time on the GBT for observations of known transient phenomena, exploratory time, and targets of opportunity. The policy is designed to accommodate observations of unusual or rare events which cannot be supported by the routine proposal process in a timely manner.

With the activation of the VLA on-line data archive in October 2003, VLA archive data are now readily accessible to many astronomers. The fraction of refereed VLA papers utilizing archive data should increase over the next few years. In 2002, approximately 15 percent of the VLA papers appearing in the refereed literature relied upon archive data.

VLBA Highlights

His Royal Highness, the Duke of York, was given a tour of the AOC on October 20. Prince Andrew was visiting Socorro for the ground breaking ceremony of the Magdalena Ridge Observatory. Included in the AOC visit were demonstrations of EVLA electronics developments and a tour of the VLBA control center.

Annual maintenance visits to the VLBA antennas were completed for the 2003 calendar year on October 23 when an azimuth wheel assembly was replaced at the North Liberty antenna. Other maintenance activities completed during the quarter include the replacement of the hydrogen maser at the Brewster VLBA station and the installation of a prototype digital tachometer at Hancock.

Management and Scientific Services

Milestones	Original Date	Revised Date	Date Completed
VLA/VLBA Proposal Deadline	10/01/03		10/0103
VLA/VLBA/GBT Archive On Line	10/01/03		10/01/03
VLA/VLBA Target of Opportunity Implementation	10/31/03	10/01/03	10/01/03
New Mexico Symposium/Jansky Lecture	11/15/03	10/03/03	10/03/03
Duke of York visit to Array Operations Center	10/20/03		10/20/03
VLBI Calibration Transfer for 1 VLA Antenna	05/26/03	10/31/03	10/31/03
AIPS++ Stable Release 3	12/01/03		12/08/03
VLA Archive Data On-Line Within 48 Hours	12/10/03		12/10/03
Release frozen 31DEC03 AIPS version; begin 31DEC04 version	01/02/04		12/10/03
Second AO for Chandra/NRAO Joint Proposal Process	12/12/03		12/12/03
VLBI Calibration Transfer for GBT Completed	10/15/03	05/31/04	12/31/03
Test Report on VLA Water Vapor Radiometer Prototypes	12/18/03	01/15/04	
AIPS++ Stable Release 4	02/01/04	01/15/04	
VLA Large Proposal Deadline	02/02/04		
VLA/VLBA General Proposal Deadline	02/02/04		
Santa Fe Workshop on Radio/X-ray Connections	03/31/04	02/06/04	
VLBI Future Report Completed	09/30/03	02/15/04	
Complete Tests of Resurfaced Subreflector at Pie Town	05/15/03	02/28/04	
AIPS++ Stable Release 5	03/15/04		
EVLA Phase 2 Proposal Submitted to NSF	02/28/04		
Global 3mm VLBI Session	04/21/04		
Temporary Office Space Occupied	05/10/03	05/15/04	
Pie Town 3mm Test After Re-setting Panels	05/31/04		
VLA/VLBA General Proposal Deadline	06/01/04		
Synthesis Imaging Summer School	06/30/04	06/22/04	
Large Proposal Review Committee Meeting	06/30/04		

Very Large Array and Very Long Baseline Array

Milestones	Original Date	Revised Date	Date Completed
Complete VLBA Pilot Program for Spacecraft Navigation	01/30/04	08/31/04	

Electronics

Milestones	Original Date	Revised Date	Date Completed
Pie Town Link (LO/IF)			
Complete construction & checkout of spare L6, F4, and Pie Town data sets. Develop a full system checkout procedure	09/30/04		
Lab Services			
Implement ESD procedures in assembly areas	07/30/04		
Receivers (FE)			
Install K-band receivers #27 and #28 in the VLA	4/30/04		
Improvements			
Replace the maser at Brewster, WA	02/15/04		12/12/03
Repair the back-up maser (EFOS) at VLA	02/16/04		
Develop Windows based QA tools for VLBA Base Band Converter (BBC) repair	03/05/04		
Replace the maser at Hancock NH	07/30/04		
Install digital tachometer system at Hancock, NH and at Pie Town, NM	07/30/04		
Upgrade the ACU power supply & backplane at Pie Town, NM	09/15/04		

Engineering Services

Milestones	Original Date	Revised Date	Date Completed
Complete B array reconfiguration	10/17/03		10/17/03
Complete CnB array reconfiguration	01/30/04		
Complete C array reconfiguration	02/20/04		
Mechanical Group			
VLBA drive wheel construction	10/01/03		10/01/03
VLBA Pie Town 3 year FRM maintenance	10/15/03		10/15/03

Very Large Array and Very Long Baseline Array

Milestones	Original Date	Revised Date	Date Completed
North Liberty azimuth wheel assembly replacement	10/23/03		10/24/03
Paint Transporter #2	08/31/03	10/30/03	11/14/03
Receive new azimuth bearings	04/30/04		
Replace Ant #14 azimuth bearing	05/30/04		
Resurface Pie Town subreflector	06/30/04		
Mauna Kea azimuth rail repair	06/16/03	09/30/04	
Electrical Group			
Water tank inspection	11/13/03		11/04/03
VLBA prototype Tachometer	09/30/03	11/30/03	12/15/03
CW7 transformer repair	01/30/04		
VLA anemometer upgrade	04/01/04		
Site & Wye Group			
Complete track repairs between BN6-AN5	12/31/02	04/30/04	

Computer Infrastructure

Milestones	Original Date	Revised Date	Date Completed
Migration to Windows 2K domain	07/31/03	In Progress	
Increase archive to 8TB	11/01/03	11/30/03	11/30/03
Establish NRAO-NM VPM Capability	06/30/03	01/15/04(1)	
Increase archive to 11TB	01/15/04		
Replace AOC Wireless Notebook	12/31/03	01/30/04	
Phase 2 AOC Rewire	07/31/03	01/30/04(2)	
Upgrade to RedHat 9.0	09/30/03	01/30/04(3)	
Configure/build Filehost Replacement	11/30/03	02/15/04	

1. Delayed waiting for collaboration from CV
2. This was the begin date…project is ahead of schedule and phase 3 will start soon
3. Delayed from CCE until now, in progress.

Array Support

Milestones	Original Date	Revised Date	Date Completed
'Real-time' VLA data flow to archive 01-Jan-04	01/01/04		10/25/03
Correlator controller – support line mode	12/31/02	08/31/03	12/31/03

Milestones	Original Date	Revised Date	Date Completed
Online VLA recording to DAT	02/01/04		
Correlator controller transition plan	02/28/04		
Correlator controller changes to Modcomp	03/30/04		
Controller -bug fixes	03/31/03	03/31/04	
"Track" program modifications for Mark 5 sytems	10/30/03	04/01/04	
Satellite tracking software mods	02/01/04	04/01/04	
VLA Ops. Logs on archive web page	01/01/04	05/01/04	
Transcribe VLA observe/system files	11/30/02	05/31/04	
Correlator controller – integrate line/continuum	06/30/03	06/31/04	

AIPS

Key Developments

1. Rolled the 31DEC03 version over to 31DEC04 and froze the 31DEC03 release. Issued an AIPS Letter to describe the changes in the last six months.

2. Added various suggestions from Australian users to enable them to run the midnight job.

3. Made a variety of improvements to the VLBA calibration task APCAL including the use of the available weather data, improved interpolation options, and better opacity fitting and plotting.

4. Upgraded the FITS readers to support the New World Coordinate System nomenclature where possible and allow FITLD to read more than one VLBA correlator data file from disk.

5. Oversaw and verified the inclusion of calibration data from the VLA when a single VLA antenna is used with the VLBA. Corrected the handling of weather tables while doing this.

6. Solved a variety of problems with the McIntosh OS/X installation including getting very nice performance using an IBM compiler on G4 and G5 processors.

7. Updated the CookBook and other documentation files for 31DEC03.

8. Corrected major bugs handling sub-arrays when recomputing projected baselines (UVFIX) and flagging bad solutions (SNSMO) were corrected.

9. In the period May 18 to December 31, 2003, 88 sites downloaded the 31DEC02 version of AIPS and 416 downloaded the 31DEC03 (development) version. A total of 551 different sites (separate

IP addresses) made some use of the AIPS cvs facility, either during installation of 31DEC03 or running the "midnight job" to update their copy of 31DEC03.

Goals for the First Quarter 2004

1. Continue user support and bug fixes, as the major portion of AIPS effort.
2. Investigate the use of overlapping solution intervals to minimize lobe ambiguities in fringe fitting.
3. Continue the moderate-term project to explore improved troposphere calibration.
4. Add weight-based flagging to be able to use flag tables.
5. Begin investigations of new/improved imaging algorithms, including those dealing with spectral index and multiple pointings.
6. Consider methods to include source models with AIPS distributions.

Central Development Laboratory

Central Development Laboratory Highlights

During November and December 2003, the CDL and ALMA offices and laboratories were moved to the new NRAO Technology Center (NTC).

Development of amplifiers using InP transistors in the range 1-4 GHz for the EVLA reached prototyping stage.

The ALMA Band 6 SIS mixer-preamps were successfully tested in nearly-final configuration. The SIS Band 6 mixer-preamp and cartridge test dewars were completed and successfully used to test prototype systems. Improved methods of SIS mixer construction were implemented.

Electromagnetic work on feeds supporting 1-2 GHz observations on the GBT and EVLA made good progress.

The ALMA 2-antenna prototype correlator was completed and its operation verified. The ALMA 64-antenna correlator passed its Critical Design Review and detailed work began on implementing the recommendation of the CDR committee to implement a multiple-output tunable filter bank to enhance significantly the performance of the correlator.

Production prototypes of several modules of the front end segment of the ALMA local oscillator system, including Active Multiplier Chains and Power Amplifiers, were fabricated and successfully tested.

The initial version of a solar radio burst spectrometer to be installed at Green Bank for monitoring solar activity was fabricated and successfully tested in Charlottesville.

Major Developments

Milestone	Original Date	Revised Date	Date Completed
Amplifier Design & Development:			
1) Evaluation of TRW Cryo-3 devices from the point of noise, signal and dc properties at cryogenic temperatures	04–01-04		
2) Design/redesign of cryogenic amplifiers using Cryo-3 TRW devices for EVLA, VLBA, GBT and ALMA covering frequency			

Central Development Laboratory

Milestone	Original Date	Revised Date	Date Completed
range from 1 to 120 GHz	04-01-04		
1) Freeze Band 6 cartridge design	12-31-03	01-31-04	
Electromagnetic Support:			
1) GBT L-band pattern simulations	03-31-03	01-31-04	
2) Testing of EVLA C-band prototype feed horn	09-30-03	06-30-04	
3) Testing of EVLA L-band feed horn	12-31-03	04-30-04	
4) Design of EVLA X-band feed horn	12-31-03	03-31-04	
5) Testing of EVLA Ka-band feed horn	12-31-03	03-31-04	
ALMA Correlator:			
1) Complete VLBA data recording project	12-31-02	12-31-04	
2) Hold a critical design review of the baseline ALMA correlator	09-30-03	10-03-03	10-03-03
3) Achieve error-free station bin to correlator bin data transmission in all signal cables	09-30-03	12-31-03	11-01-03
4) Start the process of ordering parts for the first quadrant build	09-30-03	09-30-03	09-30-03
5) Prepare ALMA prototype correlator for shipment to Socorro	12-31-03		12-22-03
6) Release second logic card RFQ for the full ALMA correlator	12-31-03		11-28-03
7) Release RFQ for motherboards	12-31-03	2-27-04	
8) Purchase first non-RFI rack for ALMA correlator	12-31-03		12-17-03
9) Establish firm plan for correlator enhancement	12-31-03	10-03-03	12-10-03
10) Ship the prototype ALMA correlator to Socorro	03-31-04		
11) Support system testing at the AOC as far as the correlator is concerned	03-31-04		
12) Update the PCB layout of the station and correlator motherboards	03-31-04		
13) Release RFQ for motherboard assembly	03-31-04		
14) Place purchase for the remaining printed circuit card assembly	03-31-04		
ALMA LO Source:			
1) Delivery of the first LO driver	12-31-03	02-28-04	

Central Development Laboratory

NRAO Technology Center (NTC)

The entire Central Development Laboratory was moved from the building it occupied for 30 years to a newly-renovated laboratory facility which also houses ALMA Front End and Correlator work.

The NRAO Technology Center (NTC).

Amplifier Design and Development

Work continued on the development of amplifiers using devices from the JPL/TRW Cryo-3 wafer. Progress in the design and prototype development was severely limited due to the relocation efforts. The following tasks were accomplished:

1. Assembly of the 1-2 GHz balanced amplifier prototype is near completion and it soon will be ready for testing.
2. An initial design of the 2-4 GHz amplifier has been completed.
3. Models of a Q-band amplifier employing Type 4080 devices from the Cryo-3 4074-090 wafer were developed and confirmed by tests using the Jodrell Bank version of the Q-band amplifier. The performance was found to be inferior to previous amplifiers and not suitable from the point of view of Planck LFI requirements. A version of the same amplifier employing 4044-041 Type 2080 devices was tested and modeled. The gain performance was found to be suitable for LFI. This was done in support of the LFI Planck project, and the amplifier is now being evaluated at JBO.

Central Development Laboratory

Amplifier Production

The fourth quarter was dominated by relocation efforts, as the process of transferring and recreating 30 years of infrastructure from the "old" CDL to the new NTC accelerated into year end. By December 31st, all lab equipment had been moved to the NTC, and the amplifier assembly lab was again functional. Amplifier testing capability is being brought back on line as time and manpower permit.

