NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

July – September 2003

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Executive Summary

ALMA

Evaluation of the prototype antenna from VertexRSI continues at the ATF site located at the VLA. After a very successful session of holographic measurements to set the panel surface, detailed evaluation of the pointing performance has begun. A report of the evaluation of the antenna will be complete by January 2004.

The ALMA project has developed a coordinated antenna procurement strategy that establishes the framework that allows each Executive to follow their respective procurement practices while working together to insure that the overall goals of the project are met. Two Industry briefings will be held in October; one in Europe and one in North America. The RFP is scheduled for release at the end of October.

Fabrication of the two antenna prototype correlator has been completed, and software integration with the correlator is in progress. The prototype correlator is scheduled to be shipped to the ATF in December 2003.

EVLA

The second meeting of the EVLA External Advisory Committee took place. Initial outfitting of the EVLA Test Antenna was completed and the antenna was moved from the Antenna Assembly Building to the Master Pad for further outfitting and testing. Installation of the fiber-optic cable was completed on the West and East arms and continues on the North arm well ahead of schedule. In situ tests of the phase stability of the fiber began. Reorganization of the management structure of the e2e and AIPS++ software work for the EVLA was completed.

Green Bank Telescope

Several new observing capabilities, including the 22-26 GHz band, the Prime Focus2(PF2) receiver, and the pulsar Spigot Mode, were added during the third quarter of CY2003. About half of the total telescope time was scheduled for astronomical observations, with the remaining half used for tests, program checkouts, and scheduled maintenance.

A High Frequency Science Workshop was held in Green Bank in early September. The workshop examined both the scientific and instrumentation potential of the GBT. Topics included wideband spectroscopy, deep large-area continuum surveys, and the complementarity of the GBT and other instruments.

The focus of azimuth track work in the past quarter was on the continuation of the field trial of the Splice 45 retrofit, and on the finite element analysis being performed by an external

contractor(SG&H). The engineering firm of Modjeski & Masters conducted an inspection of the critical structural members of the GBT elevation tipping structure during the summer. Some cracks were found in the welds joining the elevation stub shafts to their stiffener plates, and the nature of these cracks is still under investigation. Some bearing wear in the azimuth wheel bearings has been detected, and a trial change from grease to oil lubrication is in progress. The painting program for the GBT structure continued.

Work continued to improve the reliability of the GBT spectrometer. The CPU clocks were upgraded on the Long Term Accumulator cards and resulted in better handling of the interrupts and time-out problems. Testing and verification of the Pulsar Spigot cards continued. High speed sampler modifications are underway to eliminate noise on the 1.6 GHz sampling clock.

In late Q2 2003, the Software Development Division became the Single Dish Software Integrated Product Team, expanding to become a more diverse group of software engineers and astronomers, drawing from both telescope control and data analysis disciplines. A standard, semi-quarterly development cycle was established to align software development activities with engineering, operations, and science activities in support of site-wide goals for the GBT. A key accomplishment was the establishment of a fully searchable Knowledge Management and Collaboration System (the "wiki"). Although started as an experiment to track software documentation more effectively, use of the wiki has spread throughout the site and is now being used for project planning in many areas.

A new system to monitor the temperature of key points on the GBT structure was successfully installed in the third quarter, on time and on budget. The system is part of the Precision Telescope Control System, which will provide effective operation of the GBT in the 3 mm wavelength band. The goal of the temperature sensor project is to characterize the effects of thermal gradients on telescope pointing, focus, and surface accuracy through careful correlation with observational data. Initial results comparing measured pointing and focus offsets within a single commissioning session with the temperature sensor data are encouraging.

The Ease-of-Use project is intended 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. During this quarter the effort was focused on the Configure and the Observe/Status work packages.

During the past quarter, the baseline investigation concentrated on consolidation and documentation of the results to date. Phase stable coaxial cables and passive cable temperature buffers were installed at critical points in the common IF system. Many of the original optical fiber modulators, which have a characteristic gain ripple of approximately 2.4 MHz period, were replaced with newer compensated modules that have greatly reduced ripple levels, and the rest will be replaced during the coming quarter.

Executive Summary

Progress on the Penn Array project included the production of a mechanical prototype for the detector array, at Goddard, and the successful cryogenics tests in Green Bank of the test dewar and the GBT helium compressor lines. The electrical and mechanical interfaces between the receivers and the Caltech Continuum Backend have been designed and documented. Much of the fabrication in Green Bank of the 26-40 GHz receiver is completed, including the feedhorns, polarizers/OMTs, and the dewar mechanical parts. During the next quarter the receiver assembly will continue, and cold testing will begin.

Very Large Array & Very Long Baseline Array

Scientific results obtained with the VLBA during the fourth quarter of 2003 include a new astrometric distance measurement of 300 pc for pulsar B0656+14. This distance places the pulsar within the Monogem Ring, a 100,000-yr old supernova remnant. The pulsar/supernova association lends credence to the likelihood that this single supernova may be responsible for the local excess of high-energy cosmic rays. On the VLA, two large projects recommended by an external review committee were begun during the BnA configuration in September. One of these is a survey of the entire sky above –30 degrees elevation at the low 74-MHz frequency. This will mark the first large-scale survey ever done at such a low frequency with high sensitivity and arcminute resolution.

A damaged elevation bearing at the St. Croix VLBA antenna was replaced during a special visit in July 2003. The failure mode apparently was the same as that of a similar bearing at Los Alamos several years ago, and may have been caused during the initial installation process. VLA antenna 15 had its azimuth bearing replaced in September; this was the 7th such bearing replacement on a VLA antenna. At least five more VLA antennas will need bearing replacements over the next several years.

The third successful session of scientific observing was carried out using the Pie Town link. This link makes use of a commercial fiber-optic connection to the Pie Town VLBA antenna, and doubles the effective resolution of the VLA. A total of 23 science projects were observed, for approximately 280 hours of successful observing. This included 5 projects, for 62 hours, using a specially installed 74 MHz receiver at Pie Town.

Final testing of the on-line VLA/VLBA/GBT archive was carried out, in preparation for public access to that archive in October 2003. The AIPS data-reduction package has been modified to enable users to load VLA data sets from disk, as they will be available from the archive.

VLA/VLBA Computing was reorganized in order to create a Computing Infrastructure Division and an EVLA Computing Division. This will bring all EVLA computing activities, including monitor & control as well as end-to-end data flow, under a single EVLA management structure. An Interferometry Software Division was formed under joint management of the ALMA Project and VLA/VLBA Operations in order to facilitate communication and common development among the operational interferometers (VLA and VLBA) and the new projects (EVLA and ALMA).

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Central Development Laboratory

A design for a new 1-2 GHz balanced amplifier for the EVLA was completed and fabrication of a prototype began. Ten 40-50 GHz and four 4-12 GHz amplifiers were built for the EVLA.

Successful tests of the ALMA Band 6 SIS mixer-preamp and cartridge test dewars were carried out. For the ALMA Band 6 preamplifiers, which are needed in large quantities, a commercial firm has begun construction of sample amplifiers of the NRAO design for evaluation.

A design study for a new 385-500 GHz SIS mixer with 4-12 GHz IF bandwidth was begun, and a grant was received to build, measure, and compare different type of Hot Electron Bolometer mixers; both projects are in collaboration with the University of Virginia.

Detailed design of a 26-40 GHz feedhorn for the GBT Ka-band receiver was completed, and a prototype was successfully tested. A design for a 26-40 GHz feed for the EVLA was completed.

The 2-antenna prototype ALMA correlator was completed. The design of a multiple-output polyphase filter as an enhancement to the baseline design was completed. Preparations were made to hold the Critical Design Review, which will be the first ALMA hardware CDR.

New power amplifier chips for the ALMA LO system were successfully tested. Measurements indicate that the newly complete active multiplier chains will meet the ALMA sideband noise specification. A mockup of the Band 6 warm cartridge assembly which will be outside the dewar was successfully built. Work continued on evaluating the final frequency multipliers for Band 9.

Work began under an NSF MRI grant to instrument antennas at Green Bank as a solar radio burst spectrometer to provide the solar radiophysics community with a new research tool

Computing and Information Services

The major effort this quarter has been to plan for the installation of networking and phones in preparation for the migration of the CDL staff from the Dynamics Building to the new NRAO Technology Center (NTC). The wiring plan is complete, and will include the infrastructure for Voice over IP and IP telephony.

This past quarter saw several very nasty security problems affecting millions of computers worldwide. Thanks to our Internet router filters, vigilant anti-virus maintenance, focused patching efforts, and the watchfulness of our computer users, the NRAO was almost completely spared. The very popular "Spam Assassin" spam-tagging software was upgraded to a newer, more effective version. Sadly, the producers of e-mail spam seem to be able to stay one step ahead of the ability of SpamAssassin to catch them.

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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 the construction at Edgemont Road in Charlottesville. Service is now available in Charlottesville, and identical hardware for Socorro was delivered in June.

The CIS Division was given a mandate to substantially complete a Common Computing Environment by the end of CY2003. Good progress has been made, and within the year we intend to have all sites providing a standard configuration of operating systems, network services, application software availability, and user interfaces. Continued effort will be required after this time to ensure the sites' environments do not diverge, and to integrate new technology and software.

The NRAO video system is now routinely used to relay scientific and technical colloquia throughout the Observatory. The biggest remaining deficiency, the sound systems in the auditoria, will be addressed over the next few months.

Education and Public Outreach

The doors to the Science Center in Green Bank opened to the public on Memorial Day weekend, and the Center attracted a good attendance in spite of the drop in visitors experienced by other attractions in the area. Installation, improvement, and refinement of new exhibits continued through the summer months. Exhibit topics include pulsar simulation, light waves , mirrors, and a working small-scale replica of the Robert C. Byrd Green Bank Telescope. Construction of the student dorm continued, and significant progress was made during the period. The VLA Visitor center also had good attendance, and the revenue from the new gift shop there exceeded the predictions for the fiscal year.

Summer is a busy time for formal education programs at NRAO. In addition to the NSF Research Experience for Teachers, and the NSF Research Experience for Undergraduates, a Single Dish Summer School was conducted in Green Bank in collaboration with the Arecibo Observatory. There were a Chautauqua program in Socorro and a NRAO/NASA teacher workshop in Green Bank.

NRAO co-sponsors the Enchanted Skies Star Party in new Mexico, and conducts monthly Star Parties in Green Bank. In August, when interest was spurred by the close approach of Mars, 125 persons attended the evening in Green Bank, and 300 persons attended the special session in New Mexico.

Environment, Safety and Security

NRAO worked with officials in Socorro County to formulate an Emergency Preparedness Plan, and a member of the ES&S group has been tasked with providing community liaison. Emergency Services at the VLA is considered part of the plan.

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The focus of ES&S activities was somewhat different at each of the sites. In Socorro the effort was directed to fire protection, and the annual inspection and testing of sprinkler systems and devices was undertaken. The Green Bank site was inspected for hazardous materials and the data base of information on hazardous materials was updated. In Charlottesville the focus was on the preparation of the NTC building, and on the video security surveillance in the Edgemont Road site. A number of improvements to the Charlottesville Communications Plan were identified as a consequence of the visit to the area by Hurricane Isabel.

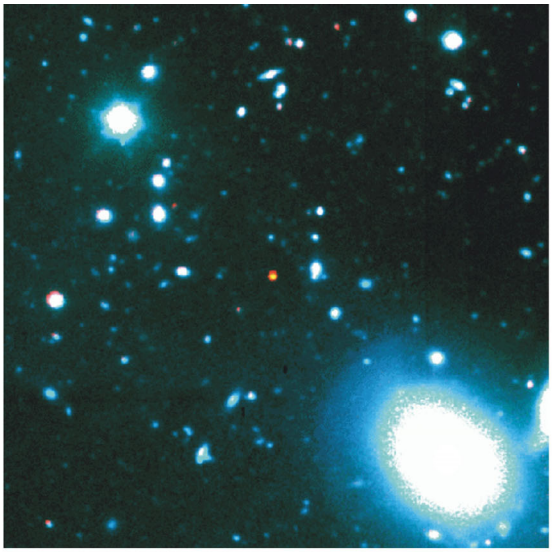
ES&S worked with the EVLA Data Acquisition Group to develop procedures for splicing the fiber optic cables in remote locations along the arms of the VLA.

Science Highlights

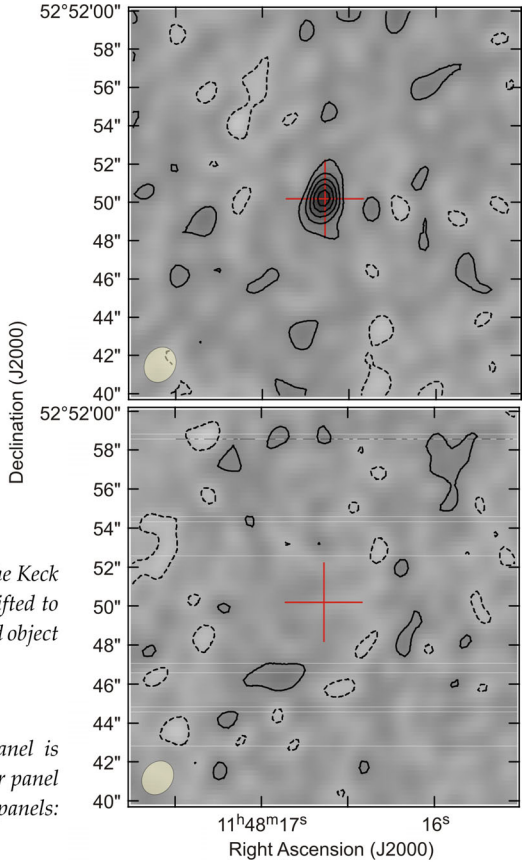
Very Large Array

VLA Detects CO in Most Distant Known Quasar - Astronomers using the VLA to study the most distant quasar yet found in the Universe discovered a massive reservoir of CO gas already present in an object seen as it was only 870 million years after the Big Bang. The quasar, J1148+4251, at a redshift of 6.4, was discovered by the Sloan Digital Sky Survey earlier this year. The amount of CO found indicates that, even at such an early time in the history of the Universe, galaxies already had large reservoirs of molecular gas from which new generations of stars could be formed. The carbon and oxygen forming the CO detected by the VLA in this object had to be formed in the cores of some of the first stars in the Universe, during the Epoch of Reionization.

Investigators**:** F. Walter, C. Carilli and K.Y. Lo of NRAO; F. Bertoldi (MPIfR), P. Cox (Institute of Space Astrophysics, Orsay, France), R. Neri (IRAM), A. Omont (Paris Institute of Astrophysics), K. Menten (MPIfR), X. Fan (Steward Observatory), and Michael Strauss (Princeton).



Above: A true-color optical image of J1148+5251, obtained at the Keck 10-meter telescope. Due to its distance the quasar's light is shifted to redder colors by a factor 7.42, and stands out as an unusually red object in the centre (Keck image by S.G. Djorgovski, Caltech).