Production during the quarter was unavoidably limited by the relocation activity and focused primarily on emergency repairs. Five older C-band amplifiers were repaired and shipped for use outside of NRAO. Five Q-band amplifiers were modified with Cryo-3 devices for use at the GBT, with replacement of a number of components damaged by an error in biasing electronics. A set of four K-band amplifiers was largely completed and should be ready for testing in late January. The amplifier group continued to support ALMA, with one technician temporarily dedicated to LO/multiplier production.

Other Projects

The chemistry lab move involved a commercial materials company (Clean Harbors) and on December 30th they transported various chemicals and plating baths to the NTC and disposed of various unneeded and dated chemical materials. Outfitting of the new chemistry lab is largely complete, with HVAC and fume hood installations to be finished by mid-January 2004.

Superconducting Millimeter-Wave Mixer Development

Much time this quarter was spent planning and executing the move of the CDL and ALMA activities to the new NRAO Technology Center.

ALMA Receiver Development

Band 6 Cartridge:

The prototype cartridge is now complete, except for the OMT which is being fabricated and tested in Tucson. A cartridge technical design document is being prepared in time for the forthcoming cartridge PDR. All machine drawings are being finalized prior to being sent to commercial machine shops for bids on parts for the first eight cartridges.

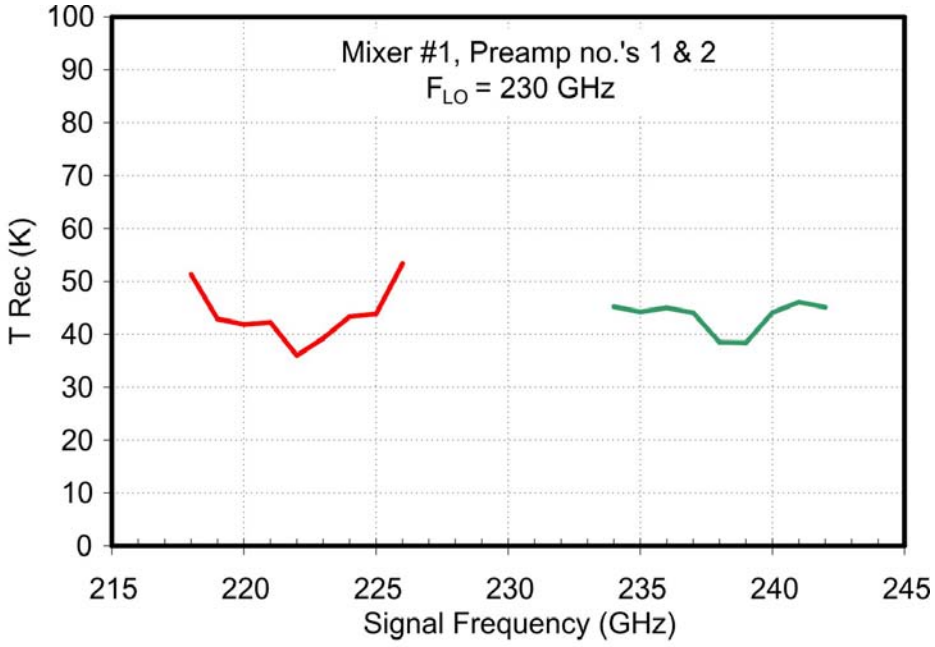
The cartridge optics (the horn and two focusing mirrors) were sent to IRAM for measurement. The results [1] show some discrepancy with the physical optics design calculations, but are within acceptable margins.

A finite element structural analysis of the cartridge optics [2] indicates that deflections under gravity are acceptable.

The phase stability of the blind-mating LO waveguide flanges was measured as a function of tilt angle between the two mating flanges. The results [3] indicate that phase variations due to flexing between the cartridge base plate and the rear module are unlikely to be of concern.

Mixer-Preamp Test System:

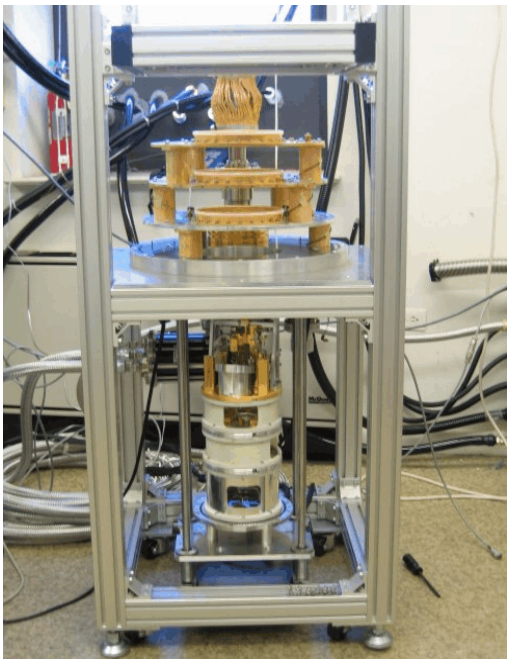
Construction of the mixer-preamp test dewar is now essentially complete. Three mixer-preamp modules have been tested in it, and the results are consistent with tests in the development dewar JT2. Shortly after the system was tested for the first time, it was disassembled and moved to the new lab. The mixer-preamp reaches a physical temperature of 3.4 K. It was decided to add a temperature controller so the mixer-preamps could be tested at the temperature at which they are expected to operate in the ALMA receiver dewar (cartridge cold plate at 3.8 ± 0.2 K) and at which the cartridges are required to meet the ALMA noise temperature specifications. A commercial temperature controller is being purchased for the system for this purpose. Some final software development remains to be completed before the system is ready to start routine production testing of mixer-preamps. The figure shows a typical plot of receiver noise temperature versus signal frequency, measured in the test system, with the LO at 230 GHz. The red curve indicates the lower sideband noise temperature and the green curve the upper sideband noise temperature.



A typical plot of receiver noise temperature vs signal frequency, measured in the test system, with the LO at 230 GHz. The red curve indicates the lower sideband noise temperature and the green curve the upper sideband noise temperature.

Band 6 Cartridge Test System:

The cartridge test set became operational this quarter, and was successfully moved to the NTC. The photographs show (right) the two rack units and (left) the test dewar with the prototype cartridge on the loading mechanism and the vacuum jacket removed. Performance of the system was verified by taking data on a prototype ALMA Band 6 cartridge. Most of the major equipment purchases are complete, and only a few hardware modifications will be required as the cartridge evolves from prototype (without the rear module containing the LO and bias circuits) to final production design. Software, based on LabView, has been written to support the system, and has also been tested.



Band 6 Cartridge Test System.

4-12 GHz IF Preamplifiers:

NRAO is building eight more preamplifiers for immediate use (each Band 6 cartridge contains four preamps). At the same time, Advanced Control Components (ACC), a potential supplier of ALMA production quantities of these amplifiers, is working with NRAO to learn how to build them. ACC originally expected to deliver prototype amplifiers in October, but these had still not been received at the end of the quarter. The problem lies in setting appropriate wire bonder parameters; as ACC has the same type of bonder we use, we are confident that this will not be a persistent problem. Delivery of the prototypes is expected early next quarter.

During testing of the Band 6 prototype cartridge, it was found that the prototype wiring harness caused the amplifiers to oscillate at several MHz. This was remedied by using larger bypass capacitors in the bias lines (the original 680-pF capacitors were replaced with 100-nF capacitors). To accommodate the larger capacitors, a small modification has been made to the amplifier body.

SIS Mixer Development

385-500 GHz SIS Mixer Development:

Development of the circuit model for the 385-500 GHz SIS mixer started in this quarter, but was delayed for several weeks because the circuit optimization routine of our microwave circuit design software MMICAD would not work under the new Windows XP operating system; it was necessary to switch to a new microwave circuit design package, Microwave Office, for this task. The work was further delayed due to the move of the CDL to the NTC building. The design work will continue in the next quarter. This is a joint R&D project between NRAO and UVA, and is supported mainly by an NSF grant to UVA.

SIS Mixer Fabrication:

We have developed an improved method for mounting our SIS mixer chips in split waveguide blocks. The mixers require a good ground connection along both sides of the chip; DC, IF, and RF mixer currents flow through this ground connection. Previously, these ground contacts had been made using a gold wire gasket, ~0.001" diameter, along the shoulders of the substrate channel in the mixer block. When the two halves of the mixer block were bolted together, the gold wires would be crushed slightly and make the desired ground contacts. Assembly of a mixer block with two substrates (four gold wires) was tricky and required very precise matching of substrate thickness, channel depth, and wire diameter. The gold wires appeared to be the major source of failure of mixers during the first testing. For some months we have been using conducting epoxy first to attach the gold wires to the shoulders in the mixer block, then to attach the mixer chip to the gold wires. The two halves of the mixer block are assembled only after curing the conducting epoxy, and assembly is therefore much easier.

Publications & Memos:

[1] M. Carter and G. A. Ediss, "Preliminary results of the measurements of the Band 6 optics," http://almaedm.tuc.nrao.edu/forums/alma/dispatch.cgi/iptfedocs/, 2003-11-17.

[2] Jingquan Chang and G. A. Ediss, "Finite element analysis of Band 6 cartridge horn and mirror mount," http://almaedm.tuc.nrao.edu/forums/alma/dispatch.cgi/iptfedocs/, 2003-12-02.

[3] G. A. Ediss, "Waffle iron phase measurements," http://almaedm.tuc.nrao.edu/forums/alma/dispatch.cgi/iptfedocs/, 2003-11-13.

[4] S.-K. Pan, A. R. Kerr and G. A. Ediss, patent application "Millimeter- and Submillimeter-Wave Noise Generators."

Electromagnetic Support

EVLA

A wideband rectangular-to-circular stepped transition was designed and built for testing the L-band feed and the OMT. This transition, which is about 35" long, will be used for testing the feed from about 0.95 to 1.5 GHz. The transition was analyzed using HFSS software and was found to have predicted return loss better than -23 dB in the above frequency range.

GBT

Using the measured field pattern of the Gregorian focus L-band feed (1.15 - 1.75 GHz), the far-field pattern of the GBT at 1.4 GHz was calculated. The far-out sidelobes are calculated using the geometric theory of diffraction, while the main beam and first few sidelobes are calculated using the theory of physical optics. The far-field patterns of the GBT, when fed from prime focus, were also calculated. Illumination tapers varying from –12 dB to –19 dB were used. A study is under way to compare the resulting beam efficiency and spillover temperature, using either a prime focus feed or a secondary focus feed.

Spectrometers/Correlators

ALMA Correlator

The ALMA correlator Critical Design Review was held October 2-3. The correlator system design was found to be acceptable and was approved for production with only minor issues to be resolved, most of which were resolved by the end of the year. The prototype ALMA correlator was also completed during this quarter and it is ready for shipment to Socorro for integrated testing.

System testing continued, as did software and firmware development.

A major decision was made at CDR concerning system performance enhancement. It was recommended by the CDR committee that the current digital filter card design be replaced by a tunable filter bank card with the same form factor. This change will increase the performance of the correlator by up to a factor of 32 in spectral resolution at minor additional cost.

Bids were sent out for a second round of card assembly for the correlator as was a bid for production of the custom correlator chip. Resulting bids were evaluated and purchase orders written.

Central Development Laboratory

A purchase order for the racks necessary to build the first quadrant of the correlator was submitted.

A new test fixture for the correlator card reflecting the change to a -48 VDC system power supply was designed, and the PCB for it completed. The –48 VDC power supplies for the entire correlator (7000 pounds of equipment) were received.

No work was done on the VLBA data translation project due to ALMA pressures.

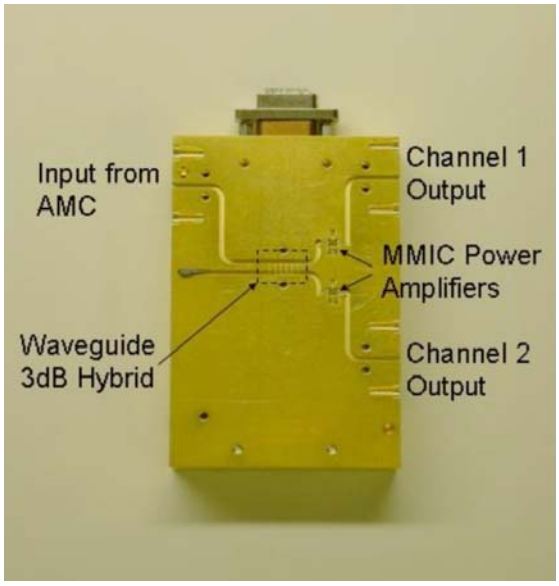
ALMA LO Source

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.

On-wafer and packaged measurements of the HRL InP power amplifier MMIC wafer run were completed. The two new Band 7 (94-121 GHz) designs look good and both will be used in the Band 7 LO driver. Unfortunately, neither of the two new Band 9 (120-144 GHz) designs will be useable. Both of the new designs involved power-combining four 150-μm periphery InP HEMTs on chip. To make this work up to 140 GHz, the power-combining structure must be very compact with the HEMTs very close to one another. This means there is not enough room to put all the vias in that one would like (or as the results seem to show, one needs). We knew this was risky, which is why 50% of the wafer contained proven designs that could be externally power-combined as a backup solution. Since this design and fabrication run, HRL has recently put in some process improvements for smaller vias allowing them to be closer together and more effective. HRL has also recently presented some impressive InP HBT results; it appears the HBT technology has potential to work past 140 GHz, with higher reliability than InP HEMTs as well. For now, with amplifiers required in the next month, we will use the backup solution of external power-combining of two 300-μm output periphery MMIC amplifiers using waveguide hybrids. This will give close to the same power as a single 600-μm MMIC, but requires twice as many chips per amplifier.

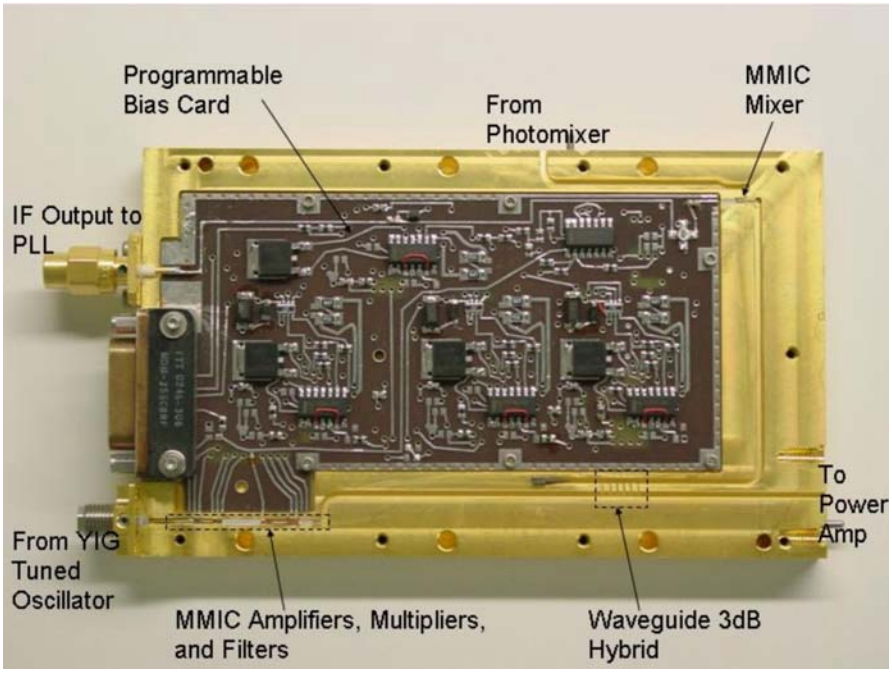
Drawings for the final version of the Band 6, 7 and 9 power amplifier modules were completed and sent out for competitive bids from outside machine shops. Three suitable shops were identified and each band was sent to a different shop. The first batch of Band 6 power amplifier bodies was delivered. They look good and the first is being assembled now. The Band 7 and 9 power amplifier modules will be delivered later this month.

The prototype Band 6 dual-output power amplifier module shown below delivers more than 22 mW over the required tuning range, which is more than adequate to drive the final Band 6 frequency triplers.



Band 6 dual-output power amplifier module.

The prototype Band 3 Active Multiplier Chain (AMC) looked very good with less than 0.5 dB power difference between the two output channels and over 2 mW output over the entire 92-108 GHz band. The prototype Band 6 AMC required some modifications and is suitable for use as a sideband source. It was found that the lack of a proper CPW-to-microstrip transition on the filter substrates was adversely affecting the return loss and causing a large amount of ripple in the AMC output power. A new filter substrate with proper transitions was designed and will be delivered later this month for use in the ALMA deliverable AMCs. The pre-prototype Band 7 LO driver was tested by IRAM with very encouraging results. The sideband noise added by the LO matched that of a Gunn LO over most of the band with a small increase over the bottom 15% of the band attributable to the bandpass filters. Drawings for the final versions of all four AMCs were also sent to an outside shop for fabrication and will be delivered later this month.



Band 6 Active Multiplier Chain module.

The programmable bias card for the AMC was designed, assembled, and tested in the Band 6 prototype AMC. After a few minor modifications, it is working properly. The design and parts kit was sent to ACC, Inc. for assembly and the delivered units tested well. These tested and programmed bias cards will be sent back to ACC, along with remaining parts and bodies for three Band 6 AMCs for complete assembly. It is planned that all PCB assembly and micro assembly for the PLL box, AMCs, and power amplifiers will be done commercially, freeing up our time for final testing of the LO assemblies, modifications, and possible improvements

Investigation of Beamlead HEB Mixers for Heterodyne THz Biohazard Detection

This is a SGER (Small Grant for Exploratory Research) awarded by the NSF under the ACT (Approaches to Combat Terrorism) program. This is a one-year grant to build, measure, and compare different types of HEB mixers in a 600-720 GHz receiver using existing NRAO equipment. The delivered mixer blocks had some machining errors and were returned to Custom Microwave for rework. Meanwhile, further simulations of the mixer block and substrate design were done using CST, and it appears that this design should work over the entire 600-720 GHz band. (It was initially thought that there would be multi-moding problems above about 660 GHz, but we decided on this block design for the sake of expediency, since this is a one-year project.) Only a little work has been done on this project due to pressing ALMA deadlines; preliminary permission has been given from the NSF for an extension.

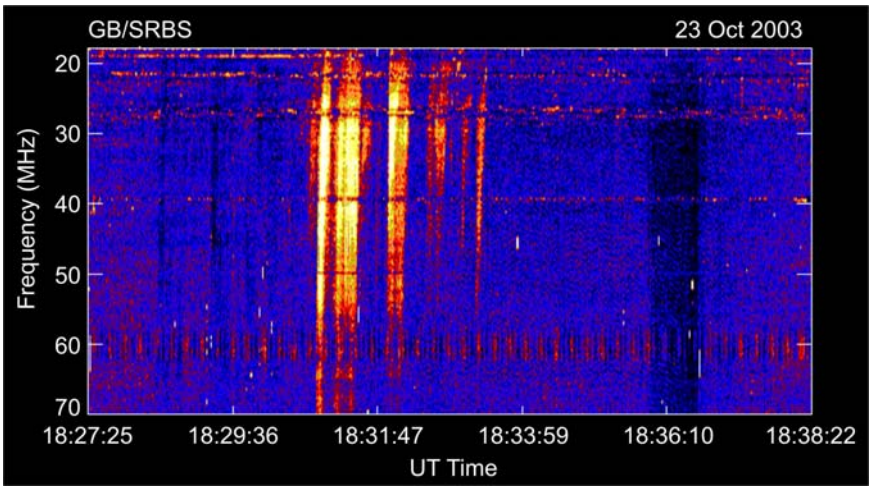
Central Development Laboratory

Green Bank Solar Radio Burst Spectrometer (GB/SRBS)

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

One student intern was involved in the R&D activities this quarter. The low band spectrometer (GB/SRBS-LO) was operated for several weeks in its temporary location in Charlottesville for evaluation. The software was refined and made more robust. The 100-MHz version of the low-noise, high-dynamic range active balun proved highly successful. Several solar bursts were recorded by this instrument even though the RFI environment was severe due to strong AM and FM broadcast stations nearby, producing numerous intermodulation products (spectrogram is shown below). The instrument is scheduled for deployment in Green Bank in early January 2004.

Work has begun on the 350-MHz upgrade to the spectrometer. A prototype of the 20-350 MHz active balun was designed, built, and evaluated, yielding excellent performance. A rugged version of this balun is currently being fabricated. This design is also being considered for adoption by the LOFAR community. A prototype of the 20-350 MHz antenna (log-periodic wire antenna) was also designed.



Radio spectrogram taken from the roof of the old Ivy Road laboratory building, showing several Type-III bursts. Intermodulation products due to strong RFI from local broadcast stations are also visible.

Computing and Information Services

As a result of Internet router filters, vigilant anti-virus maintenance, and focused patching efforts, the NRAO has been almost completely spared from major virus outbreaks. All sites are now cautious about verifying operating-system patches and anti-virus protection on non-NRAO systems (visitors' laptops, for example),and the automated patching processes established by the Common Computing Environment(CCE) group for both Windows and Linux are functioning well.

The CCE group has as its goal to ensure that all sites provide a standard configuration of operating systems, network services, applications software availability, and user interfaces. A target list of activities is used and refined in regular review and discussion meetings, and brief weekly reports describe the progress. Approximately 90% of the targets set in March 2003 by the project members were met by the end of the year, and the remainder should be completed before the project review meeting in March 2004.

A major effort this quarter was the completion of the networking and phone infrastructure to prepare for the migration of the Central Development Lab and the ALMA Electronics from the old Dynamics Building to the new NRAO Technology Center (NTC). Communication between the Edgemont Road Building and the NTC employs a DS43 (45Mbps) link carrying both data and voice services. For network support within the NTC a backbone comprising Cisco Systems equipment for Ethernet switches and routers has been deployed. The Cisco equipment also provides the infrastructure for Voice-over-IP and IP telephony.

After some delay caused by limited resources, the current plan for upgrade of the network service to the VLBA Kitt Peak antenna envisions the deployment to be completed in the next quarter. As a result of lower costs for the new intranet contract it will be possible to upgrade the service at three other sites as well. When this is complete, five of the six VLBA stations that connect via frame relay intranet will have full T1 connections.

Computing and Information Services

Central Computing Services

Milestone	Original Deadline	Revised Deadline	Date Completed
Update Computing Security Policy	02/05/01	05/31/04	
VPN deployed (NM)	06/30/03	01/31/04	
VPN policy fully implemented for both concentrators	04/30/04		
Personal firewall on all Linux systems	03/31/04		
Personal firewall on all Windows systems	05/31/04		
CCE: Linux laptop configuration	07/31/03	10/31/03	12/30/03
CCE: Linux add-on package management deployed	04/30/03		
CCE: deploy automated Windows installation service	11/15/03		12/15/03
CCE: end AD domain full testing	09/15/03	02/27/03	
CCE: begin AD production client migration	09/30/03	04/01/04	
CCE: Accelerated-phase project review meeting	03/31/04		

Security

Thanks to our Internet router filters, vigilant anti-virus maintenance, focused patching efforts, and the watchfulness of our computer users, the NRAO continues to be almost completely spared from major virus outbreaks. Laptops infected at other locations and subsequently connected to the internal NRAO network show up occasionally and are cleaned up quickly. All sites are now more cautious about verifying operating-system patches and anti-virus protection on non-NRAO systems, and the automated patching processes established by the CCE groups for both Windows and Linux are functioning well. In addition, "personal firewall" software will be automatically installed on all NRAO computers to reduce the chance of compromise through services that do not need to be open, whether the computer is on an NRAO network or connected elsewhere. The growing volume of rapidly-spreading new viruses also prompted us to change our approach to attached files in email: we no longer permit machine-runnable binary files to be transmitted in this way.

Virtual Private Networking (VPN) is needed for employees who are required to work frequently or for extended periods of time at non-NRAO locations, and to support telecommuters during construction at Edgemont Road in Charlottesville. VPN testing began in Charlottesville in late 2002, and the service there was made available to users in May. Identical hardware for Socorro was delivered at the end of June 2003. Settings on the Charlottesville VPN box had to be adapted and transferred to the Socorro equipment. Deployment had been planned for the past quarter, but due primarily to staff commitments in preparing for new facilities in Charlottesville, we were unable to meet this goal. The Computing Security Committee has determined system configuration requirements for VPN access, including, for unrestricted access to internal resources, the required use of "personal firewall" software to

prevent compromise while systems are not on the NRAO network (behind the protection of our filtering routers). This requirement will apply to non-NRAO computers whose users need this type of access, as well as to systems administered by NRAO support staff. Completion of this item overall is awaiting final concentrator configuration and documentation thereof.

Common Computing Environment (CCE)

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

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

The target list is used and refined in regular target-review and discussion meetings of the UNIX and Windows CCE groups. Brief weekly reports are submitted by CCE project members, covering the near-term targets for which they are responsible. Approximately 90% of the targets set by the project members for 2003 were met by the end of the year. Except for a few longer-term objectives, the remainder should be completed before a project review meeting which is planned for March in Green Bank.

During the past quarter, the UNIX group has standardized network time service configuration, Web browser versions (Mozilla 1.4) and default settings, UNIX fileserving for Windows systems, and FTP/Secure FTP services, and has continued to expand and improve documentation on computing services for both users and system staff. In addition, RedHat 9 upgrades are ongoing, and work has begun on NRAO-wide deployment of a third-party software management tool at all sites. RedHat recently announced changes to its Linux offerings which leave us with several options of varying cost and suitability. By the end of March, the CCE group will need to decide, in consultation with other divisions at the NRAO and external organizations similar to ours, what path to take for future Linux installations. This is a decision facing all sites which have depended on RedHat Linux.

The Windows administrators have completed final review of critical Active Directory domain settings (numbering in the hundreds), and domain testing is now ready for selected users. Automatic Windows operating-system installation servers have been set up at all four sites, which will be used to

ensure clean and consistent configurations across the Observatory. The install servers will also provide every NRAO Windows computer with some of the core applications agreed upon by the administrators, including automatic inventory of hardware components and installed software. Other software will be deployed through the use of domain policies which will support software installation on demand. Without such automation and standardization, new systems can take several days to customize, and patching is literally impossible to keep up with. Some of these tasks proved more time-consuming than was initially anticipated. As a result, production availability of the AD domain has been postponed, and should be achieved at the end of the coming quarter. At that time, a tutorial will be presented on the changes that our users can expect to see.

Web Infrastructure

Milestones	Original Date	Revised Date	Date Completed
Integrate Web stats from mirrors	10/30/02	01/01/04	01/01/04
Purchase proxy servers for VLA, CDL	06/05/03	03/01/04	
Plan Web Server upgrade to RedHat 9	03/01/04		
Evaluate additional Groupware	04/01/04		

The hardware upgrade (more disk space, spare RAID disks) planned for this quarter was ordered and deployment has begun. Work will need to begin in the next two quarters on a plan for the next generation of web servers, given the age of the existing machines. This planning needs to be carried out in collaboration with the software groups working on archives and data flow.