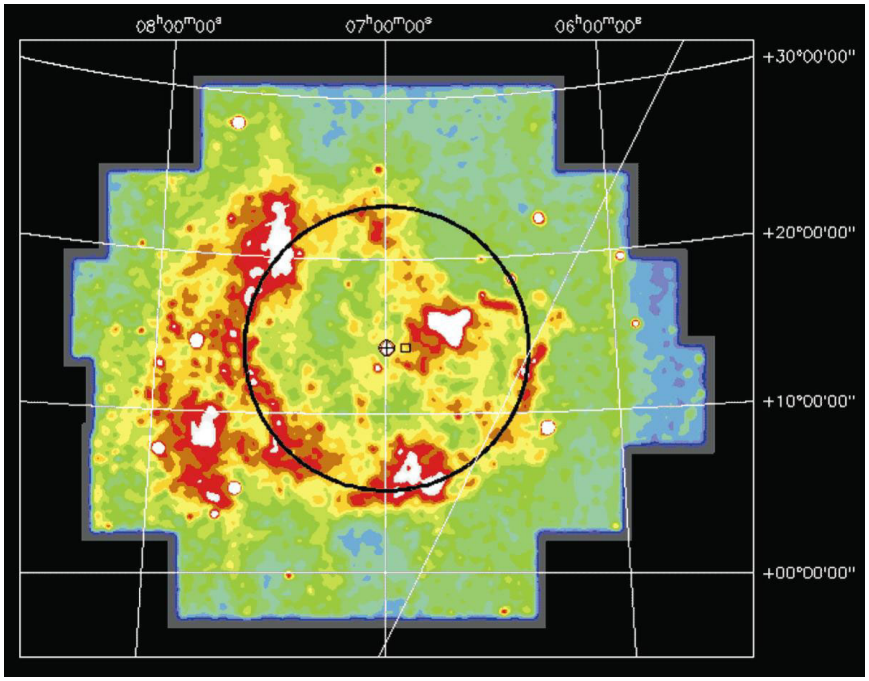
Right: VLA CO(3-2) detection of J1148+5251; the upper panel is the CO(32) line at 46.6 GHz (line strength: 0.6 mJy); the lower panel is a continuum image at this frequency (rms in both panels: 0.05 mJy/beam).

Science Highlights

Very Large Baseline Array

VLBA Distance Measurement Solves Astrophysical Mysteries **-** A team of observers used the unique ability of the VLBA to do ultra-precise astrometry of a pulsar to measure its parallax, thus resolving questions about its origin and also possibly solving a mystery about the energy distribution of cosmic rays. The VLBA parallax measurement resolved a dispute about the distance of pulsar B0656+14, placing it at essentially the same distance as the Monogem Ring supernova remnant, supporting the association of the two. With this resolved, B0656+14 and the Monogem Ring appear to be at the proper distance and the correct age to account for an excess of cosmic rays at a specific energy.

Investigators: W. Brisken (NRAO), S. Thorsett (UC Santa Cruz), A. Golden (National University of Ireland), R. Benjamin (Wisconsin), and W.M. Goss (NRAO).



The Monogem ring, as seen in the ROSAT all-sky survey. The Galactic plane is shown with a diagonal line, the current pulsar position is marked with cross hairs, and a 9.2 degree circle is shown centered on this point to illustrate the primary ring structure. Image copyright by the AAS, used with permission; ROSAT all-sky survey data were processed at MPE.

Science Highlights

Green Bank

GBT Discovery of Two Binary Millisecond Pulsars in the Globular Cluster M30 - Investigators have reported the discovery of two binary millisecond pulsars in the core-collapsed globular cluster M30 using the Green Bank Telescope (GBT) at 20 cm. PSR J2140-2310A (M30A) is an eclipsing 11-ms pulsar in a 4-hr circular orbit and PSR J2140-23B (M30B) is a 13-ms pulsar in an as yet undetermined but most likely highly eccentric (e>0.5) and relativistic orbit. Timing observations of M30A with a 20-month baseline have provided precise determinations of the pulsar's position, and spin and orbital parameters, which constrain the mass of the companion star. The position of M30A is coincident with a possible thermal X-ray point source found in archival Chandra data which is most likely due to emission from hot polar caps on the neutron star. Future observations of M30 may allow both the measurement of post-Keplerian orbital parameters from M30B and the detection of new pulsars due to the effects of strong diffractive scintillation.

Investigators: Scott M. Ransom (McGill/MIT), Ingrid H. Stairs (UBC),Donald C. Backer (UC Berkeley), Lincoln J. Greenhill (CfA), Cees G. Bassa (Utrecht Univ.), Jason W. T. Hessels (McGill), Victoria M. Kaspi (McGill/MIT)

ALMA

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

Evaluation of the prototype antenna from VertexRSI continues at the ATF site located at the VLA. After a very successful session of holographic measurements to set the panel surface, detailed evaluation of the pointing performance of the antenna has begun. Early problems with the contractor supplied pointing software delayed the completion of the pointing evaluation. The contractor returned to the site in September and has completed the necessary corrections to their software and pointing evaluation has resumed using the optical pointing telescope. Preparations for radiometric evaluation will begin in early October. A report of the evaluation of the VertexRSI antenna will be complete by January 2004.

The ALMA project has developed a coordinated antenna procurement strategy that establishes the framework that allows each Executive (AUI and ESO) to follow their respective procurement practices while working together to insure that the overall goals of the project are met. The procurement strategy is designed to meet the following requirements:

- Procure a total of 64 antennas, 32 by each Executive.
- Procure antennas that meet all of the requirements set forth in the Technical Specification and applicable Interface Control Documents.
- Procure antennas that are based on a selected design that has been thoroughly evaluated by testing an ALMA Prototype Antenna at the ALMA Test Facility in New Mexico. This means that the antennas procured by each Executive should follow the same design.
- Maintain competition in the procurement process to insure a low price.
- Insure that the resulting production contract(s) hold the vendor(s) responsible for meeting the specifications.

A preliminary Inquiry was sent to industry in September to solicit interest in receiving the Request For Proposal. Two Industry briefings will be held in October; one in Europe and one in North America. The RFP is scheduled for release at the end of October.

Fabrication of the two antenna prototype Correlator has been completed. Software integration with the Correlator is in progress. The prototype Correlator is scheduled to be shipped to the ATF in December 2003. The Critical Design Review for the production Correlator is scheduled for early October. After the CDR, production contracts for the fabrication and assembly of the various boards required for the Correlator will be let.

ALMA

A meeting was held in Richmond Virginia in September attended by the senior staff of all IPTs from both North America and Europe. This "mini ALMA week" provided a significant opportunity for advanced planning for all parts of the project. Special topics discussed included operations planning, construction milestones and their dependencies, OSF architectural concepts and planning for the upcoming ALMA Management Advisory Committee meeting in October.

Expanded Very Large Array

Expanded Very Large Array Highlights

The second meeting of the EVLA External Advisory Committee took place. Initial outfitting of the EVLA Test Antenna was completed and the antenna was moved from the Antenna Assembly Building to the Master Pad for further outfitting and testing. Installation of the fiber-optic cable was completed on the West and East arms and continues on the North arm well ahead of schedule. In situ tests of the phase stability of the fiber were commenced. Reorganization of the management structure of the e2e and AIPS++ software work for the EVLA was completed.

Expanded Very Large Array Progress

Milestones	Original Date	Revised Date	Date Completed
EVLA post processing requirements	07/03/03		07/03/03
C-band receiver drawings finished – components ordered	05/31/03		07/09/03
Archive ready for test antenna	06/30/03	07/07/03	07/14/03
Backend Alpha Version Production Code	06/27/03	07/14/03	07/15/03
Begin MIB/module integration H/W & S/W	02/24/03	07/15/03	07/15/03
Sampler/DTS module assembled	07/22/03		07/18/03
MIB Application Framework	04/30/03		07/21/03
Install new C-rack into test antenna	07/21/03		07/21/03
L350 ICDs due for MIB software	11/22/02	07/14/03	07/21/03
Take delivery of the 50 GHz vector network analyzer	09/31/03		07/22/03
Schematics of card cage control card	09/15/03		07/22/03
L304 LO reference receiver module assembled	07/17/03		07/24/03
L-band receiver drawings to drafting	07/21/03		07/25/03
Assemble and test RFI tight G and H-racks	07/25/03		07/25/03
Start MIB board assembly	07/22/03		07/30/03
Repair feed horn ring machine	07/30/03		07/30/03
Order & start assembly 2nd iteration MIB board	07/22/03		07/31/03
Model the performance of all EVLA receivers to determine the predicted noise figure and dynamic range	07/31/03		07/31/03
Verify that the performance of Zote Foam LD33 is acceptable for the L, S, and C band RF window	08/15/03		07/31/03
Deformatter assembled for test antenna	03/07/03	07/31/03	07/31/03
Feed cone housing on test antenna	08/01/03		08/01/03
Install DC power onto test antenna	08/01/03		08/01/03

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
Move antenna 13 to master pad	08/01/03		08/01/03
Engineering software requirements	07/11/03		08/06/03
Electronic racks on test antenna	08/06/03		08/06/03
Fiber cable wrap installed on test antenna	04/07/03		08/08/03
Test antenna on master pad	08/11/03		08/11/03
L352 RTP bench integration complete	08/11/03		08/11/03
Ka-band feed prototype drawings available	04/24/03	08/11/03	08/11/03
Alpha testing of the correlator backend	06/30/03	07/14/03	08/15/03
Start RTP testing - antenna to CB	08/28/03		08/18/03
Start RTP testing on antenna	08/28/03		08/18/03
X-band feed on test antenna	08/21/03		08/21/03
Ka-band feed prototype drawings	08/11/03		08/22/03
G & H-racks installed on test antenna	08/06/03		08/27/03
Project Book chapters updated	08/15/03		08/27/03
Fiber optic cable installed on test antenna	08/16/03		08/27/03
LO/FE racks installed on test antenna	08/05/03		08/28/03
X-band receiver installed	08/28/03		08/28/03
L301 synthesizer modules assembled	07/23/03		08/29/03
Science requirements/engineering specifications audit	07/31/03		08/29/03
Sampler/DTS module assembled	08/25/03		08/29/03
L302 synthesizer assembled - ready for MIB	08/29/03		08/29/03
MIB software installed on L301 synthesizer	08/29/03		08/29/03
Establish and verify the schedule for LNA delivery from CDL	08/30/03		08/30/03
C-band feed horn assembly structure	08/30/03		08/30/03
L-band feed horn assembly structure	03/31/03	08/30/03	08/30/03
Design the prototype L and C band OMTs	08/31/03		08/31/03
Purchase initial computing platforms for embryonic hybrid array control	07/31/03		09/08/03
Prepare U/X converter specification and issue prototype contract	09/08/03		09/08/03
Optical RTP CB to VR tested	09/03/03		09/09/03
Advisory Committee Meeting	09/08/03		09/09/03
T304 downconverter module assembled	08/08/03		09/12/03
L301 synthesizer w/MIB tested	08/29/03		09/12/03
Card cage bias card layout	09/08/03		09/12/03
L351 offset generator ready to install	09/17/03		09/17/03
Prepare MIB specification and issue assembly contract	09/18/03		09/18/03

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
Begin L-band feed horn assembly	07/01/03		09/22/03
Issue draft FY2004 Budget/plan	09/19/03		09/23/03
L305 antenna reference gen/distr bench prototype assembled	12/03/02	07/25/03	09/26/03
Draft correlator M&C software design	02/28/03	09/30/03	09/26/03
L304 LO/reference receiver ready for test antenna	09/17/03		09/29/03
Examine antenna HW module readiness	07/31/03		09/30/03
L301 synthesizer module ready for test antenna	09/17/03		09/30/03
Draft EVLA CMIB drive manual	09/30/03		09/30/03
New M&C system on test antenna ready for start of array tests	08/29/03	10/10/03	
Antenna fiber internal review	07/23/03	10/15/03	
L353 LO transmitter prototype assembled & tested	07/23/03	10/15/03	
Band switches assembled	08/20/03	10/17/03	
Start L354 Central reference distributor bench prototype	01/17/03	10/20/03	
Complete hardware bench integration	03/03/03	10/22/03	
Software requirements for real-time system	08/29/03	10/27/03	
Configure EVLA computing infrastructure	03/31/03	10/31/03	
Establish NRAO-NM VPN capability	06/30/03	10/31/03	
Configure computing infrastructure	03/31/03	10/31/03	
Ka-band receiver design completed/ ready for drafting	02/05/03	11/14/03	
Start new M&C system on test antenna	07/25/03	11/19/03	
High level EVLA M&C functional specification	10/01/02	11/28/03	
Re-scoping of EVLA M&C software effort after computing reorganization	09/30/03	11/30/03	
C-rack RFI cable modifications made	10/02/03		
Test antenna MCB Ethernet operational	10/03/03		
MIB software installed on L302 synthesizer	10/03/03		
Antenna 48V DC power available	10/03/03		
Start fiber cable trenching on north arm	10/06/03		
L302 synthesizer ready for test antenna	10/08/03		
ACU/FR controller interface assembled and ready for MIB	10/08/03		
P301 & P302 power supplies ready for MIB	10/09/03		
Master LO power supplies built and tested	10/13/03		
Test antenna power supplies built and tested	10/14/03		
2nd DTS/Sampler power supply board assembled	10/15/03		
L353 LO transmitter prototype assembled	10/15/03		
L-band OMT prototype assembled and ready to test	10/17/03		
Antenna vertex room HVAC system functioning	10/17/03		

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
4/P-Band converter module ready for test antenna	10/24/03		
M301 converter interface prototype assembled	10/24/03		
RTP stability tests w/ antenna moving	10/24/03		
L320 FE transition prototype assembled	10/24/03		
L305 reference gen/distr module ready for MIB	10/24/03		
L352 RTP module w/MIB tested	10/30/03		
L350 reference generator ready for MIB	10/30/03		
T304 downconverter module ready for MIB	10/31/03		
L353 LO transmitter module ready for MIB	10/31/03		
Review of overall computing design alternatives	11/01/03		
Test of samplers, DTS and D/As	11/03/03		
Check for interference and bandpass shapes: 8GHz and 328MHz	11/07/03		
Test antenna module and rack assemblies complete	11/07/03		
Ka-Band receiver design ready for drafting	11/14/03		
U/X converter ready for test antenna	11/14/03		
M301 converter module ready for MIB	11/14/03		
F317 FE controller prototype assembled	11/17/03		
K-Band receiver on test antenna	11/20/03		
Level 2 schedule updates completed	11/21/03		
Integrated EVLA computing priorities established	11/21/03		
e2e system requirement specifications under revision control	11/24/03		
L-Band transition receiver ready for test antenna	11/26/03		
Q-Band receiver on test antenna	12/01/03		
L-Band feed horn prototype assembled and ready for testing	12/04/03		
Check for interference and bandpass shapes: 45GHz	12/08/03		
e2e observing scripts for test antenna observations	12/12/03		
L354 LO driver prototype assembled	12/18/03		
Check for interference and bandpass shapes 22GHz	12/19/03		
Receiver stability tests: 8, 22 and 45GHz	12/19/03		
Re-evaluation & iteration upon M&C Technical architecture	12/29/03		
High level diagrams of stages of hybrid array control system	08/15/03	01/31/04	
Software development plan for hybrid array control system	09/15/03	02/02/04	
EVLA Computing Overall Design	03/01/04		
Functional and technical overall EVLA M&C architectural design	04/01/04		

Expanded Very Large Array

Management

The Project Book chapters were brought up to date. An audit of the science requirements versus engineering specifications was performed and no significant disagreements between the two were found. The budget plan for the 2004 fiscal year was prepared. The EVLA External Advisory Committee met on 8-9 September to review the status of the whole project. All of the material presented to the Committee is available on-line at http://www.aoc.nrao.edu/evla/admin/advcom/advcom2/03advcom.html. GPRA data were generated for reporting 2003 earned value and 2004 predictions. The Mexican partners are negotiating to bid one of the integrated electronic modules. If successful, this will establish a process by which to spend their contributed funds.