Secure servers are now available at two sites, and one is already populated with password-protected content for various groups. A migration process to move content that is currently password protected to the secure servers has begun.

A document describing the upgrade path from a generic Linux Red Hat 9 server to a NRAO customized web server is in the process of being created. This plan should be finalized in this quarter, and the deployment of a "mirror" on the new testbed server is anticipated in the following quarter.

Finally, the issue of "groupware" continues to be evaluated and studied. A survey of group leaders was performed this quarter to obtain a consensus on the most important features of a web-based groupware suite. While NRAO already has a time-zone-aware calendar and reservation system in place and operational, it does not permit the features NRAO group leaders are interested in, i.e. personal (and timezone-aware) calendar sharing, web-based e-mail, easy group definition, and file sharing. It is unlikely that any Open Source or commercial product can satisfy all these needs, so the functionality needs have to be addressed in stages.

Computing and Information Services

Information Infrastructure

Milestones	Original Date	Revised Date	Date Completed
Start using LDAP data for phonebook	03/01/04		
Test LDAP server for authentication	04/01/04		

The process of developing the tools needed to continue the development of the OpenLDAP directory server for the NRAO phone book has continued and made significant progress. The prototype directory server has been populated, and work continues on reducing the differences between its content and the classic phone book; this has turned out to be both tedious and time-consuming.

At this point, we are cautiously hopeful that the OpenLDAP server can be made the "master" source for the phone book information sometime in the first quarter of 2004. All other targets will be dependent on this switchover.

Charlottesville Computing

Milestones	Original Date	Revised Date	Date Completed
Replace AUI Mail/Web Server	09/22/03		09/22/03
Upgrade Network Information Server	12/22/03		12/22/03
Deploy services at NTC	12/31/03		12/31/03
Upgrade Linux clients to RedHat 9	03/31/03		
Upgrade Linux servers to RedHat 9	04/30/04		
Upgrade Windows systems to Windows XP	06/30/03		

This last quarter saw the most significant disruption to the Charlottesville Computing Division in quite some time. Two factors were involved: the relocation of the entire division to temporary quarters on the second floor of Edgemont Road while our regular quarters were retrofitted with a sprinklering system, retiled and repainted; and the far more significant relocation of the entire population of the NRAO staff at the "Ivy Road" Dynamics Building to the new NRAO Technology Center (NTC).

Heroic efforts were made by the division staff to ensure the required infrastructure was in place at the NTC buildings prior to the staff relocation. Some of the major points were:

- Provision of a new Voice-over-IP (VoIP) based connection between the new facility and Edgemont Road; also a high speed network between Edgemont Road and NTC;
- Deployment of IP Telephony within the NTC buildings;
- Relocation of all computers at Ivy Road;

- Setting up a new internal-only non-routable network for NTC, including the use of NAT (Network Address Translation) technology on the NRAO's main internet router;
- Acquiring and configuring new servers for the NTC.

At the time of writing, the dust is finally settling on both of these major disruptions. All CV Computing staff are back in their regular quarters, and the staff at NTC are settling in with the new computing and network infrastructure.

The new, robust server for AUI mentioned in the previous report was deployed with no disruption to its user base.

Notable targets included for the coming year include the upgrade of our Windows and Linux clients and servers to newer versions (Red Hat 9, Windows XP). The process has already started and is partially complete; we are hopeful that most systems can be addressed by mid-year or earlier.

Observatory-wide Communications

Milestones	Original Date	Revised Date	Date Completed
Complete Intranet contract migration	08/31/03		08/31/03
Complete wiring plan for NTC	08/31/03		08/31/03
Let contract for DS3 line to NTC	09/30/03		09/30/03
Let contract for NTC network	09/30/03		09/30/03
Install DS3 to NTC	11/30/03		11/30/03
Install NTC network	11/30/03		11/30/03
Complete network to support the SCGB	08/31/03	12/31/03	12/31/03
Upgrade network service to VLBA KP antenna	12/31/02	03/01/04	
Update network traffic analysis tools	03/01/04		
Upgrade network services to VLBA BR, HN, OV antennas	04/01/04		
Network plan for Stone Hall extension	04/01/04		

The major effort this quarter was the completion of the networking and phone infrastructure to prepare for the migration of the CDL staff from the Dynamics Building to the new NRAO Technology Center (NTC). To communicate between the Edgemont Road Stone Hall (SH) building and the NTC, a contract has been let for a DS3 (45Mbps) link. This circuit now carries both data and voice services. For network support within the NTC, we have deployed a backbone comprising Cisco Systems equipment for Ethernet switches and routers. The Cisco equipment also provides the infrastructure for Voice over IP (VoIP) and IP telephony. Although we have used VoIP before to support the offices in the Old Ivy Commons building, this will be our first installation of IP telephony to the handsets. Although the IP

handsets are expensive, the IP telephony makes the routine moves, adds, and changes much simpler, leading to long-term operational savings. Using this infrastructure, all employees have been able to retain their existing phone extensions.

We are also beginning preparatory work for the new network needed for the modifications and additions to SH which will be needed when construction nears completion at the end of 2004. Although we have increased our staffing, the reassignment of the communications staff to the new building projects in Charlottesville has substantially affected our ability to work on other projects.

Although the upgrade of the network service to the VLBA Kitt Peak antenna was delayed due to the reassignment of the communications staff to the new building projects in Charlottesville, we now plan to have this deployed in the coming quarter. As a result of lower costs for our intranet contract with AT&T, we have decided to upgrade the service at three other VLBA sites. When this is complete, five of the six VLBA locations that connect via the frame relay intranet will have full T1 connections

The network traffic analysis tools previously in place are being updated to reflect the new equipment and configuration. This upgrade should be complete during the coming quarter.

The basic network to support the Science Center at Green Bank (SCGB) is installed and operational. However, there was an unpredicted delay in obtaining the new data circuit between Green Bank and Charlottesville. This network is now completely in place.

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

Education and Public Outreach

Education and Public Outreach Highlights

The NRAO initiated, organized, and sponsored a very successful conference of communicating astronomy to the public, which was held at the Keck Center of the National Academies. This was just one of five EPO related meetings in which NRAO participated during the month of October. The NSF's "The Universe from the Ground Up" and its Public Information workshop were also held in Washington with NRAO participation. In Albuquerque and Sunspot, NM, NRAO staff participated in the SACNAS and SCOPE meetings. At both the "Universe from the Ground Up" and at the SACNAS meetings, NRAO had displays. NRAO also had increased success with local print media, particularly in Virginia.

Informal Education

Attendance at both the Science Center at Green Bank and the Visitor Center at the VLA showed significant increases this quarter compared to last year at this time. Some of this may be due in part to better attendance keeping, but the changes are sizeable enough that they likely represent real increases. Another factor at Green Bank is that for the first time, the Science Center was open during November and December and had regularly scheduled tours. Clearly the impact of the winter season is stronger at Green Bank than at the VLA.

Site	October	November	December
Green Bank	5,800	871	355
VLA	2,086	1,317	1,062

New exhibits installed at the VLA Visitor Center include an art gallery of VLA photos, taken mainly by the staff with plans to request such pictures from visitors along with permission to use such pictures. Another new exhibit is a 3cm receiver, encased in plexiglass that has been cut with a big slice out of the feed horn so we can see inside it. A third exhibit is a dynamic one showing the changes in the VLA as progress is made towards EVLA. Distribution of VLA Visitor Center brochures at the Albuquerque airport through our membership in the Albuquerque Visitor and Convention Bureau has gone so well that a new large order for brochures was required. At Green Bank, a striking new Science Center brochure was produced by the Green Bank graphics artist who is half time with EPO and half time with Green Bank operations. During their annual meeting, held this year in Snowshoe, some of the West Virginia Science Teachers came for a special tour at the Science Center in Green Bank.

Education and Public Outreach

Professor Donald Backer presenting the 38th Annual Jansky Lecture.

The Jansky lectures, an annual fall highlight, this year featured Dr. Donald Backer speaking about "Massive Black Holes, Gravitational Waves, and Pulsars." There were large turnouts at all sites including estimates of 75 at Green Bank, 250 at Charlottesville, 250 at Socorro, and 200 at Tucson. In concert with the Jansky lecture in Socorro another highly successful New Mexico Symposium was held with a lively and informative exchange of information, research results, and instrument development.

The new gift shops at both Green Bank and the VLA began the fiscal year strongly, greatly exceeding revenue over the same periods the previous year. The three to four fold increases were due to several factors including greater attendance, a larger selection of offerings, and the creation of real gift shop space where either very little or none had existed at this time last year. The revenue generated helps to support the ongoing education and outreach activities at both sites and also assists in generating greater attendance at both sites.

Education and Public Outreach

Gift Shop	October – December, 2004	October-December, 2003
Green Bank	$27,329	$8,411
VLA	$29,510	$6,273

The Café at the Green Bank Science Center is currently generating only a little more than one third as much revenue as from the gift shop, but patronage is increasing. October Café revenue was the highest yet, while December had the highest per captia capita expenditure yet which leads one to expect better in the future.

New student bunkhouse at Green Bank.

The dorm/bunkhouse is essentially done and will house visiting student, youth, and other educational groups during visits to the Observatory. It is anticipated that the NRAO will take ownership of the building next month and have it furnished by the end of the month.

Formal Education

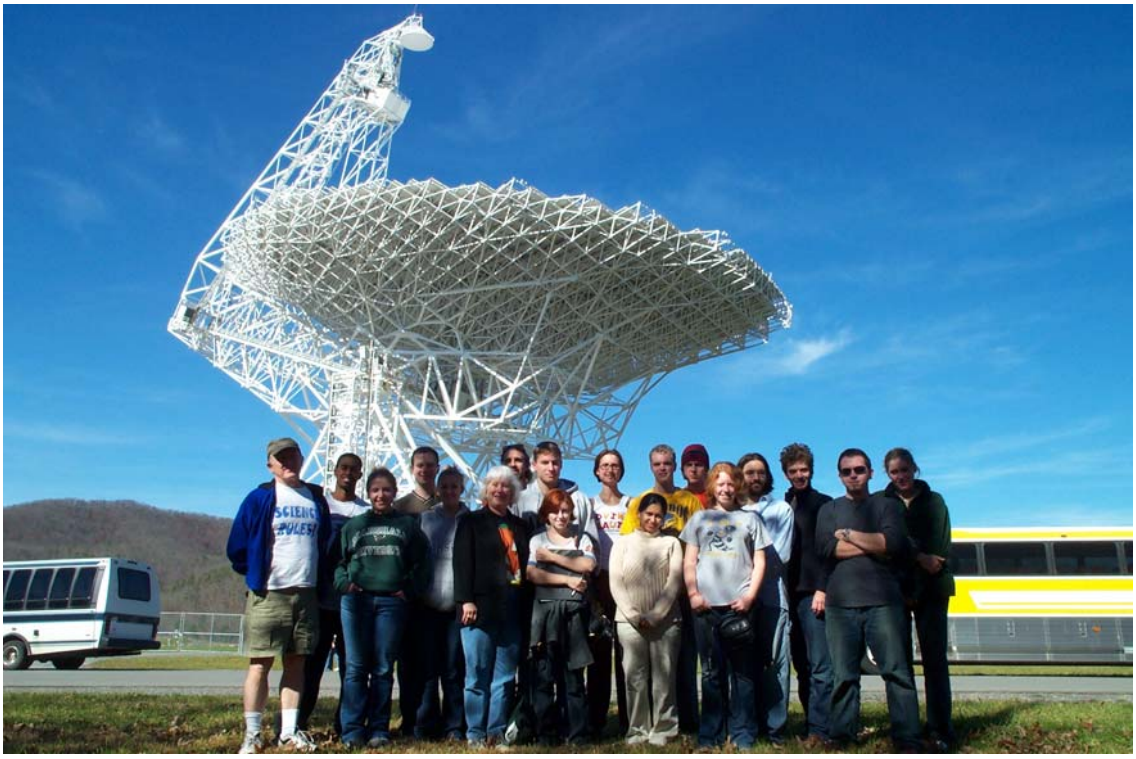
A good deal of education efforts this quarter was spent in preparation for future programs. Two grant proposals for NASA IDEAS funding were submitted, one each from Socorro and Green Bank.

The Socorro program, "Doing Dishes: Observational Radio Astronomy for Science Education," will enlist teachers in a week-long project. They will work with staff from the NRAO and New Mexico Tech to develop optimal content and structure for a 2-week radio astronomy course for teachers which will be available to all teachers through the New Mexico Tech Master of Science Teaching program.

The Green Bank program, "Quiet Skies: Exploring Radio Astronomy and the Noisy World We Live In," will develop instrumentation and curriculum for 7-12 grade students to investigate the issue of

radio frequency interference (RFI). It is proposed that NRAO staff will design and build the initial Quiet Skies detectors. The NRAO will then collaborate with teacher-interns to test, calibrate and modify the instruments and to develop a curriculum. Afterwards a larger group of teachers will field-test "Quiet Skies" with their students. The program will then be expanded statewide in West Virginia and eventually nationally.

Groups using the 40-foot telescope this quarter for observing sessions included the Forsyth Astronomical Society, Marshall University, James Madison University, Bridgeport High School, Western Albemarle High School, Villanova Astronomical Society, Fairfield Area School District, and Fox Chapel Area High School. The Yeager Scholars from Marshall had the added bonus of witnessing an aurora display when they arrived in Green Bank. Other groups visiting Green Bank for extended visits included Bluefield High School, Highland County Middle School Gifted students, Blue Ridge Community College, West Virginia University, East Hardy County Middle School Gifted, George Madison University, Central Appalachian Astronomy Club, White Sulphur Springs Elementary School, and Allegany High School.



Marshall University Yeager Scholars at Green Bank in October, 2003.

Community Relations

The NRAO hosted a West Virginia regional science fair at Green Bank. The U.S. Forest Service made use of the facilities at the Science Center and were impressed and appreciative. The Marlinton

Rotary Club had a special meeting at Green Bank that included a visit to the exhibits, a Starlab planetarium demonstration, and a light dinner in the Café.

In New Mexico, the NRAO provided the instructor with a grant writing mini-course for the local Rural Economic Development Through Tourism Council. The NRAO also participated in a special Teacher Night at the museums in Albuquerque. His Royal Highness, Prince Andrew, the Duke of York came to Socorro in connection with a ceremony for New Mexico Tech's Magdalena Ridge Observatory and as a follow up the Prince experienced a helicopter flyby of the VLA and had an approximately hour long tour of the AOC.

For the total lunar eclipse in November, NRAO staff members participated in observing sessions in Charlottesville, VA and in Greenbelt, MD. Turnout was excellent at both events.

Prince Andrew, New Mexico Tech President Dan Lopez, & Jim Ulvestad at the AOC.

Education and Public Outreach

Astronomy Community

October was an unusually busy conference/meeting month for EPO participation. First and foremost was the Conference on Communicating Astronomy to the Public (CCAP) which was initiated and sponsored by the NRAO and held at the National Academy's Keck Building in Washington, DC. Instead of the 60 or so participants expected, the registration was over 130 with waiting list. The conference went very well, with attendance holding steady through the last day of a the 3-day meeting. Approximately 20 participants elected to take a tour of NRAO at Green Bank on the day after the conference concluded. Another outcome of the meeting was a call for a statement on the importance of EPO for all astronomy institutions. An initial draft was created at the meeting, with a final version, The Washington Charter for Communicating Astronomy with the Public statement, approved in December with plans to have that statement officially forwarded to the AAS and other astronomy organizations seeking their formal endorsements.

Professor Jon Miller of Northwestern addressing the CCAP meeting.

The NSF's in addition to supporting the CCAP meeting, also sponsored two additional meetings in the Washington, DC area the same month. The Universe from the Ground Up highlighted NSF's ground-based facilities and included an NRAO display and a presentation by Dr. K. Y. Lo, NRAO Director, on the Atacama Large Millimeter Array (ALMA). One of the NRAO's public information officers also participated in NSF Public Information workshop. An outcome of this last meeting was an invitation and responding interest in holding a retreat for Public Information Officers at NSF facilities in Socorro in 2004. NRAO also participated in the meeting of the Southwest Consortium of Observatories for Public Education (SCOPE) meeting in Sunspot, NM. Meanwhile, at the same time as the CCAP conference, Albuquerque was hosting the annual meeting of the Society for Advancement of Chicanos and Native Americans in Science (SACNAS) at which the NRAO had a display.

Education and Public Outreach

SACNAS conference participants at the NRAO display.

To meet the continuing needs of the Observatory, significant EPO staff effort was provided for producing the AUI Management Proposal, the 2004 Program Plan, the January Newsletter, the internal Point Source, various NRAO brochures, plus images, work on the ALMA logo, replicating ALMA graphics CDs, the annual NRAO calendar, and NRAO science meetings signage.

The NRAO was again a sponsor for the 10th annual Enchanted Skies Star Party in Socorro. At the 9th annual Mid-Atlantic Star Party in North Carolina an NRAO speaker gave a presentation on the Green Bank Science Center, only to be scooped by having the immediately preceding speaker extol the wonders of visiting Green Bank, the Science Center, and using the 40-foot telescope.

Media Relations

There were three new NRAO national press releases during this period, including one connected to a story on the cover of Nature magazine. In anticipation of the upcoming AAS meeting, NRAO public information officers successfully lobbied for two press conferences related to work done by NRAO scientists. One of these stories also led to a local front page story on the ALMA groundbreaking. One of the subsequent outcomes of that story was a meeting with the reporters and editors of the Charlottesville newspaper and an expressed greater interest in doing stories on the NRAO. Following soon on the heels of that was another front page story, this time on the new Science Center in Green Bank and that story in turn was picked up by the Richmond newspaper and drew mention in the Washington Post.

Education and Public Outreach

Local coverage in West Virginia and New Mexico has also been good with stories in the Charleston and Albuquerque newspapers. An NRAO connection is one of the nine prime links across the top of the Pocahontas County, WV website (http://www.pocahontas.org/home.aspx) while a search of the West Virginia Tourism site quickly brings up the National Radio Astronomy Observatory. Similarly, the VLA is listed as on the first page of the Southwest Region of the New Mexico Tourism website (http://www.newmexico.org/maps/Southwest.html) and a search on the home page (http://www.newmexico.org/) quickly finds either the NRAO or the VLA.

As an additional means of creating awareness, experiments are being done with boilerplate press releases for groups that visit the sites, particularly for groups that observe with the 40 Foot Telescope. A recent example of this type of success was a story in Pittsburgh about a group of middle schoolers that had visited Green Bank. Snowshoe Mountain Resort, which is about 30 minutes travel from Green Bank, displays NRAO Science Center brochures and had an ad highlighting the Green Bank facility.

The GBT in the entrance foyer of the National Academy's Keck Building.

Environment, Safety and Security

Environment, Safety and Security

NRAO revised the Emergency Preparedness Plan for the AOC and the VLA in Socorro. At the ALMA Test Facility in Socorro, the emphasis was in the development and implementation of the AEC contractor safety program. The Green Bank site was inspected for safety items and a concerted effort was placed on the installation of security surveillance cabling. In Charlottesville, the focus was on the preparation of the NTC building and the associated move of the chemistry lab and on the access control card system at the Edgemont Road site. With the office in Santiago, ES&S began meeting to resolve procedures for safe operations and medical surveillance protocols.

ALMA

The ALMA Correlator CDR was conducted with ES&S participation and review of potential hazards. Working with the ALMA Correlator team, the hazards of the design were addressed and where appropriate, the design modified or procedural practices implemented to prevent accident and injury. The official ALMA groundbreaking ceremony was held with ES&S providing safety consultation to ensure the attending dignitaries were adequately protected from the effects of decreased oxygen pressure at the high altitude of the ALMA site. Precautionary notices were included in the invitations and the ALMA Site team provided oxygen and other protective services including ambulance and medical support if needed. The event went off without any health related incidents.

A continued issue was resolved that involved the responsibility and authority of the ALMA Safety Officer at the ALMA Test Facility in Socorro, NM. At the Antenna Test Facility, the AEC antenna contractor designated a safety officer to provide daily program guidance. The ALMA Safety Officer met daily with the contractor staff to provide guidance and assistance in the development of the contractor safety program. There remains a concern for the future liability associated with the project upon acceptance of the AEC antenna and the role of the NRAO with our partners at such time.

NRAO-NM

The Emergency Preparedness Plan was drafted to include emergency evacuation routes and emergency contacts for both the AOC and the VLA sites. The Laser Safety Program was reviewed and modifications proposed to include the use of fiber optic lasers being incorporated into the ALMA project.

During the period, the development programs included the preparation of first aid inventories, emergency lighting inventories as well as a update to the hazardous chemical inventory for the VLA site.

Environment, Safety and Security

The ALMA Safety Officer continued making daily visits to the ALMA Test Facility (ATF) and worked with the AEC Safety Officer to develop crane safety and a heavy lifting program for the AEC antenna hoist. The ALMA Safety Officer also revised and updated the AEC antenna lockout/tagout procedures.

NRAO-GB

New employee training sessions were provided and included site specific training for GBT Authorization access. Without this session, employees must be escorted when accessing the GBT to ensure that proper safety precautions are addressed and the antenna and personal safety are maintained. Fire extinguisher safety training was provided to the staff of the Green Bank Visitor Center to ensure proper response to fire emergencies.

Attention was provided to the items identified in the site safety inspection performed last quarter. Follow-up safety inspections are planned for the second quarter 2004.

With respect to security implementation, the cabling for the security surveillance cameras was pulled by the Plant Maintenance team and preparations are in place for camera installation.

NRAO-CV

At the Edgemont Road project site, contractor work included the selection of the card access control system. The ES&S security requirements for access control were addressed in a series of meetings with the contractor representatives and Observatory Administration. The installation of video security surveillance for the Edgemont Road site was delayed because of the additional attention to the NTC move. It was decided that installation of security video at the NTC would be delayed to focus on the build out and construction deadlines for relocation.

For the NTC move, ES&S coordinated the chemistry lab move and disposal of hazardous substances.

General

The Management of the ES&S Division participated in the Human Resources management training sessions.

Effort was placed in the development of security procedures with the EPO staff and management for management and mitigation of security incidents associated with the public interface. Issues such as management of theft, counterfeit money, as well as personal security in similar events were addressed.

Environment, Safety and Security

ES&S issues were also addressed with the NRAO Santiago staff in the effort to ensure proper startup of the Chilean operations. ES&S items addressed included emergency preparedness and business continuity, employee training, liability issues, as well as medical examination requirements for visitors to the ALMA site.

During this quarter, continued effort was placed on the development of the NRAO wide safety program for vehicle use. The plan is based on the guidance from our insurer. Additional focus was placed on the development of a Supervisory Safety Training Program. The presentation of these programs is anticipated for the first quarter in 2004.

Telescope Usage

The NRAO telescopes were scheduled for research and maintenance during the fourth quarter of CY2003 in the following manner. Note that time lost and actual observing for the arrays are computed as fractions of the total antenna arrays. For example, losing 27 VLA antennas for one hour counts as 1.0 hour of time lost, while losing one out of ten VLBA antennas for one hour counts as 0.1 hours of time lost. Also note that in the case of the GBT, Test and Calibrations occasionally require less time than is scheduled for them, and the excess time is then allocated to refereed backup science programs.

	VLA	VLBA	GBT
Scheduled Observing (hrs)	1637.20	1025.00	1074.00
Scheduled Maintenance and Equipment Changes	246.00	218.64	353.00
Scheduled Tests and Calibration	267.30	373.75	706.00
Time Lost	150.60	52.50	131.00
Actual Observing	1486.60	972.50	979.00

GBT Observing Programs

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

No.	Observer(s)	Programs
BG141	Greenhill, L. J. (CfA) Braatz, J. A.	Launching of the NGC 1068 Jet. 3.5 cm
BU027	Ulvestad, J. Neff, S. G. (GSFC) Teng, S. (Maryland)	Detecting High-Velocity Masers to Reveal Nuclear Disks in Nearby AGNs. 1.3 cm
GBT01A-061	Lane, W. (NRL) Briggs, F. H. (ANU) Chengalur, J. (NCRA (TIFR)) Kanekar, N. (Kapteyn Astronomical Institute) Kassim, N. E. (NRL)	An H I Map Covering the SIRTF First-Look Survey. 21 cm
GBT02A-012	Minter, A. Balser, D.	A Search for the Next Interstellar Aldehyde Sugar: Glyceraldehyde. 2, 1.3 cm
GBT02A-028	Braatz, J. A. Langston, G. I. McMullin, J. Garwood, R.	Galactic HI Mapping of X-Ray, UV, and Optical Deep Fields. 21 cm
GBT02A-046	Braatz, J. A. Henkel, C. (MPIR) Wilson, A. S. (Maryland)	Studying PSR J2229+6114: an Energetic Gamma-ray Emitting Young Pulsar. 50, 21 cm
GBT02A-063	Claussen, M. J. Wootten, H. A. Marvel, K. (AAS) Wilking, B. A. (Missouri)	Detection of AGN in Apparently "Normal" Galaxies. 1.3 cm
GBT02A-069	Fisher, R.	A Search for High Velocity 21cm Emission toward III Zw 2. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT02C-020	Henkel, C. (MPIR) Balser, D. Desmurs, J. F. (Observatorio Astronomico Nacio) Braatz, J. A.	Probing the AGN Environment in Moderate Velocity Active Galactic Nuclei (H2O). 1.3 cm
GBT02C-048	Kondratko, P.T. (Harvard) Greenhill, L. J. (CfA) Moran, J. M. (CfA) Herrnstein, J. (Renaissance Technology) Garcia Miro, C. (Madrid Deep Space Communication Complex, Spain)	Measuring Nuclear Disks in NGC 1386 and IC 2560 (H2O). 1.3 cm
GBT02C-058	Stairs, I. (U. British Columbia) Xilouris, K. (Virginia) Kramer, M. (NRAL) Backer, D. C. (UC, Berkeley) Cognard, I (CNRS-Orleans)	Probing the Magnetic Field on Sub-Parsec Scales in the Accretion Disk of NGC 4258 (H2O Zeeman). 1.3 cm
GBT02C-065	Braatz, J. A. Henkel, C. (MPIR) Wilson, A. S. (Maryland)	Search for extreme Faraday rotation in AGN. 21, 3.5 cm
GBT03A-014	Lockman, F. J.	A Search for 21cm Absorption in High Redshift Damped Lyman-Alpha Absorbers. 38 cm
GBT03A-016	Stairs, I. (U. of British Columbia) Manchester, D.R. N. (Australia Telescope) Lyne, A. G. (NRAL)	Timing Binary Pulsars at the GBT. 21 cm
GBT03A-024	Cordes, J. M. (NAIC and Cornell U.) Bhat, R. (MIT) McLaughlin, M. (Manchester)	A GBT search for the young neutron star in Gamma Cygni. 38 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT03B-001	Eisner, J.A. (Caltech) Greenhill, L. J. (CfA) Claussen, M. J.	High-Resolution 70-cm Radar Imaging of the Lunar South Pole: Searching for Evidence of Ice. 70 cm
GBT03B-014	Stairs, I. (U. British Columbia) Ransom, S. (McGill) Kaspi, V. (McGill) Hessels, J. W. T. (McGill) Backer, D. C. (UC, Berkeley)	Timing the Pulsars in the Globular Cluster M30. 21, 11 cm
GBT03B-016	Walsh, A.J. (CfA) Myers, P. C. (CfA) Zhang, Q. (CfA) Di Francesco, J. (NRCC) Bourke, T. (CfA) Wilner, D. (CfA)	Timing of a Millisecond Pulsar Discovered in a Survey of Mid-Latitude EGRET Error Boxes 38. 21 cm
GBT03B-030	Benjamin, R. (Wisconsin,) Lockman, F. J.	XTE J1807-294 Target of Opportunity. 11 cm
GBT03C-003	Stairs, I. (U. British Columbia) McLaughlin, M. (Manchester) Kaspi, V. (McGill) Lorimer, D. (Manchester) Kramer, M. (NRAL) Camilo, F. (Columbia) Gavriil, F. (McGill) Backer, D. C. (UC, Berkeley)	A Direct Measurement of Fine Structure "Constant" Evolution from OH and HI Absorption Lines 38. 21 cm
GBT03C-010	Sahai, R. (JPL) Claussen, M. J.	Follow-Up Observations of Extragalactic H2O Masers Discovered with the GBT. 1.3 cm
GBT03C-014	Lovell, A. (Agnes Scott College) Schloerb, F. P. (Massachusetts) Howell, E. (Arecibo)	HI Narrow Self-Absorption: A New Tracer for Measuring The Magnetic Field in Dense Molecular Clouds. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT03C-029	Camilo, F. (Columbia) Halpern, J. P. (Columbia) Helfand, D. J. (Columbia) Gotthelf, E.V. (Columbia) Ransom, S. (McGill) Roberts, M. (McGill)	Timing the pulsars in M62, NGC 6544, and NGC 6624 & Search for Ultra-fast pulsars 38. 21 cm
GBT03C-038	Kovalev, Jr., Y. Tyulbashev, (Pushino Radio Astronomical Observatory of Astro Space Center, Lebedev)	RRS Observations of the Double Binary Pulsar J0737-3039 21. 11 cm
GD017	Diamond, P. J., et al. (See VLBA Observing Programs)	Late Time Observations of GRB 030329. 3.5 cm
GU003	Ulvestad, J., et al. (See VLBA Observing Programs))	NGC 1068: Identifying the Nucleus and Launching the Jet.. 4, 6 cm