Systems Integration

Bench testing of remaining prototype and some of the completely assembled electronic modules continued. The power supplies needed for both the antenna and the Master LO systems are built and ready for Module Interface Board (MIB) software development. Most of the hardware interface control documents written to develop the MIB software for the devices are complete. Good progress has been made toward completing the build of module enclosures for the test antenna. Several assembled hardware modules have undergone RFI testing.

Civil Construction

Installation of the fiber-optic cable along the arms of the VLA continues to go well. By the end of the quarter, installation on the East arm was complete after successfully cutting through the rocky terrain at the end of the arm. The fiber installation is now 70% complete and several months ahead of schedule.

Antenna

The structural modifications required for the EVLA design are complete on antenna 13, the EVLA Test Antenna. The Feed Cone, the prototype AZ cable wrap, the main 48V DC power supply that drives the electronic modules and the vertex room HVAC equipment were installed. Air ducts to the LO and F-rack were fabricated and installed. Electrical distribution throughout the vertex room has commenced. Antenna 13 was moved from the Antenna Assembly Building to the Master Pad, where remaining outfitting and testing will take place.

Front End

The fabrication of rings, which make up the L-Band (20 cm) feed horn commenced. Design work on the L-band OMT finished and the machine shop started making the initial quadridge sections. One of the existing X-band (4 cm) receivers was installed on antenna 13. The addition of cryogenics lines running from outside compressors to the vertex room on antenna 13 has begun.

Expanded Very Large Array

Local Oscillator (LO)

Most of the LO modules are assembled and ready for a Module Interface Board (MIB). The 12-20GHz synthesizer is functioning with a MIB. The LO rack was installed on antenna 13. The MIB and software to run the 10.8-14.8GHz synthesizer are installed in the module and being tested.

Fiber Optics

The outfitting of fiber on the test antenna is complete. Round trip phase testing of the fiber is on-going. The assembly of one of the two DTS/sampler modules is complete. The module is undergoing testing. Assembly of the other DTS/sampler and the LO transmitter prototype has started. Testing of the phase stability performance of the fiber, both under the ground and in the antenna was started.

Intermediate Frequency System

A downconverter was installed on antenna 13 to prepare for X-band receiver tests. The design specifications of the integrated version of the U/X converter was finalized and sent out for bids. A contract was awarded to build the U/X converter prototype.

Correlator

The Canadian Partner announced that the Canadian Treasury Board approved the budget submittal of $C 20M over 5 years. The correlator chip digital design and manufacturer's feasibility testing was done. Development of an RFP for the correlator chip commenced. The correlator WBS was defined, and the level of effort estimate for near term tasks completed. The detail scheduling effort continued. The TIME CODE board and TIME CODE backplane schematic design was completed. Design and bench-test of the recirculation controller is complete and debugging of its functionality started. A position has been filled to work on correlator chip cases, simulations and writing reports.

Monitor and Control (M/C)

Construction of transition modules, required to monitor and control some of the old VLA hardware using the new M/C system, continued. With the functionality of the MIB demonstrated, work is now focused on developing software to run the various hardware modules. The M/C software written for one of the LO synthesizers is complete.

Expanded Very Large Array

Data Management and Computing

Reorganization of the management structure of the AIPS++ and End-to-End (e2e) software activities was completed. The M/C and e2e activities required for the EVLA are now combined together in a new single Division called the EVLA Computing Division. Gustaaf van Moorsel has been appointed Division Head of this Division. The AIPS++ work has been moved into a new division called the Interferometry Software Division which is jointly headed by Jim Ulvestad for EVLA/VLA/VLBA activities and Brian Glendenning for ALMA activities. The data archive was prepared to accept both astronomical and M/C data from the EVLA Test Antenna.

Green Bank Telescope

Green Bank Technical Highlights

Antenna Temperature Sensor System – A new system to monitor the temperature of key points on the GBT structure was successfully installed in the 3rd quarter, on time and within budget. The system is part of the Precision Telescope Control System project, which will provide effective operation of the GBT in the 3 mm wavelength band. The goal of the temperature sensor project is to characterize the effects of thermal gradients on telescope pointing, focus, and surface accuracy through careful correlation with observational data. Initial results show that the measured pointing and focus offsets within a single commissioning session can be fit accurately by linear combinations of temperature sensor data. Further work is underway to extend the predictive capability of the models to different data sets.

GBT Antenna & Operations

Milestone	Original Deadline	Revised Deadline	Date Completed
Azimuth Track Project Inspection of GBT welds/structure	06/30/02	09/30/03	09/25/03
Complete Phase I of track analysis	07/31/03		07/18/03
Complete Phase II of track analysis	10/31/03	12/19/03	
Complete Retrofit trial period	12/31/03		
Complete Development of new rail concepts	12/31/03		
Hold Review Panel Meeting	01/31/04		

GBT Electronics

Milestone	Original Deadline	Revised Deadline	Date Completed
K Band receiver upgrade	09/30/03		09/30/03
Spectrometer Upgrades: Spigot Card Expert Mode released	02/28/03	12/01/03	
High Speed Sampler Upgrades	01/30/03	12/01/03	
Cross-correlation/polz. test fixture designed	01/01/04		
Cross-correlation/polz. test fixture constructed	03/01/04		
Begin polarization mode checkouts	04/01/04		
DMA error fixes	12/01/03		

Green Bank Telescope

Milestone	Original Deadline	Revised Deadline	Date Completed
LTA redesign (engineering only)	04/01/04		
Sample distributor redesign (engineering)	08/01/04		
RFI Improvements: Finish LO Receiver Module RFI retrofit	10/15/03		
Finish GBT Receiver room HVAC suppression	12/01/03		
Complete anechoic chamber upgrades	01/01/04		

GBT Mechanical Engineering and Central Instrument Shop Work

Milestone	Original Deadline	Revised Deadline	Date Completed
Ka band feed for GB (Re-designed)	05/30/03	07/15/03	07/30/03
ALMA Module boxes	07/08/03		07/01/03
Ku Band Phase shifter mandrel (4)	09/04/03		08/26/03
VLA K-band front-ends (5)	07/25/03	10/15/03	
Ku Circular – Rectangular transition	11/08/03		
Penn Array Dewar	12/03/03		

GBT Software and Computing

Milestone	Original Deadline	Revised Deadline	Date Completed
Visiting observers infrastructure & facilities	06/30/01	08/31/03	
Institute Software Customer Satisfaction Surveys	06/30/03	08/31/03	
M&C v3.15	07/02/03	07/09/03	07/09/03
M&C v3.16	08/20/03		08/20/03
M&C v3.17	10/01/03		09/29/03
M&C v3.18	11/04/03		
M&C v3.19	12/30/03		

GBT Projects

Milestone	Original Deadline	Revised Deadline	Date Completed
PTCS			
In-progress review	10/6/03	12/03/03	
Feedarm tip trilateration experiment	8/15/03		09/05/03
Antenna temperature sensor installation complete	8/15/03		08/05/03
Ready for Q-band observing	9/30/03	11/12/03	
Ease of use			
Release configuration Tool for general use	12/30/03		
First prototype GO replacement	12/31/03		
Data Handling			
GBT/Class interface	12/31/03		
Generate requirements for Imaging	12/31/03		
Analysis Conceptual Design Review	02/09/04		
Spectral Baselines			
Complete evaluation of Ku Thermal Transition	11/01/03		
Install improved feed defroster	01/01/04		
Begin installation of IF fixes	01/01/04		
Ka-Band (1 cm) Rx			
Complete assembly of 1 cm receiver	11/01/03		
Test 1 cm receiver in laboratory, work out any problems	01/01/04		
Complete assembly of common MM converter prototype and evaluate performance. Refine design if necessary	01/01/04		
Begin design of production system packaging, M&C, and begin fabrication of common MM converter	11/01/03		
Penn Array Receiver: Hold CDR	10/18/03		
Finish final dewar construction	12/03/03		

Green Bank Telescope

Milestone	Original Deadline	Revised Deadline	Date Completed
3 mm Receiver: Restart Project	11/15/03		
Revise Project Plan	12/01/03		
Prepare Budget request for FY2004	12/31/03		
Caltech Continuum Backend: Hold CDR in Green Bank	12/15/03		
Complete FITS spec.	12/31/03		
Determine if DBSWITCH suffices as primary photometry mode or specify new antenna mode if needed	12/31/03		
Revisit and finalize Configuration/Use scenarios	12/31/03		
Specify direction for CCB data analysis	12/31/03		

Astronomy Education Center Project

Milestone	Original Deadline	Revised Deadline	Date Completed
SC main building informal opening	05/24/03	05/24/03	05/24/03
SC main building construction complete	10/15/02	10/28/03	
SC dormitory construction complete	07/18/03	11/30/03	

GBT Commissioning and Observing Activities

Several new observing capabilities were added during the third quarter of 2003. The K-band receiver upper frequency band (22-26 GHz) was upgraded with new CDL Indium-Phosphide amplifiers that substantially lower the noise temperature in that band. The Prime Focus 2 (PF2) receiver, which covers the 900-1200 MHz band, was commissioned and is now available for use. This quarter also marked the first significant set of polarimetry observations with the GBT using the Spectral Processor backend. The new pulsar Spigot Mode of the Spectrometer, which allows up to 800 MHz analysis bandwidths, also saw first astronomical results. This capability substantially increases the sensitivity of pulsar observing. The Interference Protection Group made significant improvements in the low frequency RFI environment at the GBT through suppression of RFI from sources on site and in the surrounding community.

About half of the total telescope time was scheduled for astronomical observations, with the remaining half used for tests, program checkouts, and scheduled maintenance. The 3rd Quarter was a

heavy maintenance period owing to structural inspections and painting. Maintenance time drops to three days per week in the 4th Quarter and will be two days per week in the 1st Quarter of 2004.

A High Frequency Science Workshop was held in Green Bank in early September. The workshop examined both the scientific and instrumentation potential of the GBT in the 20-115 GHz frequency range. The workshop was well-attended by both external and internal participants, all of whom were extremely enthusiastic over the scientific possibilities of the GBT at higher frequencies.

The focus of azimuth track work in the past quarter was on continuation of the field trial of the Splice 45 retrofit, and on finite element analysis performed by an outside contractor (SG&H). The engineering firm of Modjeski & Masters conducted an inspection of the critical structural members of GBT elevation tipping structure during the summer. Inspections will continue next summer. The painting program for the GBT structure also continued.

The past quarter has been a very active period for project work to enhance GBT performance. A new project management system was put into place which is working quite efficiently. Based on the long-term strategic plan and a six month forward look, development cycles are organized into 6-week periods, each of which have clear deliverables. The top priority development projects are the Azimuth Track upgrade, the Ease of Use initiative, Data Handling project, Spectral Baseline improvement project, and the Precision Telescope Control System for 3 mm observing. Other development projects include the Ka-band Receiver, Penn Array Camera, Caltech Continuum Backends, 3 mm Receiver, and Pulsar Spigot Mode of the Spectrometers.

Further details on these activities appear below.

High Frequency Science Workshop

On the 8th and 9th of September we held a workshop in Green Bank to discuss future high frequency science with the GBT. We managed to attract a set of high-profile participants from both the University community and from within the NRAO, with a total attendance of just under 50. There was clear interest in the high-frequency capabilities of the GBT. Some key areas interest were:

- high surface-brightness sensitivity with good resolution, for mapping of distant SZ clusters, Galactic star forming regions, and nearby galaxies (in both continuum and spectral-line);
- wideband spectroscopy to determine redshifts of star-forming galaxies;
- wideband spectroscopy at higher resolution for astrochemical studies, for instance of low-mass protostars;
- deep large-area continuum surveys at mm wavelengths for studies of high- redshift galaxies;
- sensitive pointed photometry to support small-scale CMB anisotropy measurements (intensity and polarization) with other instruments;

- the complementarity of the GBT at 3mm to many planned submm/far-IR instruments (SIRTF, SOFIA, SCUBA-II, etc)

Low-resolution wideband spectroscopy is a particularly attractive capability since the technology is well-developed and the backend could be usefully used at a range of frequencies starting at those currently accessible with the GBT (K or Ka band). We are exploring possibilities for construction of such a backend.

Azimuth Track

As detailed in the previous quarter's report, the test period for the trial modification continues. The joint has been stable, as indicated by wheel tilt measurements. Some wear was seen on the wear plate trial geometries, and will be checked again at the end of the fourth quarter. The Teflon-bronze shimming material has been effective at mitigating fretting and appears to have a lifetime of about one year. The zinc shimming material, in contrast, has proven ineffective; nearly all of the joints shimmed with zinc have been re-shimmed with the better performing Teflon-bronze material.

No propagation of the remaining wear plate cracks has been found. Four spare plates are on hand if any plates do experience a significant crack as cold weather arrives. If we begin to use these plates as replacements, we will place an order for more.

Phase 1 of the finite element analysis was deemed satisfactory, and the firm of Simpson, Gumpertz, and Heger has begun work on the three-dimensional, quasi-dynamic model. This phase will include the original design, modeling of the partially welded joint, increase in bolt tension, and will also examine if a one-piece, continuous track model holds promise. Completion of Phase 2 is not expected until mid-December.

An information search of material properties that may be suitable for either a new track construction, or at least replacement of the existing wear plates, has expanded to about 30 materials. In addition to physical properties, the ability to consistently manufacture the materials in the shapes needed, and the life cycle costs for the materials are being considered.

GBT Operations and Maintenance

Telescope Operations Activities

The firm of Modjeski and Masters inspected the critical members of the tipping structure, elevation shaft, and counterweight during this quarter. Fatigue-type cracks were found in the members of the front walkway at the elevation bearing level, and in a seal weld on a cover of the counter weight. Repairs of these items are in progress as of this writing. Cracks were also found in the welds joining the elevation stub shafts to their stiffener plates. The nature of these cracks is still under investigation. A

thorough ultrasonic inspection was made of these welds with significant assistance from Modjeski and Masters and a structural fatigue expert. A measurement of the strains in this assembly is scheduled for late October, and remediation of the defects will be based on the outcome of these measurements. The new structural engineer will be tasked to develop a finite element model of this assembly upon his starting date.

Efforts to further tune the elevation and azimuth servomotor control system to meet design specifications started in the second quarter and continued through this quarter. In conjunction with this effort, tuning of the telescope emergency power system and autostow program is also in progress. Further tests and tuning of these systems will continue into the fourth quarter.

Some bearing wear has been detected in the azimuth wheel bearings. An internal inspection revealed areas of the outer race that were not greased, directly behind the trailing edge of the bearing rollers. The bearing manufacturers and lubrication engineers were consulted, and the apparent root cause is inadequate viscosity to allow the lubricant to maintain a thin film between the roller and the race. A trial change from grease to oil lubrication is in progress. The oil is a very high viscosity oil, used in similar slow, partial-arc revolving machinery. A set of trial shaft seals, more suitable to oil service, have been ordered, and will be installed and monitored during the fourth quarter.

Achievement of the year's goal for painting of the GBT was severely hampered by rain and the structural inspection. Still, about 80% of the alidade access stairway was painted, and painting of the lower portions of the vertical feed arm began after the inspection. Most of the walkway grating sections on the alidade were also removed and inspected, fasteners replaced or tightened, and structural members painted as well. Other items included both generators, the load center and motor generator set, and conduit and cable tray fasteners.

The Operations Group also completed some rearrangements of the GBT Warehouse building to transform it to a GBT Maintenance Building. Improvements were made to tool and material storage areas, the lockout/tagout station, and the operator office was relocated to the larger room. The lightning detector used during construction was also put back in service, and a new commercial lightning detector system was placed in service in the GBT Control Room in the Jansky Laboratory.

GBT Electronics - Digital Group

PTCS Work

Support was provided to the PTCS Project at the level of about 4 FTE's. These support activities ranged from system design, electronics design and experimental support to active surface development.

Green Bank Telescope

Spectrometer work

We continue to commission and repair the GBT spectrometer. We are plagued by failures in the Long Term Accumulator (LTA) cards that are intermittent and/or slot dependent. A significant effort this quarter was the upgrade of the CPU clocks on the LTA's and the system monitor cards to 32 MHz. This was necessary because the firmware disabled interrupts for longer than a character time, resulting in lost characters on the serial port. This in turn led to unreliable operation. The LTA upgrade also seems to have helped the DMA timeout problems, which were due to the LTA not delivering data to the VME bus before the system timed out.

We are also supporting the testing and verification of new modes. The Pulsar Spigot card testing continues. Several of the spigot card modes were tested, with more to be done. We have experienced firmware problems with these cards as well, which have been solved as they have been discovered. The Spigot card has been used in observations in parallel with the BCPM; measured pulse shapes and noise levels agreed well with the BCPM. Testing and verification will continue throughout the quarter. The Spigot card is being run in "expert" mode, that is, manually set up, manual data collection and coordination. It is not ready for general use.

High-speed sampler modifications are underway to eliminate noise on the 1.6 GHz sampling clock. The modifications have begun, but testing the first article has revealed some problems with the modification. These problems will be solved the coming quarter, and the high speed samplers will be upgraded.

We are working on a design for a new test fixture to allow signals of known properties to be injected into the spectrometer for testing. Our current test fixture was cobbled together from junkbox parts, and has a few problems. The new test fixture will also support polarization cross product testing. This work will continue at a low level throughout this quarter.

Software requirements covering both the native spectrometer pulsar mode and the spigot mode were written.

About 2.5 FTE have been spent on the spectrometer over this quarter. We expect this to continue for the next quarter.

Good progress has been made on some reliability issues. Only two hardware related failures occurred this quarter: a blown up capacitor and what appeared to be a contact failure in one of the sampler backplane connectors (this is another gold/tin interface!) This is certainly getting to the tolerable level. Also, in project check-outs, we have seen no DMA failures since the 32 MHz upgrade of the LTA and system monitor cards.

Antenna Support

The Digital group also provided engineering and technicians to the antenna electrical system and the antenna servo systems. This quarter 1 FTE was supplied.

Network and Infrastructure Support

Support was provided to maintain printers, connectorize fiber optic cables, move computing equipment, and so forth. About 0.5 FTE is assigned to this task.

GBT Electronics - Microwave Group

In addition to the development projects, the microwave group has been at work on a number of other things.

Antenna Range Support

The new indoor anechoic chamber antenna range hardware was installed, aligned and calibrated. It was used this quarter to measure a Ka band feed. This measurement was repeated at MIT Lincoln Labs, and agreement between the ranges was good. The outdoor antenna range is being upgraded with better positioners and software. This upgrade should complete this quarter.

PF 2 receiver

The receiver was commissioned this past quarter, and performed well. The PF2 band has some fairly bad RFI from airborne and satellite sources, and so careful attention to observing frequency is required.

IF/LO systems

A method of increasing the power output of the Gigatronics LO2 synthesizers was investigated. These modifications have begun, and will be completed this quarter. This will increase the drive power at the converter modules, and should help with baseline stability. Work continued on a MMIC-based IF amplifier. Prototypes have been built, and work. These amplifiers will go into production for GBT use this quarter.

Cryogenics

Routine support for the GBT and CDL was supplied by the cryogenics team. Refrigerators in several receivers were rebuilt, compressors maintained and repaired. The GB Cryo team has begun

installing helium lines in the new NRAO Technology Center building in Charlottesville. This is an extensive job that will consume several weeks of time.

K-band Receiver

During the summer, extensive work on the GBT 18-26 GHz front-end was completed. New InP cryogenic amplifiers supplied by CDL were installed, requiring complete rewiring of the dewar to incorporate diode protection circuitry. In support of this amplifier upgrade and for future receive construction, a new HFET bias card supporting up to six HFET stages was designed and built using surface-mount component technology. The new amplifiers provide significantly lower receiver temperatures above 22 GHz.

GBT Electronics - RFI Group

RFI Suppression:

After a bit of investigation and planning, the RFI group led an effort to install RFI screen assemblies on the GBT active surface electronics. After installing the screens, which were designed and built as a part of the GBT project, RFI from the active surface electronics is no longer present in RFI scans and should no longer be a problem for Observers.

After identifying the LO receiver module as a contributor to Observer RFI complaints, a RFI retrofit of the module was undertaken. Bench testing indicates the retrofit was successful and the unit will be installed and tested on the GBT in the short term.

In support of pulsar Observers, the RFI group spent some time in the community suppressing power line, cable TV, electric fence, and street light RFI during the quarter. To increase efficiency, some new instrumentation was developed to accomplish this.

A plan to mitigate most of the remaining RFI risks in the new Science Center was developed.

The overhaul of the windows and doors in the Jansky Lab shielded rooms was completed, but issues in the floor shielding seems to be limiting the total shielding effectiveness. Work to deal with this has begun. Acrylite covers are being fabricated and installed on the windows to prevent condensation and future degradation.

The Boltek lightening detector, with RFI fixes, was installed in the GBT control room.

After being identified as a shielding effectiveness weak spot in the roof of the GBT receiver room, the Q Band receiver is being modified to reduce RFI leakage.

NRQZ Administration:

Sixteen requests for the preliminary evaluation of 49 transmitter sites were completed. 37 regular applications for 70 transmitter sites were completed and 19 applications from the Nextel Partners backlog were approved. ERPd restrictions were requested on 6 transmitter sites. 7 site inspections were conducted.

Anechoic Chamber:

Four items were tested for harmful emissions and reports were provided. Upgrades to improve the efficiency and accuracy of our anechoic chamber testing were implemented and will continue in the forth quarter.

Other:

Various members of the RFI group participated in meetings and hosted site visits to nurture our relationship with other spectrum users and the general public.

The report on the Chajnantor Chile RFI Survey (ALMA memo 470) was completed.

Members of the group provided direct support to Observers, by participating in 10 pre-observation RFI scans and three dedicated RFI scans. They also conducted research and responded to many Observer requests for RFI information for the 300 MHz to 10.1 GHz range.

GBT Mechanical Engineering Development

The Mechanical Engineering (ME) Division has been working closely with the Operations Division on track evaluation. The second quarter saw the installation of the track modification outlined by the review panel and monitoring will be ongoing at least through the winter. The ME division this quarter will also continue to identify and evaluate possible materials for use in improvements. In addition this quarter the Mechanical and Operations Divisions will address the problems with the elevation shaft. Work continues on the PTCS with the ME Division providing design support for various devices including the Quadrant Detector and the Temperature Monitoring System.

In the Central Instrument Shop the third quarter saw completion of challenging Ka band phase shifter mandrels for the GBT. The shop also fabricated enclosures and other hardware for the PTCS Temperature Monitoring System. The fourth quarter will see the completion of the Penn Array dewar and continued work on the Ka band receiver.

Green Bank Software Development and Computing

GBT Software Development Infrastructure & Operations

In late Q2 2003, the Software Development Division (SDD) became the Single Dish Software Development Integrated Product Team (SDD IPT), as it was expanded to become a more diverse group of software engineers and astronomers from both telescope control and data analysis disciplines. The combined team started jointly executing work in Q3 2003. At this time a standard, semi-quarterly development cycle was established to align software development activities with engineering, operations, and science activities in support of achieving sitewide goals for the GBT.

The SDD produced three regular releases of its key product, M&C, with v3.15 on July 9, 2003, v3.16 on August 20, 2003 and v3.17 on September 29, 2003. Several spectrometer tasks were completed. At the beginning of the cycle, new self-tests were added to support hardware troubleshooting for the spectrometer, additional debugging statements were included, DRAM and SRAM errors were included in a self-test, Xilinx load failure message inconsistencies were removed, and a hardware reset was implemented in software. To aid in the resolution of DMA issues, additional logging capabilities were added in September. At this time the DMA block size was reduced, and a feature was added to retry DMA reads when errors are detected.

Scoping work on improvements necessary for reliable DCR operations was completed early in the quarter, and the Project Charter was finalized at the end of July. During the initial investigation, the team solved several DCR issues which were included in M&C v3.16, such as correcting the problem where the DCR was starting one second early. The device is also now able to take more than 5000 scans per observation successfully, and an issue with a sliding data window was resolved as well.

Many smaller issues were also addressed throughout the quarter, and included in regular releases. The Active Surface Manager is no longer sensitive to disabled actuators, it is much easier to toggle power supplies on and off, and it is no longer one scan behind the others (causing the system to abort). Reliability of the messaging system was remarkably improved in August. Also, work was completed on Phase 1 of the Antenna Test Range, an activity continued from the summer of 2002. Because the programming was done in Labview, a rapid application development environment for interfacing with hardware, the Electronics division was able to take over the remaining work at the end of the summer.

Progress towards 2003 goals in software operations were furthered during Q2 2003. Building upon the framework that was established last year at this time, the SDD expanded its unit tests slightly over the quarter for the M&C product from 309 to 317. This is to be expected, since new maintenance work this quarter was for devices which already had unit tests, for the most part. Although continuous refactoring was continued, build warnings remained steady at 44. The target for this continuous improvement effort remains 0 Errors and 0 Warnings by the end of 2003.

Green Bank Telescope

A key accomplishment during Q3 2003 was the successful establishment of a fully searchable Knowledge Management and Collaboration System (the "wiki") located at http://wiki.gb.nrao.edu. Although started as an experiment to track software documentation more effectively, use of the wiki has rapidly spread throughout the site, and it is now being used for project planning in addition to serving as a project dashboard for Green Bank's top priority projects. In July, there were 3148 saves or uploads to the wiki, which doubled to 7093 in August and again to 15971 in September. We are on pace for 27000 saves and uploads in October, indicating the wide use of this free tool throughout the site. As of the end of Q3, the wiki is also being used for real-time management of all software development activities. Because keeping documentation up to date is so much easier using this tool, no new software products are being released without adequate users' and programmers' documentation.

Green Bank Computing

This has been a busy quarter for the Computing Division. Various different groups have been supported including the Single Dish Summer School and a High Frequency Workshop along with the usual support for summer students and assorted other visiting groups. Supporting the large number of people for the summer school required a lot of shifting around of machines and network connections to allow the new Science Center computer lab to be used for this.

Various items of new and upgraded software have been installed to support different projects. At the request of the Software Development Division a twiki web collaboration tool has been deployed. This is proving to be an extremely popular and useful tool, being used by other groups outside the Software Division. We have also installed JDBC software to support the database requirements of the PTCS project.

An experimental secure web server was set up recently as part of the ldap (lightweight directory access protocol) project to gain experience with the configuration and running of such systems. Again this is proving useful in other areas where we wish to restrict access to sensitive information.

As the students have left their machines have been redeployed to those people needing upgrades. As a result of this round of upgrades we will be able to bring all Computing Division supported windows machines into the Windows AD domain when it is deployed. The deployment of the AD domain is scheduled for later this year and testing is in full swing. The unix side is also being upgraded and we are currently in the process of upgrading our linux machines to RedHat 9.0.

This quarter also saw the retirement of Ed Childers. This is a big loss to Green Bank and his expertise will be sorely missed. As Ed's replacement is based at Charlottesville the computing division has taken over the day to day maintenance of the network and this is stretching our already limited resources even further.

The sharp rise in virus activity this quarter has provided a lot of unplanned work for Charlie Myers, patching machines and keeping virus definitions up to date. Thanks to his efforts there has not been a single outbreak at Green Bank.

The work of the division was slowed down recently by the failure of a large RAID array. Fortunately >99% of the data was recovered and the array will shortly be redeployed.

A new data reduction machine intended for reducing large data sets has been acquired and this will shortly be made available to scientists under a booking scheme.

GBT Development Projects

Development program management

Our project management system has been put in place to help us track and manage our development projects. This development program is fully described at the website given below: http://wiki.gb.nrao.edu/bin/view/Projects/ProjectPlanningProcess.

The program consists of a long-range strategic plan, a six month forward look, a quarterly set of goals, and a six week development cycle. The 6 month plan is updated quarterly, as is the quarterly set of goals. Each six weeks, aligned with the calendar quarters, we hold meetings to discuss progress from the last six week cycle, re-evaluate our priorities, and allocate resources to the next six week cycle. In this manner we are able to permit development with manageable short-term goals with flexibility to redeploy resources when required at six week boundaries.

Precision Telescope Control System (PTCS)

The PTCS project team has made excellent progress over the last quarter, and a number of activities initiated after the April 2003 Conceptual Design Review have now come to fruition.

*Antenna Characterization***:** one of the key metrics for antenna performance is the antenna tracking accuracy. We have performed a number of experiments to investigate the achievable accuracy of the GBT. Firstly (PTCS/PN/19) we have performed a number of "half-power" tracking experiments (continously sampling with the continuum detector while tracking offset by one fwhm in either azimuth or elevation from a strong point source) at X (9 GHz) and C (5 GHz) band. Under the best conditions, the rms one-dimensional pointing fluctuations were 1" or less over a period of 30 minutes, after removal of a linear trend. For the single best 30 minute scan, the equivalent two-dimensional tracking error would have been 1.25", already meeting the 115 GHz specification of 1.3". The linear trend is assumed to be due to either thermal gradients in the antenna, or residual systematic errors in the pointing/focus tracking model, both of which are being addressed in parallel. Effects such as primary drive servo errors are clearly visible in

these data, but at significantly less than the 1" level. (The potential for compensating for servo disturbances has previously been investigated in detail by Constantikes (PTCS/PN/13) using half-power track data combined with accelerometer, quadrant detector and servo monitor data. The analysis showed that servo disturbances can be predicted forward from the servo monitor tachometer signals, establishing the feasibility in principle of correcting main drive disturbances from servo tach signals.) We are therefore confident that the GBT can meet the 115 GHz tracking performance specification under benign conditions.

Under non-benign conditions, the two major contributors to pointing errors are likely to be wind, and thermal gradients in the antenna. Wind induced motions of the GBT feed arm have also been analyzed by Constantikes (PTCS/PN/14). Quadrant Detector (QD) data collected on a windy day shows turbulent pumping of the structure vibrational modes and feed arm deflections. The dominant pointing effect is clearly on the intermediate (minutes) timescale. Forward predicting the QD data one sample (0.1 second of time) successfully reduces the feed-arm pointing error contribution to << 1". This again indicates that there is a very good chance that we could correct for these motions (although the total pointing perturbation will undoutably have a contribution from the primary mirror, which cannot be quantified by the quadrant detector).

*Thermal effects and the Antenna Temperature Sensor System***:** To characterize and compensate for the last major contributor, temperature gradients, we commenced work immediately after the CoDR on the antenna temperature sensor system. This was was completed, on schedule and within budget, in early August. The sensors are already providing a wealth of extremely high quality data. In late August, we devised an experiment to isolate the effects of thermal gradients on antenna pointing and radial focus. We identified an NVSS pointing source, 0117+8928, which lies within one degree of the North Celestial Pole, and so remains at an essentially fixed azimuth and elevation of (0,38). By performing repeated pointing and focus measurements on this source under stable, low-wind conditions, we can exclude essentially all other sources (for example any gravitational effects) of pointing/focus error. The results of these experiments to date are again promising. The measured pointing and focus offsets within a single commissioning session can be extremely well fit by linear combinations of the temperature sensor data. However, the resulting fits do not do as good as job as we would like of predicting the results of a different data-set. These results are currently under intense investigation.