VLA Observing Programs

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

No.	Observer(s)	Programs
AA267	Alexander, P. (Cambridge) Riley, J. (Cambridge) Pooley, G. (Cambridge) Fabian, A. (Cambridge) Hardcastle, M. (Bristol, UK) Worrall, D. (Bristol, UK) Cotter, G. (Cambridge) Inskip, K. (Cambridge) Allen, S. (Cambridge) Crawford, C. (Cambridge)	Compact sources in the field of the Huygens-Titan Encounter. 3.6, 6 cm
AB1093	Blundell, K. (Oxford) Rawlings, S. (Oxford)	High-Z FRI quasars. 20 cm
AB1097	Bietenholz, M. (York U.) Keohane, J. (NASA/GSFC) Chen, J. (North Carolina) Massenburg, S. (North Carolina)	Expansion of 3C58 supernova remnant. 20 cm
AB1098	Branchesi, M. (Bologna) Gioia, I. (Bologna) Fanti, C. (Bologna) Fanti, R. (Bologna) Mullis, C. (ESO)	Radio sources in X-ray selected clusters of galaxies. 20 cm
AB1100	Best, P. (Royal Obs)	SCUBA sources in Z=0.9 cluster CL1604+4304. 20 cm
AB1101	Beuther, H. (MPIR, Bonn) Sridharan, T. (CFA) Keto, E. (CFA)	Spectral indices of hyper compact HII regions. 1.3, 2 cm
AB1102	Becker, R. (Calif., Davis) Helfand, D. (Columbia) White, R. (STScI)	Completing the FIRST survey. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AB1103	Bennert, N. (Bochum) Falcke, H. (MPIR, Bonn) Schulz, H. (Univ. Catolica Norte)	Helical jets in Seyfert-2 galaxy ESO428-G14. 2, 3.6 cm
AB1105	Bower, G. (Calif., Berkeley) Plambeck, R. (Calif., Berkeley) Bolatto, A. (Calif., Berkeley)	Calibrators for astrometry of radio stars in the Orion Nebula. 1.3, 3.6 cm
AC681	Cannon, J. (Minnesota) Skillman, E. (Minnesota)	Continuum emission in the low-metallicity galaxy I Zw 18. 3.6, 20 cm
AC689	Cheung, T. (Brandeis) Wardle, J. (Brandeis) Sambruna, R. (George Mason) Gambill, J. (George Mason) Urry, C. (Yale) Maraschi, L. (Brera Obs) Tavecchio, F. (Brera Obs)	Deep search for inner X-ray jet in PKS1136-135. 3.6 cm
AC696	Clarke, T. (Virginia) Kempner, J. (Virginia	Radio halos in clusters of galaxies. 20 cm
AC697	Cirasuolo, M. (SISSA-Trieste) Magliocchetti, M. (SISSA-Trieste) Celotti, A. (SISSA-Trieste) Danese, L. (SISSA-Trieste) Cristiani, S. (Padova)	Highest-redshift complete quasar sample. 20 cm
AC698	Clancy, R. (SSI, Boulder) Butler, B. Gurwell, M. (Caltech) Muhleman, D. (Caltech)	Martian atmospheric water vapor during 2003 opposition. 1.3 cm

VLA Observing Programs

No.	Observer(s)	Programs
AC699	Cohen, A. (NRL) Feretti, L. (Bologna) Kassim, N. (NRL) Orru, E. (Bologna) Lazio, J. (NRL) Lane, W. (NRL)	Cluster halos and relics from 74-MHz survey. 90 cm
AC700	Cullen, H. (Cambridge) Alexander, P. (Cambridge)	HI in interacting pair NGC 275. 20 cm
AC702	Cannon, J. (Minnesota) Skillman, E. (Minnesota)	Continuum emission in dwarf starburst galaxies: NGC 625. 3.6, 6, 20 cm
AC725	Claussen, M. Healy, K. (Arizona State) Straughn, A. (Arizona State) Starrfield, S. (AAO) Bond, H. (AAO)	Masers in V838 Monocerotis. 0.7, 1.3, 20 cm
AC727	Claussen, M. Marvel, K. (AAS) Wilking, B. (UMSL) Wootten, H.A.	VLA confirmation of high velocity water masers in a maser outburst of the young stellar object IRAS 16293-2422. 1.3 cm
AD485	Dolag, K. (MPIAP, Munich) Govoni, F. (Bologna) Schindler, S. (Liverpool JMU) Feretti, L. (Bologna)	Magnetic fields in clusters of galaxies. 6 cm
AD486	DePree, C. (Agnes Scott College) Wilner, D. (CFA) Goss, W.M. Deblasio, J. (Agnes Scott College)	H52 alpha in hyper compact HII regions in Sgr B2 Main. 0.7 cm
AD487	Dahlem, M. (ESO) Brogan, C. (Univ. of Hawaii) Breitschwerdt, D. (MPE)	Spectral indices in the halo of NGC 891. 90 cm

VLA Observing Programs

No.	Observer(s)	Programs
AD488	Dallacasa, D. (Bologna) Stanghellini, C. (Bologna) Tinti, S. (Brera Obs)	Sources whose spectra peak at high frequency. 0.7, 1.3, 2, 3.6, 6, 20 cm
AD489	Doi, A. (NAO, Japan) Inoue, M. (NAO, Japan) Kameno, S. (NAO, Japan) Wajima, K. (ISAS, Japan) Nagai, H. (Tokyo U.)	Spectral indices and variability of narrow-line Sy 1 galaxies. 2, 3.6, 6, 20 cm
AD490	Dyer, K. Owen, F.	Spectral indices of Abell 13 at low frequencies. 90, 400 cm
AD491	Demorest, P. (Calif., Berkeley) Backer, D. (Calif., Berkeley)	Investigating a new population of X-ray sources. 6, 20 cm
AF405	Feretti, L. (Bologna) Orru, E. (Bologna) Brunetti, G. (Bologna) Giovannini, G. (Bologna) Girardi, M. (SISSA-Trieste) Govoni, F. (Bologna)	Spectral indices of radio halos in clusters A2219 and A2744. 90 cm
AF406	Feretti, L. (Bologna) Orru, E. (Bologna) Giovannini, G. (Bologna) Lane, W. (NRL) Kassim, N. (NRL) Perley, R.	Spectral indices of giant radio galaxies 3C35 and 3C326. 90, 400 cm
AF407	Faber, S. (Calif., Santa Cruz) Chapman, S. (Mt. Wilson) Davis, M. (SETI) Ivison, R. (Royal Obs) Steidel, C. (Caltech) Reddy, N. (Caltech) Smail, I. (Durham)	Deep 1.4 GHz imaging of DEEP extended Groth strip region. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AF408	Frey, S. (FOMISGO) Mosoni, L. (FOMISGO) Gurvits, L. (NFRA) Paragi, Z. (NFRA)	Spectral index of J0836+0054 at Z=5.8. 3.6, 6, 20 cm
AG653	Gawronski, M. (Copernicus/Torun) Marecki, A. (Copernicus/Torun) Kus, A. (Copernicus/Torun) Kunert, M. (Copernicus/Torun)	Radio sources with hybrid FRI/FRII morphologies. 6 cm
AG654	Garland, C. (Hawaii) Pisano, D. (CSIRO) Williams, J. (CFA) Guzman, R. (Florida) Castander, F (Catalunya)	HI mapping of three luminous compact blue galaxies. 20 cm
AH776	Harris, D. (CFA) Krawczynski, H. (Yale) Kassim, N. (NRL) Katz-Stone, D. (USNA) Lane, W. (NRL)	Jet/intracluster medium interactions of the radio galaxy 3C 129. 400 cm
AH820	Hyman, S. (Sweet Briar) Lazio, J. (NRL) Neureuther, J. (Sweet Briar) Nord, M. (New Mexico) Kassim, N. (NRL)	Galactic center radio transient monitoring program. 90 cm
AH821	Hardcastle, M. (Bristol)	Physical conditions and emission mechanisms in 3C351 hotspots. 0.7, 1.3 cm
AH822	Harris, D. (CFA) Biretta, J. (STScI) Junor, W. (New Mexico)	Inner jet of M87: tests of a synchrotron model. 0.7, 1.3, 2 cm

VLA Observing Programs

No.	Observer(s)	Programs
AH832	Hoare, M. (Leeds) Busfield, A. (Leeds) Lumsden, S. (Leeds) Oudmaijer, R. (Leeds)	Completing the survey of red MSX sources. 6 cm
AH835	Hachisuka, K. (NAO, Japan) Horiuchi, S. (JPL) Mochizuki, N. (NAO, Japan) Umemoto, T. (NAO, Japan) Miyoshi, M. (NAO, Japan)	Survey of water masers in the outer Galaxy. 1.3 cm line
AI110	Ivison, R. (Royal Obs) Webb, T. (Leiden) Yee, H. (Toronto) Hoekstra, H. (Groningen/Kapteyn) Gladders, M. (Carnegie Obs.)	Survey of a Z=0.77 cluster with excess SCUBA sources. 20 cm
AI111	Impey, C. (Arizona) Miller, L. (Oxford) Lopes, A (Oxford)	Potential new wide-separation gravitational lenses. 3.6 cm
AJ298	Johnson, K. (Wisconsin) Seth, A. (Washington)	Massive star formation in Magellanic irregular NGC6822. 2 cm
AJ299	Johnson, K. (Wisconsin) Plante, S. (Laval)	Star cluster formation at low metallicities: SBS0335-052. 1.3, 2 cm
AJ304	Jimenez-Garate, M. (MIT) Tomsick, J. (Calif., San Diego) Rupen, M. Dyer, K.	Unusual ultraluminous X-ray source M81 X-9. 3.6, 6 cm
AJ306	Juvela, M. (Helsinki) Vaisanen, P. (ESO) Mattila, K. (Helsinki) Harju, J. (Helsinki) Dahlem, M. (ESO)	Radio counterparts to sources detected in ISOPHOT CIRB program. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AJ307	Jimenez-Serra, I. (CSIC) Martin-Pintado, J. (Yebes Obs) DePree, C. (Agnes Scott College) Rodriguez-Franco, A. (CSIC)	Hot molecular condensation in Cepheus A HW2 region. 0.7 cm
AK550	Kulkarni, S. (Caltech) Berger, E. (Caltech) Soderberg, A. (Caltech) Chevalier, R. (Virginia)	Type Ibc supernovae. 1.3, 3.6, 6, 20 cm
AK571	Kording, E. (MPIR, Bonn) Colbert, E. (Johns Hopkins) Falcke, H. (MPIR, Bonn)	Radio loud IXOs. 3.6 cm
AK573	Kulkarni, S. (Caltech) Berger, E. (Caltech) Frail, D. Soderberg, A. (Caltech)	Radio afterglows of GRBs. 0.7, 1.3, 2, 3.6, 6, 20 cm
AL560	Lazio, J. (NRL) Fabian, A. (Cambridge) Kassim, N. (NRL) Perley, R.	Old radio lobes in the intracluster medium of the Perseus cluster. 400 cm
AL597	Laing, R. (Oxford) Bridle, A. Parma, P. (Bologna)	Spectrum of 3C31 from 74 to 8400 MHz. 90, 400 cm
AL602	Linz, H. (Puerto Rico) Hofner, P. (NMIMT) Araya, E. (Puerto Rico) Stecklum, B. (Thuringian) Henning, T. (Jena U.) Kurtz, S. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Marti, J. (U. Jaen)	Dust around the massive star at the center of HH80/81. 0.7 cm

VLA Observing Programs

No.	Observer(s)	Programs
AL603	Leipski, C. (Bochum) Huttemeister, S. (Bochum) Falcke, H. (MPIR, Bonn)	Extended emission around radio-quiet quasars. 3.6, 6 cm
AL604	Laing, R. (Oxford) Parma, P. (Bologna) Bridle, A. Fanti, R. (Bologna)	Depolarization asymmetry in extragalactic radio sources. 6, 20 cm
AL606	Lim, J. (SA/IAA, Taiwan) Takakuwa, S. (CFA) Choi, M. (SA/IAA, Taiwan)	Imaging binary low-mass proto stellar system L1551 IRS5. 0.7 cm
AM763	Martin, S. (Caltech) dePater, I. (Calif., Berkeley) Gibbard, S. (LLNL)	Lower tropospheric motions in Neptune. 0.7, 1.3 cm
AM766	Monnier, J. (CFA) Greenhill, L. (CFA) Tuthill, P. (Sydney) Danchi, W. (NASA/GSFC)	Monitoring colliding wind binary WR112. 3.6 cm
AM777	Murgia, M. (Bologna) Parma, P. (Bologna) deRuiter, H. (Bologna) Mack, K-H. (NFRA) Fanti, R. (Bologna)	Spectral index imaging of fossil radio galaxies. 3.6, 6, 20 cm
AM778	Montero-Castano, M. (Madrid Obs) Herrnstein, R. (CFA) Ho, P. (CFA)	Ammonia absorption against Sgr A*. 1.3 cm
AM783	Mason, P. (New Mexico State) Gray, C. (U. Texas-El Paso)	Survey of magnetic cataclysmic variable stars. 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AO170	O'Dea, C. (STScI) Guerra, E. (Rowan) Daly, R. (Penn State) Donahue, M. (STScI)	Propagation of powerful radio galaxies. 6, 20 cm
AO174	Olmi, L. (Puerto Rico) Cesaroni, R. (Arcetri) Hofner, P. (Puerto Rico) Araya, E. (Puerto Rico)	Variability of new source near massive protostar IRAS20126+4104. 1.3, 3.6, 6 cm
AO175	Owen, F. Morrison, G. (IPAC) Lonsdale, C. (Caltech) Smith, G. (UC, San Diego) Xu, K. (Caltech)	Observations of the SWIRE deep field. 20 cm
AP452	Perley, R. Condon, J.J. Cotton, W.D. Lane, W. (NRL) Cohen, A. (NRL) Kassim, N. (NRL) Lazio, T. (NRL) Erickson, W. (Maryland)	4 Meter sky survey. 400 cm
AP461	Pedlar, A. (Manchester) Muxlow, T. (Manchester) Beswick, R. (Manchester) Wills, K. (Sheffield)	Monitoring radio SNe and SNRs in nearby starbursts. 2, 3.6, 6 cm
AP462	Paladino, R. (Cagliari) Murgia, M. (Bologna) Helfer, T. (Arizona) Ekers, R. (CSIRO) Blitz, L. (UC, Berkeley) Moscadelli, L. (Bologna) Wong, T. (UC, Berkeley) Gregorini, L. (Bologna)	Radio continuum in BIMA SONG galaxies. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AP463	Pisano, D. (CSIRO) Guzman, R. (Florida) Kobulnicky, C. (Wisconsin) Gallego, J. (Madrid Obs) Bershady, M. (Wisconsin)	HI and continuum observations of blue compact galaxies. 20 cm
AP466	Perlman, R. (Maryland) Rector, T.(Alaska) Padovani, P. (STScI) Landt, H. (STScI) Stocke, J. (Colorado/JILA)	Positions of X-ray loud quasars for VLBA observations. 6 cm
AR518	Rawlings, S. (Oxford) Brand, K. (Oxford) Hill, G. (Texas) Tufts, J. (Texas)	Jet alignments in forming super-structures. 3.5 cm
AR523	Rupen, M. Dhawan, V. Mioduszewski, A. Ribo, M. (Barcelona)	X-ray binaries, transients and related sources. 0.7, 1.3, 2, 3.6, 6, 20 cm
AR529	Rudnick, L. (Minnesota) Rottgering, H. (Leiden) Wilman, R. (Leiden) Rawlings, S. (Oxford) Brand, K. (Oxford) Blundell, K. (Oxford) Delain, K. (Minnesota)	Search for diffuse structures in clusters of galaxies. 90 cm
AR530	Reipurth, B. (Hawaii) Rodriguez, L. (Mexico/UNAM) Bally, J. (Colorado/JILA)	Search for radio cluster in W40. 3.6 cm
AR531	Rothberg, B. (Tufts) Chambers, K. (Hawaii) Joseph, R. (Hawaii)	Radio emission associated with galaxy mergers. 3.6, 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AR535	Ribo, M. (Barcelona) Mirabel, I. (CNRS, France) Rodriguez, J. (Switzerland) Hannikainen, D. (Helsinki)	VLA/INTEGRAL/RXTE monitoring of GRS1915+105. 3.6, 20 cm
AS762	Sokoloski, J. (Southampton) Mioduszewski, A. Brocksopp, C. (MSSL) Rupen, M.	Monitoring symbiotic binaries during outburst. 3.6, 6, 20 cm
AS772	Sandell, G. (NASA) Plambeck, R. (UC, Berkeley)	Spectral index imaging of Herbig Be star MWC297. 2, 6 cm
AS774	Snellen, I. (Royal Obs) Best, P. (Royal Obs) Rigby, E. (Royal Obs)	Search for distant FRI radio galaxies. 20 cm
AS776	Sandell, G. (NASA) Wright, M. (UC, Berkeley) Goss, W.M.	Continuum and H_2O study of massive protostar NGC7538S and vicinity. 1.3, 3.6 cm
AS777	Schinnerer, E. Goss, W.M. Turner, J. (UCLA) Johnson, K. (Wisconsin)	Star formation in central 300 pc of IC 342. 3.6, 6 cm
AS778	Stockdale, C. (NRL) Maddox, L. (Oklahoma) Cowan, J. (Oklahoma) Pannuti, T. (MIT) Prestwich, A. (CFA) Kilgard, R. (CFA)	Spectral-index study of nearby spiral galaxies. 6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AS779	Stockdale, C. (NRL) VanDyk, S. (UCLA) Weiler, K. (NRL) Rupen, M. Sramek, R. Panagia, N. (STScI) Paczynski, B. (Princeton)	Late-time radio emission from Type Ib/c supernovae. 3.6 cm
AS780	Schinnerer, E. Rupen, M. Kennicutt, R. (Arizona)	Spectral-index study of M51 on 100-pc scale. 6, 20 cm
AS781	Sarma, A. (Illinois) Troland, T. (Kentucky) Crutcher, R. (Illinois)	OH Zeeman observations of S88B. 20 cm
AS782	Sewilo, M. (Wisconsin) Churchwell, E. (Wisconsin) Goss, W.M. Kurtz, S. (Mexico/UNAM) Hofner, P. (Puerto Rico)	Broad radio recombination lines from hyper compact HII regions. 0.7 cm
AS784	Swaters, R. (Johns Hopkins) Verheijen, M. (Wisconsin) Bershady, M. (Wisconsin) Andersen, D. (MPIA, Heidelberg)	Kinematics of low surface brightness galaxy DDO 39. 20 cm
AS785	Sollins, P. (CFA) Ho, P. (CFA) Zhang, Q. (CFA) Keto, E. (CFA)	Ammonia absorption across ultra compact HII regions. 1.3 cm
AT294	Tsujimoto, M. (Kyoto) Feigelson, E. (Penn State) Saito, M. (CFA)	Observations of two protostars in Orion with X-ray emission. 3.6 cm
AT295	Terashima, Y. (ISAS, Japan) Ho, L. (DTM/Carnegie) Ulvestad, J.	Three ultra-low luminosity AGNs with X-ray emission. 2, 3.6, 6, 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AU096	Ulvestad, J. Mathur, S. (Ohio State) Fields, D. (Ohio State)	Narrow-line Seyfert 1 galaxies selected from SDSS. 3.6 cm
AW589	Wilcots, E. (Wisconsin) Westfall, K. (Wisconsin) Prescott, M. (Wisconsin)	High resolution HI study of NGC 2537. 20 cm
AW599	Whysong, D. (UC, Santa Barbara) Antonucci, R. (UC, Santa Barbara) Geller, R. (UC, Santa Barbara)	Search for Thompson scattering in the intergalactic medium. 20 cm
AW605	Walter, F. Brinks, E. (Guanajuato U.) de Blok, E (Univ. Cardiff). Thornley, M. (Bucknell) Kennicutt, R. (Arizona)	HI structures of nearby galaxies. 20 cm
AW607	Winn, J. (CFA) Rusin, D. (CFA) Kochanek, C. (CFA) Lovell, J. (CSIRO) Fassnacht, C. (Calif., Davis) Koopmans, L. (Caltech)	Gravitational lens monitoring. 3.6 cm
AW608	Weiler, K. (NRL) Stockdale, C. (NRL) Sramek, R. Van Dyk, S. (IPAC) Panagia, N. (STScI) Marcaide, J. (Valencia) Lewin, W. (MIT) Pooley, D. (MIT) Immler, S. (Massachusetts)	ToO observations of supernovae. 1.3, 2, 3.6, 6, 20, 90 cm

VLA Observing Programs

No.	Observer(s)	Programs
AW615	Willner, S. (CFA) Goss, W.M. Coil, A. (UC, Berkeley) Barmby, P. (CFA) Huang, J. (CFA) Wang, Z. (CFA)	High-Z galaxies in extended Groth strip. 6 cm
AW618	Wilcots, E. (Wisconsin) Prescott, M. (Wisconsin)	Dynamics of Magellanic spirals NGC 4618 & NGC 3664. 20 cm
AW619	Wilcots, E. (Wisconsin) Sanders, W. (Wisconsin) Doane, N. (Wisconsin)	Continuum and HI imaging of NGC 4395. 20 cm
AW620	Walter, F. Carilli, C. Lo, K.Y. Menten, K. (MPIR, Bonn) Cox, P. (IAP, Paris) Fan, X. (Princeton) Omont, A. (IAP, Paris) Strauss, M. (Princeton)	Resolving CO disk in J1148+5251 at Z=6.42. 0.7 cm
AY146	Yun, M. (Massachusetts) Scoville, N. (Caltech)	Hydrogen recombination line in starburst +AGN systems. 3.6 cm
AZ143	Zhao, J-H. (CFA) Herrnstein, R. (CFA) Goss, W.M. Bower, G. (Calif., Berkeley) Pegg, J. (CFA)	Monitoring quasi-periodic oscillations of SgrA*. 0.7, 1.3, 2 cm
AZ147	Zapata, L. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Kurtz, S. (Mexico/UNAM) O'Dell, C. (Vanderbilt)	Search for exciting source(s) of OMC-1S outflows. 1.3 cm

VLA Observing Programs

No.	Observer(s)	Programs
S50252	Kaaret, P. (Columbia) Corbel, S. (CNRS, France) Rupen, M.	Chandra/VLA monitoring of ULX source in NGC 5408. 6 cm