*Engineering Measurement System and Laser Rangefinders***:** One of the the main activities for Q2/Q3 2003 identified at the CoDR was to complete the Engineering Measurement System (EMS) and characterize the current, delivered performance of the laser rangefinders as well as their potential for assisting in achieving 3 mm operation of the GBT. The EMS was completed on schedule in August; the first successful trilateration experiment was performed on 5th September. We consider the EMS implementation to be a great success. The application delivers precisely the "toolkit/algorithm prototyping" enviroment we had hoped for, and was instrumental in allowing detailed investigations of the performance of the rangefinders.

During the course of performing the trilateration experiments in August/September, two main results became apparent. The first was poor overall system reliability: despite intensive efforts, we failed to achieve full operation of the 12 rangefinders, for any trilateration experiment, due to a variety of equipment failure and reliability problems. The second, more fundamental issue, was poor agreement between rangefinder results and simultaneous traditional surveying measurements. In order to understand this, Constantikes (PTCS/PN/22) has developed an error analysis for the trilateration experiments which accounts for the geometry of the experiment, and the contributions of both monument position and range errors. This analysis indicates that, combining the geometries currently available with even optimistic estimates of potential range accuracies, the current rangefinder system will not provide the performance required for 3mm or even 7mm operation. We do not believe we can overcome these limitations in time to improve GBT performance during the Winter 2003/4 observing season.

Accordingly, we have decided that continued development of the rangefinder system should be postponed at this time, so that we can devote our efforts over this Winter (2003/04) to improving the antenna performance via a combination of both traditional, and more innovative astronomical techniques. We will reassess the potential of continued development of the rangefinder system, most probably to address the surface accuracy and collimation issues, in April 2004. By that time, we will have made the required short-term improvements to the antenna for Q-band operation for the Winter 2003 observing season, and will have a good understanding of the strengths and limitations of the alternative techniques.

Progress to Q-band Observing: The final major goal set at the April CoDR was to be ready for Q-band observing by October 2003. Although we are rather close, we have not quite achieved this goal. The major outstanding item is to complete the upgrades to the Antenna Manager necessary to implement some residual elevation (gravity) dependent corrections to the pointing and focus tracking models, and to allow dynamic correction of the thermal effects as discussed above. We expect these upgrades to be complete by mid-November. In the meantime, these effects can be mitigated by frequent local pointing/focus checks, as normally required.

Documentation: The activities described above have started to result in a significant amount of documentation, both in the form of formal PTCS Project Notes, and more accessible web pages. All of these can be found linked from the main PTCS web page at: http://www.gb.nrao.edu/ptcs.

In-Progress Review: The initial date proposed for the first PTCS In-progress Review was October 2003. Unfortunately, we found it was impossible to assemble all of the panel members at that time, and the earliest acceptable date was 3/4th December 2003.

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 the first two. In July and August, scientists articulated the full scope of capabilities of the GBT, and then extracted 41 cases representing the current offerings of the instrument. For each of these 41 cases, astronomical keywords were identified which could be used to explicitly characterize observations for each case. In mid-August, work began in earnest on developing to this specification. By the end of September, 18 of the 41 cases had been fully tested in interactive, command-line and scripting modes by the Project Scientist, and the utility had been tested successfully in several program checkouts. The team is on pace to deliver the functionality internally for testing early in Q4, and release this as a production capability by the end of the year.

Much work was also performed on the Observe/Status work package. In August, the glish-based observing interface GO was reverse engineered, so that the SDD would have a greater understanding of how it works. The result of this exercise was the release of GO LITE, a more maintainable version of the code with several fixes and enhancements included. In September, technical proof of concept exercises were conducted to identify a rapid application development framework in Python for building graphical user interfaces. The wxPython package was selected, along with the Boa Constructor tool, and astronomers as well as software engineers were able to very quickly create mockups of screens for the new observing tool. Because these screens require connectivity to the underlying telescope control system, a SOAP interface was appended to M&C this quarter. This significant addition concurrently satisfies needs of the Data Handling Improvements and PTCS Projects, by making it easier to expand the accessibility of GBT data to commercial packages such as Matlab.

The focus of work during Q4 will be 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 which can be used and tested internally by the beginning of 2004.

Data Handling Improvements Project

This project covers all aspects of observer-facing software that are encountered after an observation is successfully made, from data quality assessment through imaging. The goal is to enable observers to analyze their data more readily, maximizing the amount of science that can be delivered from the GBT. It is not the intent to choose "one true data handling solution" and develop advanced components in that framework, but to open the GBT up to any fully interoperable, component-based data reduction system. This way, scientists (particularly NRAO staff exploring the capabilities of new devices) will be able to develop new data reduction capabilities in the tool that best fits the task. Upon completion of this project, the learning curve for processing GBT data will be sufficiently shortened, making the GBT

easier to use post-observation and relieving the burden on scientific support staff in GB. The project will ensure that for every major observing type, there is a recommended and supported path of data analysis for new users.

Work during Q3 included:

- Segmenting the data preprocessing capabilities in the AIPS++ filler for more general use
- Validating those capabilities and benchmarking results against previously verified AIPS++ work
- Preparing the initial draft of a memo describing how GBT data can be unified into one FITS file
- Iterating on that draft based on extensive comments from a subset of the scientific staff
- Using GBT unified FITS files to create an IDL filler from reusable data preprocessing components
- Creating a "Using IDL" guide for GBT observers

In addition, the PTCS project was supported by creating a new path for reduction of pointing and focus data entirely in Python, and making use of preprocessing components. Work during Q4 2003 will include 1) making GBT data accessible to CLASS, in conjunction with external observers who have requested this option, 2) generating requirements for imaging based on gap analysis of available tools, and 3) synthesizing the prototypes that have been developed during Q3 2003 into one cohesive strategy and roadmap for data analysis of GBT data.

Baseline Investigation

During the last quarter, the baseline investigation concentrated on consolidation and documentation of results to date. An Electronics Division Internal Report (EDIR 312) was completed, describing the findings to date. Phase stable coaxial cables and passive cable temperature buffers were installed at critical points in the common IF system. Many of the original optical fiber modulators, which have a characteristic gain ripple of approximately 2.4 MHz, were replaced with newer compensated modulators that have greatly reduced ripple levels. This replacement will be completed in all eight IF channels during the fourth quarter.

In addition to the above work, R&D into possible future improvements continued. We are researching design improvements to the thermal gaps in circular waveguide which are in most of the GBT receivers. This quarter a "photonic crystal" design at 12-15 GHz was modeled and fabricated, and characterization is underway. Also, careful measurements to quantify the reflections from the feed radome were made on the 4-6 GHz receiver.

Penn Array Receiver

A Penn Array project meeting was held in Green Bank on July 02 and 03 to review interface issues, which had been the focus of work in Q2, and to plan for the upcoming Critical Design Review. Throughout the quarter GB continued to assist in defining packaging and interfaces. This included a draft design for the RFI enclosure for the electronics, RFI measurements of the pulse tube cooler's stepper

motor, receiver room vibration measurements, and providing a serial/optical converter designs. Penn drafted documents describing the software interfaces to the housekeeping and DAQ electronics.
There are some gray areas in the DAQ interface and we plan to resolve these in collaboration with UPenn when the multiplexing electronics are operational in the laboratory.

Two major milestones were achieved in this period:

- With Roger Norrod's assistance, Mark Supanich from UPenn performed successful cryogenics tests on the GBT in late September. In these tests the Penn Array test dewar was placed in the GBT receiver room and run off the standard GBT helium compressor lines. Focal plane temperatures of 325 mK were achieved and held for the duration of the test (12 hours), during which time the telescope was slewed over a wide range of elevations all the way down to less than 15 degrees. There was no significant variation in the focal plane temperature over this time.

- In early September Goddard produced a mechanical prototype for the detector array.

A panel has been assembled and a Critical Design Review is scheduled for 17 and 18 October. Further effort has been focused on preparing material for the review.

Caltech Continuum Backend

In Q3 Caltech has proceeded with the backend design, with substantial consultation from the Green Bank Electronics Division on electrical, RFI, and mechanical interface issues. This resulted in delivery of a document describing the electrical and mechanical interfaces between the Ka/W band receivers and the Caltech Backend at the end of the quarter, which will be reviewed by Green Bank personnel early in Q4. At the end of Q2 Caltech also delivered the software library which will be used to interface to the backend, along with documentation. The software interface was reviewed and approved in Q3.

1cm Receiver Construction

Much of the fabrication for the 26-40 GHz receiver is completed, including the feedhorns, polarizers/OMTs, and the dewar mechanical parts. The feedhorn patterns were measured both on the new Green Bank indoor anechoic chamber range, and at a MIT range, with good agreement between ranges and with theory. The receiver uses a fairly complicated "psuedo-correlation" topology, and a trial fit up of the components and waveguides which will be cooled was accomplished. Design and layout of the required control cards is underway, and design of the detector video amp/ filter cards is beginning at the start of the fourth quarter. The design for microstrip multiplexers, which segment the 26-40 GHz range into four bands for detection, continues to mature. Three units have been completed, although two of these should be considered prototypes as the tuning process improves with each unit. During the next quarter, the receiver assembly will continue and cold testing will begin.

Green Bank Telescope

3mm Receiver Construction

Because of assignment of personnel resources to other projects, no new work was accomplished on this project in the third quarter. We hope to resume work late in the fourth quarter.

Common MM Downconverter

This effort was also temporarily suspended due to lack of personnel resources. Most purchased parts are in hand. Testing, packaging and completion of Green Bank designed RF parts will be restarted next quarter.

Pulsar Spigot Mode

Work continues on the spigot card testing. 12 modes have been completely tested, with several more in the process of engineering checkout. The specification for the spigot mode software has been written, and awaits allocation of software effort. Expert mode observations have begun, although they are highly experimental and manpower intensive. This system is not yet available for general use until further testing and verification are completed, and the system is easier to support.

New Science Center/Dormitory

The new NRAO Science Center in Green Bank, WV has reached Substantial Completion. The contractor has substantially met all construction requirements of the contract and is finalizing the punch list items. The final pay estimate has been received and will be paid upon completion of the remaining punch list and outstanding contract items. The center has been open to the public since May 24, 2003 and is enjoying great success as a tourist destination and as an educational facility.

The associated dormitory is still under construction, but is completely under roof with windows and doors installed. The Heating, Ventilating and Air Conditioning (HVAC) system has been activated and the interior finishes are being installed. Construction is expected to be complete by the end of November, 2003.

Very Large Array and Very Long Baseline Array

VLBA Highlights

In March 2003, the regular VLBA "Tiger Team" maintenance visit was carried out at the St. Croix VLBA station. This resulted in a finding of significant metal flakes in the grease for one of the elevation bearings. After monitoring over the next several months, it was decided that the condition was sufficiently worrisome that budget was reallocated in order to schedule a bearing replacement. This replacement was accomplished during July 2003, after a refined finite-element model was derived in order to ensure safe support of the antenna structure during the bearing change. The center guide flange of the inner ring of the bearing was found to be fractured; consultation with the bearing manufacturer indicates that this was most likely due to excessive thrust load on the bearing. This failure mode is similar to that at the Los Alamos VLBA antenna, which had a similar bearing failure and replacement in January 2001, and it now is believed that the excessive thrust load may be due to the initial installation process for the bearings. Engineering personnel will continue to monitor the bearing grease and pointing characteristics of all VLBA antennas proactively in order to detect similar problems with any of the other antennas.

VLA Highlights

The VLA became a 26-antenna array in August 2003, as the EVLA prototype antenna was moved to the VLA master pad for completion of its outfitting and another antenna replaced it in the Antenna Assembly Building. Despite the significant demands of EVLA prototyping during FY 2003, the final statistics for the year indicated that a total of 168,000 antenna-hours of scientific data acquisition were achieved, well above the prediction of 160,000 antenna-hours made under the Government Performance and Reporting Act. This corresponds to successful scientific observing for approximately 74 percent of the hours in the year, with an average of 26 available antennas.

Management and Scientific Services

Milestones	Original Date	Revised Date	Date Completed
Announce new Rapid Response Science Procedures	07/31/03		07/15/03
VLBA Automatic Experiment Release Implemented	07/15/03		08/04/03
VLA Loses One Antenna to be EVLA Prototype	06/30/03	08/11/03	08/11/03
VLBA 10th Anniversary Celebration	08/21/03		08/21/03
Annual Release of Worldwide VLBI Scheduling	08/01/03		09/18/03

Very Large Array and Very Long Baseline Array

Milestones	Original Date	Revised Date	Date Completed
VLA/VLBA Proposal Deadline	10/01/03		
VLA/VLBA/GBT Archive On Line	10/01/03		
VLA/VLBA Target of Opportunity Implementation	10/31/03	10/01/03	
New Mexico Symposium/Jansky Lecture	11/15/03	10/03/03	
Duke of York visit to Array Operations Center	10/20/03		
VLBI Calibration Transfer for 1 VLA Antenna	05/26/03	10/31/03	
AIPS++ Stable Release 3	12/01/03		
VLA Archive Data On-Line Within 48 Hours	12/10/03		
Second AO for Chandra/NRAO Joint Proposal Process	12/12/03		
Test Report on VLA Water Vapor Radiometer	12/18/03		
Complete Tests of Resurfaced Subreflector at Pie Town	05/15/03	12/18/03	
VLBI Future Report Completed	09/30/03	12/19/03	
Release frozen 31DEC03 AIPS version; begin 31DEC04	01/02/04		
AIPS++ Stable Release 4	02/01/04		
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	
Global 3mm VLBI Session	04/21/04		
Temporary Office Space Occupied	05/10/03	05/15/04	
VLBI Calibration Transfer for GBT Completed	10/15/03	05/31/04	
Synthesis Imaging Summer School	06/30/04	06/22/04	
Complete VLBA Pilot Program for Spacecraft	01/30/04	08/31/04	

Very Large Array and Very Long Baseline Array

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. Full system check out procedure	09/30/04		
Lab Services			
Develop a dynamic drafting scheduling tool	07/31/03		07/31/03
Receivers (FE)			
Build and install one more 86 GHz receiver for a total of nine	12/30/02	Pending funding	
VLBA Improvements			
Replace the maser at Mauna Kea, HI	09/31/03		08/05/03
Replace the maser at Fort Davis, Texas	09/23/03		09/23/03
Develop a new VLBA recorder idler with better forward/reverse characteristics	11/30/03		09/05/03
Develop Windows based QA tools for the Formatter	12/05/03		
Replace the maser at Brewster, Washington	02/15/04		
Install digital tachometer at Hancock, NH	07/16/04		
Upgrade the ACU power supply & backplane PT, NM	09/15/04		

Engineering Services

Milestones	Original Date	Revised Date	Date Completed
Complete BnA array reconfiguration	09/19/03		09/16/03
Complete B array reconfiguration	10/17/03		
Complete CnB array reconfiguration	01/30/04		
Mechanical Group			
Kitt Peak maintenance visit	07/22/03		06/14/03
St. Croix Elevation Bearing Change	07/27/03		07/25/03
North Liberty maintenance visit	08/18/03	09/17/03	09/17/03
Paint Transporter #2	08/31/03	10/30/03	
Antenna #15 azimuth bearing change	09/01/03	10/31/03	08/26/03
North Liberty azimuth wheel assembly replacement	10/23/03		
Resurface spare subreflector	06/30/04		
Mauna Kea azimuth rail repair	06/16/03	09/30/04	
Electrical Group			
VLBA production Tach	09/30/03	11/30/03	

Very Large Array and Very Long Baseline Array

Milestones	Original Date	Revised Date	Date Completed
Site & Wye Group			
Complete track repairs between BW8-AW5	09/30/03		09/06/03
Complete track repairs between BN6-AN5	12/31/02	04/30/04	
ES Engineering Group			
1000 Gallon Diesel Fuel Tank Procurement/Installation	07/02/03		08/13/03

Computer Infrastructure

Milestones	Original Date	Revised Date	Date Completed
Establish NRAO-NM VPN Capability	06/30/03	12/31/03 (1)	
Phase 2 AOC Rewire	07/31/03	In Progress	
Upgrade to RedHat 9.0	09/30/03	In Progress	
Configure/build Filehost replacement	11/30/02	10/31/03 (2)	
Migration to Windows 2K domain	07/31/03	In Progress	
Increase archive to 8TB	11/30/03		
Replace AOC Wireless network	12/31/03		

(1) Delayed waiting for collaboration from CV

(2) Filehost's replacement has been ordered; awaiting arrival

Array Support

	Original Date	Revised Date	Date Completed
Start tests of alternative VLA data recording	07/01/03		07/01/03
Radio Telescope at Visitors Center	11/01/02	07/01/03	07/01/03
Correlator controller -support line	12/31/02	12/31/03	08/31/03
Decide on VLA data flow/primary path	12/01/03		
'Real-time' VLA data flow to archive	01/01/04		
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	
Transcribe VLA observe/system files	11/30/02	05/31/04	
Correlator controller – integrate line/continuum	06/30/03	07/31/04	

Very Large Array and Very Long Baseline Array

AIPS

Key Developments

1. FILLM, the task that reads VLA archive data into AIPS, was corrected to account for the change in array center when the Pie Town antenna is included. The "real-time" version of FILLM now reads data from the mirror disk area and can begin reading with data taken one or more days previously.

2. Plotting tasks may now draw colored lines using the full range of colors under task control. At present this is used, optionally, to display the polarization angle, to contour multiple spectral channels on top of each other, and to separate multiple IFs or spectral channels in plots of visibility data.

3. The pipeline reduction procedure set for VLA data, called VLARUN, was cleaned up and its use encouraged.

4. New tasks to fit and correct the residual zenith delay (DELZN) and to account for its effect on calibration of other sources (DFCOR) were written.

5. The task FIXWT which resets weights depending on actual visibility data rms was completely rewritten and may now be useful. The task MSORT designed to sort visibility data which are nearly in the correct order was greatly improved through the use of more memory and through the addition of an alternate, brute-force algorithm.

6. The installation script was changed to make the setup for "midnight jobs" more robust and to ask the installer whether the machine is a "laptop," with the answer controlling how later steps are handled.

Goals for Fourth Quarter 2003

The following efforts are expected:

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

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

3. Make 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. Have the FITS readers support the New World Coordinates System nomenclature where possible and allow FITLD to read more than one VLBA correlator data file from disk.

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

6. Continue the moderate-term project to explore improved troposphere calibration.

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

8. Test and enhance AIPS performance on McIntosh computers with the G4 and G5 processors.

Central Development Laboratory

Central Development Laboratory Highlights

An ALMA Band 6 mock-up cartridge was built and successfully cooled to 3.2 K in the cartridge test dewar, and the test instrumentation for this dedicated facility was nearly completed. The dedicated test dewar for Band 6 mixer-preamps was successfully cooled to 3.4 K.

An end-to-end test of the ALMA 2-antenna prototype correlator was successfully completed, including passing real data all the way through to the Correlator Data Processor.

Newly-fabricated custom MMIC power amplifier chips designed by NRAO staff for the ALMA local oscillator system were delivered by HRL and successfully tested.

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 range from 1 to 120 GHz	04-01-04		
1) Freeze Band 6 cartridge design	12-31-03		
Electromagnetic Support:			
1) Feed pointing optimization of the VLA antenna	06-30-02	12-31-03	
2) GBT L-band pattern simulations	03-31-03	12-31-03	
3) Testing of GBT Ka-band feed horn	06-30-03	09-30-03	08-29-03
4) Testing of EVLA C-band prototype feed horn	09-30-03	12-31-03	
5) Design EVLA Ka-band feed horn	09-30-03		09-30-03
6) Testing of EVLA L-band feed horn	12-31-03		
7) Design of EVLA X-band feed horn	12-31-03		
8) Testing of EVLA Ka-band feed horn	12-31-03		

Central Development Laboratory

Milestone	Original Date	Revised Date	Date Completed
ALMA Correlator:			
1) Complete VLBA data recording project	12-31-02	12-31-03	
2) Test the fiber optic receiver card to filter card interface in the prototype system using a DTS receiver simulator card	06-30-03	07-09-03	08-01-03
3) Hold a critical design review of the baseline ALMA correlator	09-30-03	10-03-03	
4) Use the DTS receiver simulator card to test the system	09-30-03		08-15-03
5) Achieve error-free station bin to correlator bin data transmission in all signal cables	09-30-03	12-31-03	
6) Start the process of ordering parts for the first quadrant build	09-30-03	09-30-03	
7) Prepare ALMA prototype correlator for shipment to Socorro	12-31-03		
8) Release second logic card RFQ for the full ALMA correlator	12-31-03		
9) Release RFQ for motherboards	12-31-03		
10) Purchase first non-RFI rack for ALMA correlator	12-31-03	10-03-03	
11) Establish firm plan for correlator enhancement	12-31-03		
ALMA LO Source:			
1) Delivery of the first LO driver	12-31-03	02-28-04	
2) Build and deliver improved LO to SRON	06-30-03	07-31-03	08-20-03
3) Verify leveling using power amplifiers	06-30-03	07-31-03	07-24-03
4) Complete testing of UMS wafer	06-30-03	07-31-03	08-10-03
ALMA Frequency Multipliers:			
1) Band 9 frequency quintupler evaluation at spot frequencies	03-31-03	07-31-03	07-18-03
2) Complete Band 6 frequency tripler evaluation set with actual driver amplifiers	12-15-03		
3) Complete Band 7 frequency tripler evaluation set with actual driver amplifiers	12-15-03		
4) Complete Band 9 frequency quintupler evaluation set with actual driver amplifiers	12-15-03		
5) Complete evaluation of four Band 6 frequency triplers for immediate cartridge work	10-15-03		
6) Order Band 6 and Band 7 frequency triplers for ALMA production	11-14-03		
7) Finalize action plan for Band 9 frequency quintupler	11-14-03		

Central Development Laboratory

Amplifier Design and Development

Work continued on the development of amplifiers using devices from the JPL/TRW Cryo-3 wafer. During this quarter, the following tasks were accomplished:

1) An evaluation of Cryo-3 devices at L-band frequencies has been performed, and a design of a 1-2 GHz balanced amplifier has been completed. (The mechanical drawing for the new design has been provided to the machine shop).

2) A study of the repeatability of the cryogenic performance of 4200 devices (4 fingers, 200-micron gate width) from three different Cryo-3 wafers (4044-041, 4074-090, 4099-040) in the NRAO 4-12 GHz design has been started. Preliminary results show no significant differences, although it is too early for conclusions due to the small number of amplifiers with devices from wafers 4074-90 and 4099-040.

3) Models of the Q-band amplifier employing Cryo-3 (4044-041) 4080 and 4060 devices in all stages were developed, and a version with 4080 devices was built and tested. The amplifier has slightly better noise performance than our standard design (Cryo-3 in the first stage, MAP devices in subsequent stages), but consumes only half as much power for the same gain performance. This work was done in support of the LFI Planck project, and the amplifier is now being evaluated at the Jodrell Bank Observatory.

Work on 2-4 GHz balanced amplifiers and 4-8 GHz amplifiers has started.

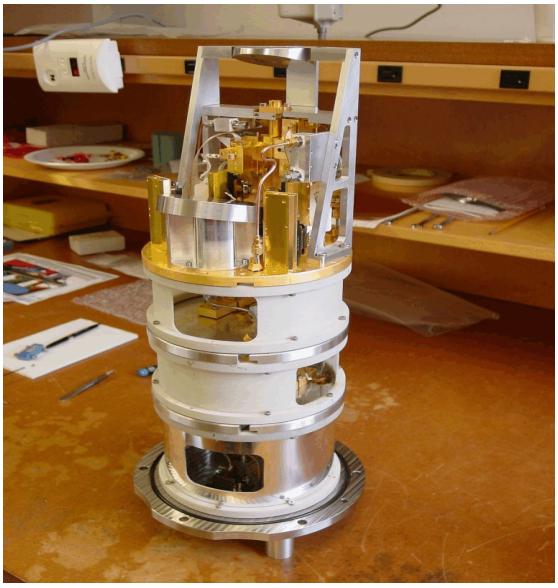
Amplifier Production

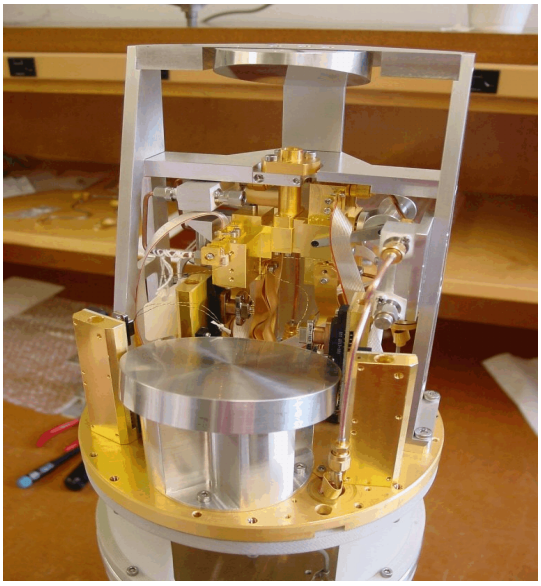
A total of 14 amplifiers was completed during the third quarter: ten 40-50 GHz units for use by the VLA/EVLA and four 4-12 GHz units. The amplifier group has been providing extensive support to ALMA projects in the assembly of MMIC amplifiers, IF amplifiers, mixer chain components, and the assembly of test racks to be used for ALMA production.

The amplifier group has also been involved in both planning for the new NRAO Technical Center (NTC) and in providing manpower for the installation of cryogenic infrastructure at the new building. One of the group's most senior technicians has retired after a 30-year career with NRAO.

Other Projects

The amplifier group continues to support the chemistry lab where plating production has averaged 40-50 completed pieces per week. Problems earlier in the year with electroform production of custom waveguide components have been fully resolved, with electroform production now at full tank capacity of 5-6 finished pieces per month.





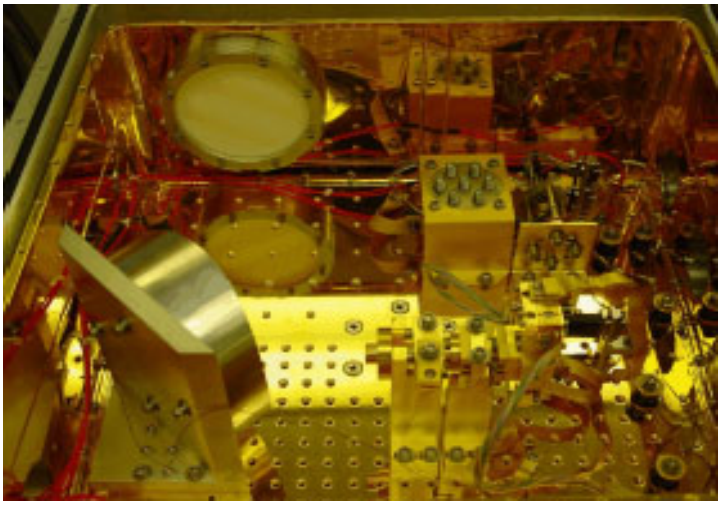
Two views of the assembled Band-6 cartridge. The upper and lower aluminum ellipsoidal mirrors are clearly visible, and also the OMT, mixer-preamps, IF quadrature hybrids, and the horn which illuminates the upper mirror.

Superconducting Millimeter-Wave Mixer Development

ALMA Receiver Development

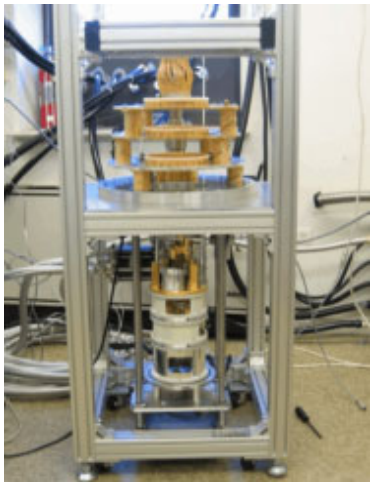
Band 6 Cartridge: A complete Band 6 cartridge has been assembled and cooled in the cartridge test Dewar. Several dummy components were used (*e.g.*, OMT, mirrors, LO tripler), as the final components were not yet available. The mixers reached 3.2 K. The photographs show two views of the cartridge.

Mixer-Preamp Test System: Construction of the mixer-preamp test Dewar is complete and the most of the internal components have been installed – see photograph.



The inside of the mixer-preamp test Dewar, showing the 20 K IR filter (top left), ellipsoidal mirror (lower left), feed horn and mixer-preamp assembly (lower right), and coaxial SP6T and hangeover switches (top right).

It only remains to make cooling straps for the mixer-preamp and IF hybrid, and bias cables. Several cool downs have been performed, and there appears to be ample cooling capacity. The first and second stages reach 30 K and 3.4 K, respectively, in about four hours with a temperature stability of ± 25mK at the cold stage. Software is being developed to perform the data collection, as described below.



The Band-6 cartridge test Dewar with the outer vacuum vessel removed. The lower section shows the Band-6 cartridge mounted on the loading mechanism. The upper section shows the 90 K, 20 K, and 4 K stages of the refrigerator. The braid heat strap at the top connects the refrigerator cold plate to the 4-K plate

Central Development Laboratory

Band-6 Cartridge Test System**:** The cartridge test system is now nearing completion. The Dewar (see figure on preceding page) has been tested with a cartridge installed. It remains to complete the instrumentation, in particular, the chopper wheel and mirror assembly on top of the Dewar, Dewar vacuum window and IR filters. We are awaiting delivery of LO and sideband sources.

Mixer-Preamp and Cartridge Test Software**:** We have completed software to allow a fast Agilent power meter to measure receiver noise powers with the chopper wheel running. Software was also written to test the instrumentation in the Band 6 cartridge test rack. The existing I(V) and noise temperature measurement software was ported from the old "JT-2" R&D test system to the new ALMA mixer-preamp test system. We are also porting the fast noise temperature measurement software from Visual Basic to LabVIEW to compare the merits of each language for future test system software development.

Receiver Stability Measurements**:** Further gain stability measurements of the mixer-preamplifier were made during the quarter. The stability of the IF system was improved to 5×10^{-5} at 1-second integration; the entire test system, with the mixer-preamp, now measures 2×10^{-4} at 1-second integration time.