VLBA Observing Programs

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

No.	Observer(s)	Programs
BA068	Asaki, Y. (ISAS) Hachisuka, K. (Valencia) Deguchi, S. (NRO) Honma, M. (NAOJ) Imai, H. (JIVE)	Measuring the transverse motion of a Galactic evolved star, S Per. 1, 2 cm
BA069	Anderson, J. (NMIMT) Ulvestad, J.	Measuring LLAGN sizes using intraday variability studies. 4 cm
BB168	Bartel, N. (York) Bietenholz, M. (York) Lebach, D. (CFA) Ratner, M. (CFA) Shapiro, I. (CFA)	Proper motion of the "core" of the quasar 3C345. 4, 13 cm
BB172	Brunthaler, A. (MPIR, BONN) Falcke, H. (MPIR, BONN) Greenhill, L. (CFA) Henkel, C. (MPIR, BONN) Reid, M. (CFA)	Proper motions in the local group. 1 cm
BB174	Bower, G. (Calif., Berkeley) Bolatto, A. (Calif., Berkeley) Plambeck, R. (Calif., Berkeley)	Trigonometric parallax of radio stars in the Orion Nebula. 2 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BC120	Chatterjee, S. (Cornell) Backer, D. (Calif., Berkeley) Benson, J. Brisken, W. Cordes, J. (Cornell) Ellis, R. (Calif., Santa Cruz) Fomalont, E. Golden, A. (Ireland) Goss, W.M. Kramer, M. (Manchester) Lazio, T. (NRL) Lyne, A. (Manchester) McKinnon, M. Thorsett, S. (Calif., San Diego) Wong, D. (Cornell)	Pulsar astrometry with the VLBA. 20 cm
BC127	Cawthorne, T. (Lancashire) Gabuzda, D. (Cork) Jorstad, S. (Boston) Marscher, A. (Boston) Stirling, A. (Lancashire)	Precessing jet in BL Lacertae?. 0.7, 1, 2, 4 cm
BC128	Claussen, M. Marvel, K. (AAS) Wilking, B. (UMSL) Wootten, H.A.	Monitoring of water masers around low and intermediate luminosity young stellar objects. 1 cm
BC134	Chatterjee, S. (Cornell) Cordes, J. (Cornell) McLaughlin, M. (Manchester) Lazio, T. (NRL) Arzoumanian, Z. (NASA/GSFC)	Proper motion of a faint anomalously-located pulsar. 18 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BC135	Cotton, W.D. Bakker, E. (JIVE) Chagnon, G. (Obs. de Paris) Coude du Foresto, V. (Obs. de Paris) Diamond, P. (Manchester) Kononen, P. (Metsahovi) McAllister, H. (George State) Mennesson, B. (JPL) Perrin, G. (DESPA) Ragland, S. (CFA) Ridgway, S. (NOAO) Traub, W. (CFA) van Langevelde, H. (JIVE) Vlemmings, W. (Leiden) Waters, R. (Amsterdam)	Obs. of bright O-rich Mira stars. 0.7 cm
BC137	Cesaroni, R. (Arcetri) Beltran, M. (Arcetri) Codella, C. (Firenze) Furuya, R. (Arcetri) Moscadelli, L. (Cagliari) Testi, L. (Arcetri)	Study of H_20 and OH masers tracing two bipolar outflows in the high-mass cluster. 1 cm
BC138	Cheung, T. (Brandeis) Taylor, G. Wardle, J. (Brandeis)	Three lobe-dominated quasars with radio/optical hotspots. 90 cm
BD076	Desmurs, J. (OAN) Alcolea, J. (OAN) Bujarrabal, V. (OAN) Colomer, F. (OAN) Sanchez-Contreras, C. (OAN)	SiO masers in proto planetary nebulae. 0.7 cm
BD086	Doi, A. (Tokyo) Kameno, S. (NAOJ) Kohno, K. (Tokyo)	VLBI imaging of high-frequency excess objects. 1, 2, 4 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BD093	Doi, A. (Tokyo) Inoue, M. (NAOJ) Kameno, S. (NAOJ) Nagai, N. (Tokyo) Wajima, K. (NAOJ)	Inverse-Compton cooling in Narrow-line Seyfert . 1. 2, 4, 6, 13, 20 cm
BE028	Edwards, P. (ISAS) Kataoka, J. (Tokyo)	Constraining the predicted motion in 3C303. 6 cm
BE029	Edwards, P. (ISAS) Falcone, A. (Purdue) Horan, D. (CFA) Kataoka, J. (Tokyo) Piner, B. (Whittier)	Structure and expansion of the TeV gamma-ray source H1426+428. 4 cm
BE030	Edwards, P. (ISAS) Holder, J. (Leeds) Piner, B. (Whittier)	Puzzling parsec-scale structure of the TeV gamma ray source 1ES1956+650. 1, 2 cm
BE032	Eilek, J. (NMIMT) Hardee, P. (Alabama) Owen, F. Walker, R.C.	High resolution, low frequency observations of the Cygnus A hot spots. 90 cm
BE033	Edwards, P. (ISAS) Kataoka, J. (Tokyo) Murphy, D. (JPL)	Radio/optical/X-ray source 3C15. 2, 4, 6,13, 20 cm
BE034	Edwards, P. (ISAS) Tingay, S. (Swinburne)	Low-redshift GPS radio galaxy PKS B2254-367. 6, 20 cm
BG114	Gabuzda, D. (JIVE) Cawthorne, T. (Lancashire) Pushkarev, A. (ASC)	Toroidal B fields in BL lac objects. 1, 2, 4, 6 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BG135	Gomez, Y. (Mexico/UNAM) Anglada, G. (CSIC) Marvel, K. (AAS) Miranda, L. (CSIC) Patel, N. (CFA) Torrelles, J. (CSIC)	Tracking the proper motions of the H_20 masers in the planetary nebula K3-35. 1 cm
BG140	Goddi, C. (Cagliari) Moscadelli, L. (Cagliari)	22.2 GHz maser observations to test the circumstellar disk. 1 cm
BH105	Hough, D. (Trinity) Aars, C. (Texas Christian)	Variability in the nuclei of lobe-dominated quasars. 2, 4 cm
BH111	Horiuch, S. (Horiuchi) Lister, M. Piner, B. (Whittier) Preston, B. (JPL)	Magnetic field orientation around polarized core of superluminal quasar 1642+690. 0.7, 1, 2, 4, 6 cm
BH113	Hong, X. (Shanghai) An, T. (Shanghai) Jiang, D. (Shanghai) Wang, W. (Shanghai) Zhao, J –H. (CFA)	Millimeter VLBA observations of the core structure on a sub-parsec scale in AGN 1156+295 at Z=0.729. 0.3, 0.7, 2 cm
BI027	Imai, H. (JIVE) Diamond, P. (Manchester)	Evolution of a molecular jet from the AGB star W43A. 1 cm
BI028	Imai, H. (JIVE) Morris, M. (UCLA) Sahai, R. (JPL)	Kinematics of collimated molecular jets in evolved stars. 1 cm
BJ036	Jorstad, S. (Boston) Marscher, A. (Boston) Yurchenko, A. (St. Petersburg)	BL Lac objects with high proper motion. 0.7, 1, 2, 4 cm
BK077	Kemball, A. (UIUC) Patnaik, A. (MPIR, BONN)	High polarization sample of compact radio sources. 4 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BK101	Kunert, M. (Torun) Marecki, A. (Torun) Spencer, R. (Manchester)	Are weak and ultra-compact steep spectrum objects 'dying' CSOs?. 2, 4, 6 cm
BK103	Kemball, A. (UIUC)	Observational constraints on SiO maser excitation. 0.7, 1.3 cm
BK106	Krichbaum, T. (MPIR, Bonn) Bach, U. (MPIR, Bonn) Friedrichs, S. (MPIR, Bonn) Impellizzeri, C. (MPIR, Bonn) Britzen, S. (Heidelberg Obs) Wagner, S. (Heidelberg Obs) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	IDV 0716+71 with INTEGRAL. 0.7, 1.3, 6, 20 cm
BL105	Lobanov, A. (MPIR, Bonn) Klare, J. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Multi-frequency monitoring of the parsec-scale jet in 3C345. 2, 4, 6 cm
BL118	Loinard, L. (Mexico/UNAM) Mioduszewski, A. Rodriguez, L. (Mexico/UNAM)	Astrometric study of T Tau Sb. 4 cm
BM155	Mutel, R. (Iowa) Helton, A. (Iowa) Su, B. (Yunnan)	Structure of magnetic fields in AGN jets: Testing the shock model. 0.7, 1, 2 cm
BM177	Miyoshi, M. (NAOJ) Deguchi, S. (NAOJ) Imai, H. (JIVE) Nakashima, J. (NAOJ)	Precise proper-motion measurement of the SiO maser sources at the Galactic Center relative to Sgr A*. 0.7 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BM182	Ma, C. (NASA/GSFC) Johnston, K. (USNO) Fey, A. (USNO) Boboltz, D. (USNO) Gordon, D. (NASA/GSFC) Gaume, R. (USNO) Kingham, K. (USNO) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) MacMillan, D. (Interferometrics) Petrov, L. (NASA/GSFC) Fomalont, E. Walker, R.C.	VLBA Geodesy/Astrometry observations for 2003. 4, 13 cm
BM191	Marscher, A. (Boston) Aller, M. (U. Michigan) Gomez, J. (IAA, Granada) Jorstad, S. (U. Southampton) McHardy, I. (U. Southampton)	Relationship between X-ray events and superluminal ejections in blazars. 0.7, 1 cm
BM199	Moscadelli, L. (Cagliari) Claussen, M. Furuya, R. (NAOJ) Kitamura, Y. (ISAS) Testi, L. (Arcetri) Wootten, H.A.	Low-mass YSOs explored by H_20 masers. 1 cm
BM200	Marecki, A. (Torun) Kunert, M. (Torun)	Confirmation of a restarted activity in AGN with bright cores and weak lobes. 2, 6 cm
BN021	Nagar, N. (Arcetri) Falcke, H. (MPIR, Bonn) Maoz, D. (Tel Aviv) Wilson, A. (Maryland)	Accretion in low-luminosity AGN: A radio, UV and X-ray variability study. 6 cm
BN025	Nagai, H. (Tokyo U.) Asada, K. (NAO, Japan) Inoue, M. (NAO, Japan)	Spectral indices in CSO CTD93. 2, 4, 6, 13 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BR088	Ratner, M. (CFA) Bartel, N. (York U.) Bietenholz, M. (York U.) Lebach, D. (CFA) Lestrade, J-F. (Paris Obs) Ransom, R. (York U.) Shapiro, I. (CFA)	Astrometry of HR 8703 in 2003 for gravity probe-B mission. 4 cm
BS121	Savolainen, T. (Tuorla) Courvoisier, T. (INTEGRAL) Valtaoja, E. (Tuorla) Wiik, K. (Tuorla)	Physics of AGN, a deep understanding of the quasar 3C273. 0.7, 1.3, 2, 4, 6 cm
BS133	Savolainen, T. (Tuorla) Bottcher, M. (Ohio Univ.) Raiteri, C. (Torino) Takalo, L. (Tuorla) Villata, M. (Torino) Wiik, K. (Tuorla) Villata, M (Torino)	Multi-frequency properties of the blazar 3C 66A. 0.3, 0 .7, 1, 6, 13 cm
BU025	Ulvestad, J. Elvis, M. (CFA)	Jet and torus in NGC1068. 4 cm
BU027	Ulvestad, J. Neff, S. (NASA/GSFC) Teng, S. (Maryland)	Monitoring young supernovae in Arp 299. 4, 13 cm
BW067	Walker, R.C. Hardee, P. (Alabama)	Patterns in the 3C120 jet from 0.5 to 6 arc seconds. 90 cm
BW073	Wiik, K. (Tuorla)	Multi-wavelength millimeter observations. 0.7 cm
BX005	Xu, Y. (Nanjing) Greenhill, L. (CFA) Menten, K. (MPIR, Bonn) Moscadelli, L. (Cagliari) Zheng, X. (Nanjing)	Distance to the Perseus spiral arm. 2 cm

VLBA Observing Programs

No.	Observer(s)	Programs
GD017	Diamond, P. (Manchester) Lonsdale, C. (Haystack) Lonsdale, C. (Caltech) Smith, H. (UC, San Diego)	Monitoring evolution of compact emission of Arp 220. 20 cm
GG049	Gudel, M. (SFIT, ETH) Smith, K. (MPIR, Bonn) Conway, J. (Chalmers, Onsala) Pestalozzi, M. (Chalmers, Onsala) Beasley, A. (Caltech) Skinner, S. (Colorado/JILA) Audard, M. (Columbia)	Radio and X-ray observations of the T Tauri NS Triple System. 4 cm
GI001	Imai, H. (NFRA) Diamond, P. (Manchester)	Kinematics of expanding circumstellar envelope of W43A. 20 cm
GM048	Marcaide, J. (Valencia) Guirado, J. (Valencia) Alberdi, A. (IAA, Andalucia) Lara, L. (IAA, Granada) 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
GU003	Ulvestad, J. Elvis, M. (CFA)	NGC 1068: deep search for a nucleus plus jet/wind structures. 4, 6 cm
GT005	Taylor, G.	Late time observations of GRB 030329. 4 cm

Personnel

NEW HIRES

Dugan, Jennifer	Mechanical Engineer III	12/22/2003
Groppi, Christopher	Research Associate	10/20/2003
Hubbard, David	Hd of Obs Program Office	11/24/2003
Solatka, Michael	Designer, Senior	10/08/2003
Symmes, Arthur	Structural Engineer, Senior	11/01/2003
Van Buskirk, Philip	Software Engineer II	10/20/2003

TERMINATIONS

Downey, Elwood	Software Engineer II	11/01/2003
Jenkins, Michell Sherrie	Mechanical Engineer III	10/21/2003
King, Lee *	Research Engineer, Senior	09/30/2003
Kingsley, Jeffrey	Deputy Assistant Director	10/31/2003

*previously not reported

PROMOTIONS

Grichener, Alexander	Electronics Engineer III	12/01/2003

Publications

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

PREPRINTS RECEIVED, OCTOBER-DECEMBER 2003

ANDERSON, J.M.; ULVESTAD, J.S.; HO, L.C. Low-Luminosity AGNs at the Highest Resolution: Jets or Accretion Flows?

BEHRE, O.P.; WENDKER, H.J.; HIGGS, L.A.; LANDECKER, T.L. The Cygnus X Region XXII. A Probable HAeBe Star with a Giant Bipolar Outflow in DR 16.

BIETENHOLZ, M.F.; BARTEL, N.; RUPEN, M.P. SN 1993J VLBI. III. The Evolution of the Radio Shell.

BLOOM, J.S.; BERGER, E.; KULKARNI, S.R.; DJORGOVSKI, S.G.; FRAIL, D.A. The Redshift Determination of GRB 990506 and GRB 000418 with the Echellete Spectrograph Imager on Keck.

BLOOM, J.S.; FOX, D.; VAN DOKKUM, P.G.; KULKARNI, S.R.; BERGER, E.; DJORGOVSKI, S.G.; FRAIL, D.A. The First Two Host Galaxies of X-ray Flashes: XRF 011030 and XRF 020427.

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