4-12 GHz IF Preamplifiers**:** The CDL has now built 14 of the Type III amplifiers, and they have shown consistently low noise temperatures. For the sideband-separating receiver, the gain and phase must be moderately well-matched over the IF band, and this is achieved by selecting matched pairs of amplifiers. Only sample quantities of transistors have been received from JPL, and there is no control over which devices are received (the individual devices are untested) which makes it more difficult to obtain reasonably matched pairs of amplifiers. The erratic supply of transistors has been a major factor in development of these amplifiers – it even had to be redesigned when we ran out of the devices used in the third stage. The devices now used in the third stage result in lower overall gain. This could be remedied by using the same devices in all three stages, but that would require a further design change, which is not possible within the ALMA budget and schedule.

Advanced Control Components, Inc. (ACC) is interested in building these amplifiers in quantity and began construction of samples for our evaluation. We have been working closely with ACC to make sure they have the necessary parts and documentation. Delivery of three units is expected by the end of October.

SIS Mixer Development

385-500 GHz SIS Mixer Development**:** A preliminary design study has been carried out for a new 385-500 GHz SIS mixer. The new mixer design will be capable of operation with a very wide IF bandwidth (IF 4–12 GHz) and can be used as the building block mixer for the future Band 8 sideband-separating receivers for ALMA. Some basic mixer design parameters such as the size of the waveguide and substrate channel, substrate material and junction parameters have been chosen.

Detailed circuit design work will begin 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.

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 Hot Electron Bolometer (HEB) mixers in a 600-720 GHz receiver using existing NRAO equipment. Mixer blocks have already been obtained and Professor Lichtenberger's group at UVA is finishing fabrication of a beamlead HEB mixer on thinned Si for testing in the first mixer block.

Publications & Memos

S.-K. Pan, A. R. Kerr, M. W. Pospieszalski, E. F. Lauria, W. K. Crady, N. Horner, S. Srikanth, E. Bryerton, C. T. Cunningham, S. M. X. Claude, C.-C. Chin, J. Z. Zhang and A. W. Lichtenberger, "An 84-116 GHz Fixed-Tuned Integrated SIS Mixer-Preamplifier with Ultra-Wide-Band IF and Quantum-Limited Sensitivity," *Technical Digest of the 11th Int. Conf. on Terahertz Electronics*, Sendai, Japan, pp. 70, 24-26 September 2003.

R. B. Bass, A.W. Lichtenberger, R. M. Weikle, J. W. Kooi, C. K. Walker and S.-K. Pan, "Ultra-Thin Silicon Beam Lead Chips for Superconducting Terahertz Circuits," *Proc. of the 6th European Conf. on Applied Superconductivity*, Sorrento, Italy, 14-18 September 2003.

J. E. Effland, "Mixer Measurement Sequences," NRAO Internal Memo, 5 September 2003, at http://www.cv.nrao.edu/~jeffland/MeasurementSequences.pdf.

J. E. Effland, "Power Variation from Gain and Noise Temp Changes with Frequency for ALMA Band 6 Cartridge," NRAO Internal Memo, 14 August 2003, at http://www.cv.nrao.edu/~jeffland/cartridge/GainSlope5.pdf.

Electromagnetic Support

EVLA

A detailed design of the Ka-band (26-40 GHz) feed was completed this quarter. This feed has an illumination taper of -13 dB at the edge of the subreflector of the VLA antenna. The cross-polarized sidelobe is lower than -25 dB.

When the X-band (8.0-8.8 GHz) feed is installed on the new feed cone providing adequate space between the bottom of the receiver and the floor for servicing the refrigerator unit, the top section of the feed could cause shadowing of the adjacent feeds. Far-field patterns of the feed were calculated with the

top section of the feed removed. The illumination taper without the top section changes by about 6.0 dB to 7.6 dB, resulting in approximately a 3% loss in aperture efficiency.

GBT

Far-field patterns of the Ka-band (26-40 GHz) feed were measured at a millimeter-wave anechoic chamber at the MIT-Lincoln Laboratory. These patterns, measured in the E-, H- and 45-degree planes, show good agreement with theory. Later, the feed was also measured at the anechoic chamber antenna range in Green Bank. Comparison of the two measurements indicates that both antenna ranges perform well in the 26 to 40 GHz range. Return loss of the feed measured better than -25 dB, indicating that the ring-loaded corrugations in the throat section of the feed have been fabricated satisfactorily.

The 345-MHz prime focus feed, which is a short-backfire antenna, was modified by adding extensions to the dipole elements for operation at the 140-175 MHz frequency band. Measurements of return loss and far-field patterns were completed.

Spectrometers/Correlators

ALMA Correlator

During the last quarter, end-to-end tests of the ALMA two-antenna prototype correlator were successfully completed. The data source for these tests was the DTS receiver simulator card, and tests were performed using both simulated digital data and actual samples taken with an analog-to-digital converter connected to a test signal.

System testing of the ALMA two-antenna prototype correlator continued, as did software and firmware development.

Documentation was a major task during this quarter. A large majority of correlator documentation was submitted to the ALMA EDM site.

The two station motherboards which had wiring mistakes were replaced in the prototype correlator, and the new boards tested successfully.

Work continued on the signal interface cable. Tests of these interfaces still register a low but non-zero error rate. The rate is much lower than the specification on the fiber optic data transmission system.

Design of a polyphase filter card was nearly completed during the quarter, as were the two FPGA circuits required by the design. Computer simulations of the card indicated acceptable performance.

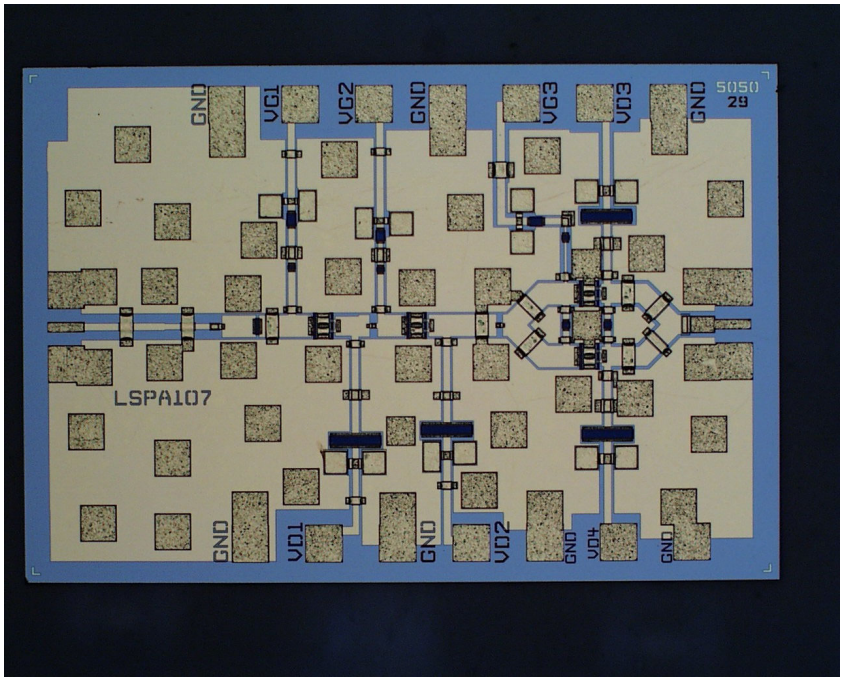
The RFI emitted by the prototype correlator was measured in the 4-12 GHz and 26-40 GHz bands, with preliminary analyses indicating the correlator in its shielded room will not be an important source of self-interference for ALMA.

The VLBA data translation project was tested in Green Bank, and translations of VLBA tapes were successfully done. Only minor work remains on this project.

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.

The InP MMIC power amplifiers from HRL have been delivered. Preliminary packaged measurements are very encouraging. 35-mW output power was measured over the Band 7 driver band (94-121 GHz) for the lower power design. S-parameters of this design match simulations very closely. Almost twice as much output power is expected for the higher power designs. The power amplifier chip is shown in the accompanying figure.

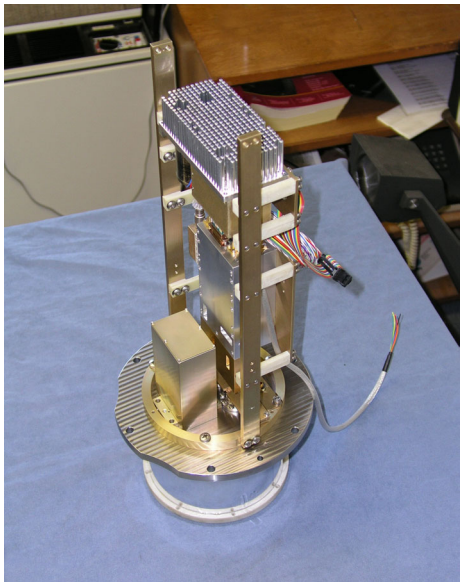


MMIC power amplifier chip for 91-124 GHz.

An integrated active multiplier chain (AMC) module was built for both Bands 3 and 6. Sideband noise measurements for the Band 6 LO using this AMC are scheduled to begin next quarter. Measurements on a partially integrated Band 6 LO showed great improvement in terms of noise and indicate the integrated Band 6 AMC should meet ALMA specifications for noise. Drawings for the final prototype AMCs for all four ALMA bands are near completion.

The Band 7 lab prototype LO was delivered to IRAM, completing the delivery of all four lab prototype LOs. First tests of this LO with the Band 7 mixer will soon begin at IRAM.

A mockup of the warm cartridge assembly (WCA) for Band 6 has been built and assembled. This assembly, shown in the next photograph, includes the warm LO components, warm IF amplifiers, heatsinks, DC bias, and control electronics. All components fit, and the assembly mates well with the remainder of the cartridge. Thermal and stability measurements of the WCA structure are ongoing.



Bank 6 warm cartridge assembly mock-up.

ALMA Frequency Multipliers

The purpose of this project is to develop millimeter- and submillimeter-wave frequency multipliers for use in laboratory experiments and receiver systems associated with ALMA. A series of multipliers using varactor and varistor circuits operating in the 50 to 950 GHz range is currently being developed and evaluated. The status of the cooled frequency multipliers for the various ALMA frequency bands in the baseline plan is described, followed by an outline of other frequency multiplier development efforts.

Central Development Laboratory

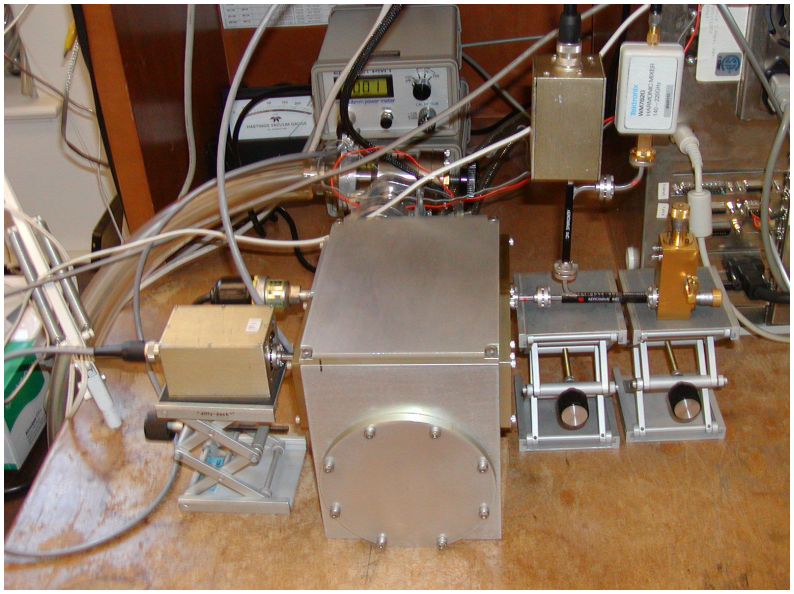
A brief summary of the activity in this quarter is given, and reference to detailed reports provided as appropriate.

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

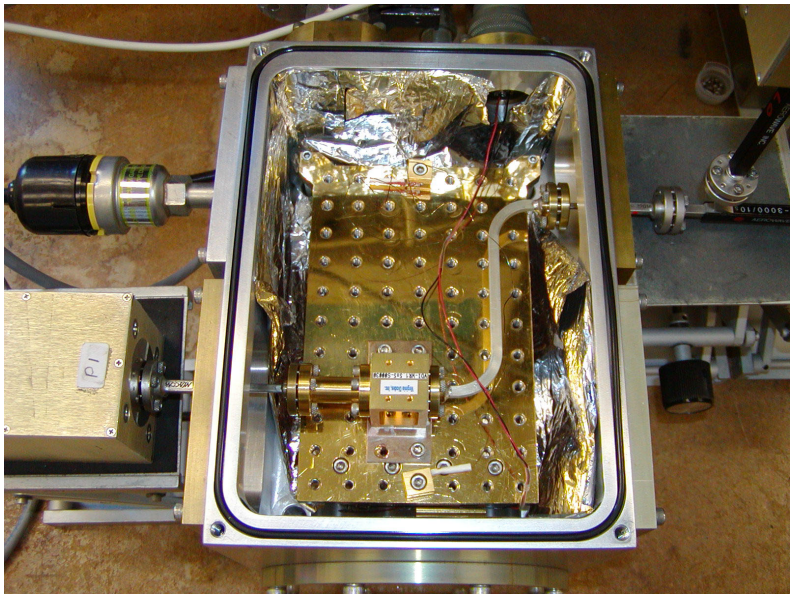
Band 6 and Band 7: The prototype frequency triplers for these bands were delivered by Virginia Diodes, Inc (VDI) earlier, and the previous quarterly report described the evaluation of these prototypes for ALMA. These prototypes were found to meet the specifications and subsequently it was decided to request that VDI provide a quote to supply the full quantity of these units for ALMA production (approximately 140 of each type.) Price negotiations with the vendor are complete and the formal Statement of Work and Specification documents await submission for NSF approval and placement of order.

In addition, four Band 6 frequency triplers were ordered and received to meet the immediate cartridge assembly and laboratory test requirements.

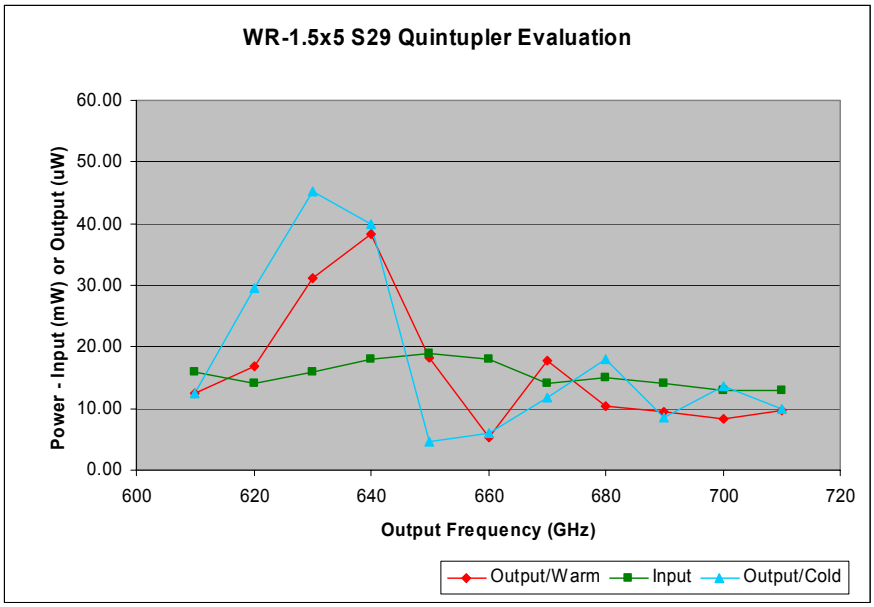
Band 9: Five VDI frequency quintuplers were evaluated with input pump power levels of about 15-20 mW and exhibited low output power levels (in the 10-40 μW range over most of the band). The improvement in output power level on cooling the units to 77 K was not significant and quite inconsistent as a function of frequency. This was true of all units tested. The input return loss was in the 6-12 dB range and seemed to degrade somewhat on cooling the units to 77 K. However, one unit had an input return loss that was in the 10-18 dB range, significantly better than that of the other units evaluated. The units exhibited no degradation as a result of RF power or temperature cycling. This initial evaluation was carried out by pumping the multipliers with a Gunn-diode oscillator source at several spot frequencies across the band (see figures below). A report summarizing the details of the above experiment is available as an ALMAEDM Document FEND-40.10.00.00-006-A-MEM.



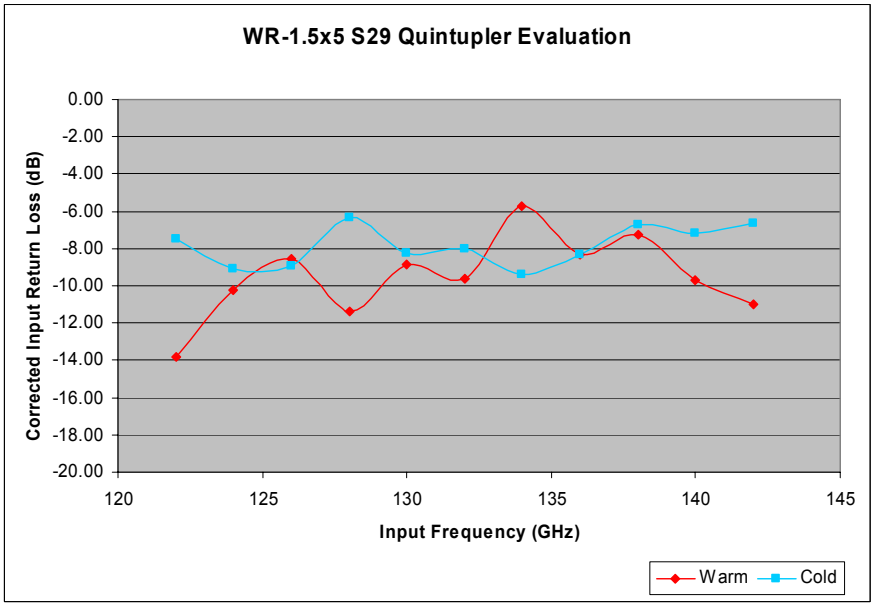
Photograph of the experimental arrangement for evaluation of the Band 9 frequency quintupler using a Gunn-diode oscillator as the pump/drive source.



A close-up view of the arrangement inside the 77 K Dewar.



Measured output power of the 132/660 GHz Band 9 frequency quintupler. The losses in the waveguide and Mylar windows attached to the input and output flanges of the frequency quintupler have been taken into account. The plot is representative of typical performance.



Measured input return loss of the 132/660 GHz Band 9 frequency quintupler. The plot is representative of typical performance.

Future Course of Action to Meet the Band-9 Frequency Multiplier Requirement and Available Options

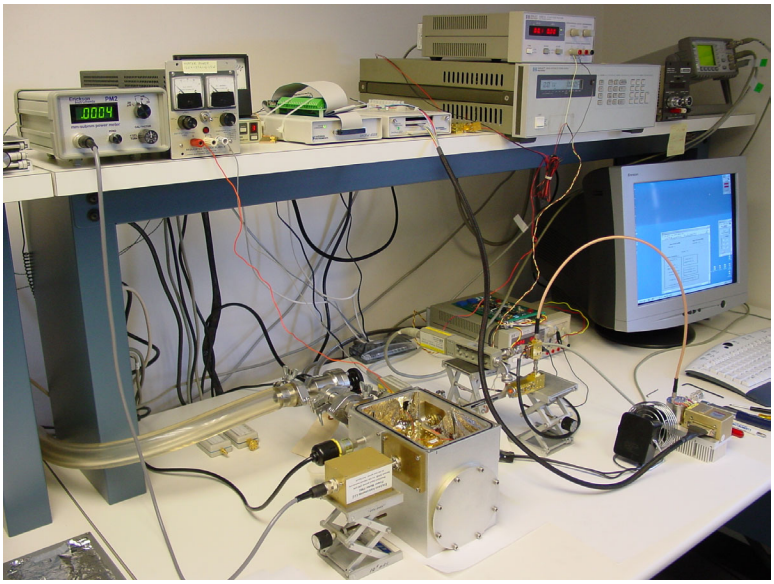
Measurements made at SRON using the prototype Band 9 receiver and the prototype Band 9 frequency quintupler indicate that the generated local oscillator power might be sufficient if the frequency quintupler were to be pumped with 30–40 mW of power. Tests on the first LO driver assembly are planned to see if that is feasible with the current amplifier designs. If not, the existing power amplifier chips could be power-combined to yield the desired output power level.

VDI has submitted a proposal to carry out a short-term demonstration of a new batch of frequency quintuplers, optimized to reduce the input power required to achieve the ALMA LO power requirement. This effort involves reoptimization of the existing frequency quintupler design, as well as use of a reduced barrier height Schottky diode to decrease pump power requirement. The effort would require funding by NRAO.

The option of the "second source for frequency multipliers," as outlined in the previous quarterly report, could be pursued. This collaborative effort with the Jet Propulsion Laboratory would also require funding by NRAO. Technical and budgetary details were finalized in the course of discussions with JPL personnel and are described in ALMA EDM document number FEND-40.10.00.00-010-A-MEM.

Evaluation of Frequency Multipliers for ALMA Production

Evaluation of all the prototype frequency multipliers was carried out manually using Gunn-diode oscillators with mechanical tuners. This is not a feasible approach for evaluation of large quantities of units at the production stage. The proposed solution is to automate as much of the testing as possible. An automated cryogenic evaluation station is being implemented to meet this need. The programmable YIG-based ALMA LO drivers are being used instead of the Gunn-diode oscillators as the pump sources. LabVIEW-based software routines perform most of the calibration and testing functions, minimizing the required operator intervention. The photograph below shows the test station configured for evaluation of the Band 6 frequency triplers.



Photograph of the automated cryogenic test station under development for evaluation of frequency multipliers.

Green Bank Solar Radio Burst Spectrometer (GB/SRBS)

Last quarter, 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 Technical Center.

Two student interns were involved in the R&D activities this quarter. The antenna support was redesigned using PVC pipe to improve the stability of the structure during harsh weather conditions. This new antenna structure was studied using Microwave Studio and was shown to yield performance over the 20-70 MHz band that is similar to the NRL prototype. The new antenna is deployed temporarily in Charlottesville and withstood the 50-60 MPH wind gusts from hurricane Isabel without any damage. The PVC pipe is also used to house the low- noise active balun. The NRL balun was repackaged to reduce the potential for oscillations and used with this antenna during initial tests. However, a new version of the active balun was designed which maintains the wide dynamic range of the NRL balun, but reduces both the power consumption and cost by an order of magnitude. The performance of this new balun has been demonstrated in the laboratory and is currently being used together with the new

antenna. The antenna and balun are scheduled to be deployed in Green Bank in mid-October. The spectrometer software has been completely rewritten under Linux C++ with significant improvements made in the areas of data acquisition speed and size of the scanned data storage. Additional software enhancements are currently under way. A fundamental form of solar monitoring is scheduled to commence before the end of the year. Furthermore, R&D work intended to increase the operating frequency of the active balun and antenna to 350 MHz will begin next quarter.

Computing and Information Services

Central Computing Services

Milestone	Original Deadline	Revised Deadline	Date Completed
Revise Security Policy	02/05/01	01/31/04	
VPN deployed (NM)	06/30/03	12/31/03	
CCE: core UNIX applications	06/30/03	07/31/03	08/31/03
CCE: Linux laptop configuration	07/31/03	10/31/03	
CCE: begin AD domain full testing	06/30/03	07/31/03	09/30/03
CCE: deploy automated Windows patching service	08/31/03		09/15/03
CCE: deploy automated Windows installation service	11/15/03		
CCE: end AD domain full testing	09/15/03	11/15/03	
CCE: begin AD production client migration	09/30/03	11/30/03	
Issue revised Windows XP policy	07/31/03		09/08/03

Security

This past quarter saw several very nasty security problems affecting millions of computers worldwide. Thanks to our Internet router filters, vigilant anti-virus maintenance, focused patching efforts, and the watchfulness of our computer users, the NRAO was almost completely spared. Less than a dozen systems were infected with any of the viruses and worms circulating during the summer, with the sources of infection being laptops infected at other locations and subsequently connected to the internal NRAO network. As a result, all sites are now being more cautious about verifying operating-system patches and anti-virus protection on non-NRAO systems, even those which are on NRAO premises for only brief periods. Anti-virus software licenses have come down in price to the point where we have now been able to purchase enough not just to cover all NRAO Windows/MacOS systems, but also deploy temporary licenses for visitors. 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.

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. Settings on the Charlottesville VPN box need to be adapted and transferred to the Socorro equipment. Deployment had been planned for this 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. 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.

During the past quarter, the UNIX group has standardized print-server configuration, completed the implementation of Dynamic DNS and associated DHCP support for all NRAO networks, upgraded the anti-virus email gateway software, implemented a mechanism to keep laptop application software synchronized with centrally-maintained versions, documented changes in RedHat Linux version 9 that will be visible to users, begun upgrading systems to RedHat 9, and continued to expand and improve documentation on computing services (helpdesks, getting started, etc.) for both users and system staff. Only minor changes to laptop configuration will be necessary to complete that task during the next quarter, when the group will also finalize time synchronization, standardize secure FTP and Samba services (sharing Unix files to Windows computers), and complete deployment of a third-party software management tool at all sites.

The Windows administrators have completed configuration of the Active Directory domain that will be the future environment for Windows systems in the Observatory; testing is now underway. The group has also set up servers at each site to support automated operating system patching. These were used very successfully following the second round of announcements of serious security flaws affecting all recent versions of Microsoft Windows. Work has recently begun on automatic Windows installation

servers. The install servers will also be able to provide every NRAO Windows computer with the set of core applications agreed upon by the administrators, including automatic inventory of hardware components and installed software. Without such automation and standardization, new systems can take several days to customize, and patching is literally impossible to keep up with. By mid- to late November, the AD domain should be substantially ready for production migration. At that time, a tutorial will be presented on the changes that our users can expect to see.

The moratorium on Windows XP at the NRAO was lifted in early September. All new installs and upgrades are now using Windows XP.

Web Infrastructure

Milestones	Original Date	Revised Date	Date Completed
Test install of Groupware products	09/30/03		09/30/03
Purchase proxy servers for VLA, CDL	06/05/03	10/31/03	
Integrate Web stats from mirrors	10/30/02	11/06/03	

The hardware on which most NRAO web services run will be augmented in the coming quarter: additional RAID disks have been ordered to provide a smooth migration to the latest operating system, to provide a "hot spare" for the filesystem from which content is served, and to increase storage space for the primary server in Charlottesville.

Preliminary work on providing a secure (SSL) web presence has begun. A test server is now operational in Green Bank, and a decision was made to roll out a secure server at each site. These will be used where sensitive information (e.g., passwords) need to be entered through the web for various uses.

Work on web statistics from all four servers continued at a lower priority level than before; given the widespread use of proxy servers by large commercial internet providers, the actual value of statistics gleaned from the web server logs is dubious at best, and hugely under-sampled at worst. However, despite this, production of "webalizer" statistics on the individual virtual servers was implemented and deployed. Integration of the statistics from the four main servers remains problematic, due to the timezone differences.

The purchase of additional proxy servers has been delayed, mainly to accommodate the schedule of construction and relocation of employees at various locations in Charlottesville. We plan on providing a web proxy for the new NRAO Technology Center once it has sufficient infrastructure and occupancy, as well as the VLA site. The existing proxy servers were updated and all four are now running the latest version of the service.

Computing and Information Services

The "spare" web server preparation continues at a good pace. The system has received its operating system and the baseline install of the latest Apache web server. Work continues on preparing it as a fifth (readonly) member of the mirroring scheme already in place on the four main servers. Preliminary tests on the server software indicate that it will resolve at least one long-standing problem with the existing infrastructure: centralization of the definition of the "intranet".

Information Infrastructure

Milestones	Original Date	Revised Date	Date Completed
Deploy mirror OpenLDAP server in NM	07/15/03		07/15/03
OpenLDAP server with Phone Book info running	04/15/03	08/19/03	08/21/03

While good progress was made in the migration to an OpenLDAP based phone directory, the departure of a key temporary worker has delayed the schedule considerably. Much time has been spent this quarter in debriefing and bringing the remaining members of the team up to speed on the details of the technology. This is an ongoing process.

A prototype directory server is in fact already running, but there are serious differences between the information it contains (gleaned automatically from a read-only connection from a Human Resources database) and the existing flat-file phone directory. It will take some time to develop the technology needed to compare and reconcile these two, and we must delay a switchover to OpenLDAP until such time as we can guarantee that no information gets lost in the transition.

Charlottesville Computing

The building activities at Edgemont Road have caused all staff in the Computing Division to relocate to temporary quarters one floor up. The effort to achieve this was considerable, as most equipment and all of several offices had to be evacuated from their regular location. Delays in the construction have forced the staff to remain in these temporary quarters longer than expected. It is hoped that we can return to our regular location in the coming quarter.

The Domain Name System (DNS) and DHCP services at NRAO/CV were upgraded to provide dynamic DNS naming during this quarter. This brings the site in line with the same services offered at other sites.

The very popular "SpamAssassin" spam tagging software was upgraded to a newer, more effective version. Sadly, the producers of e-mail spam seem to be able to stay one step ahead of the ability of SpamAssassin to catch them. However, the software (part of the infrastructure put in place to deploy

the Sophos Anti-Virus mail gateway systems) continues to be very useful in tagging mail as either "spam" (unwanted, unsolicited bulk or commercial e-mail) or "ham" (e-mail you expect and want).

The disk backup regimen implemented in the previous quarters has been enhanced to support the ever-growing prime use (non-data) filesystems. This centralized backup system can now support multiple tape volumes, which should keep our backup needs satisfied for the foreseeable future.

The system supporting the Associated Universities (AUI) web and mail services, co-located at NRAO/Charlottesville and supported by the CV Computing Division Staff, suffered not one but two devastating failures during the quarter. One was likely due to aging hardware, and the other was an unwanted byproduct of the passage of the remnants of Hurricane Isabel. Due to a solid backup regimen, the system was up and ready in each case within hours. AUI has ordered a new, server-grade system to mitigate against future incidents.

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		
Install NTC network	11/30/03		
Complete network to support the SCGB	08/31/03	12/31/03	
Upgrade network service to VLBA KP antenna	12/31/02	12/31/03	

After detailed price comparisons, the new Intranet contract was awarded to the same service provider (AT&T) at the end of February 2003 with a more cost-effective price structure available to us through the Federal Telecommunication Service (FTS2001) of the General Services Administration (GSA). Continuing with the same carrier allowed us the huge advantage of continuing our Intranet operation with no service interruption. Although there has been no disruption of service, the full implementation of the new contract did not take effect until August 2003. After two billing cycles, the new invoice structure has been accepted, although a few minor billing errors still remain.

The major effort this quarter has been to plan for the installation of networking and phones in preparation for the migration of the CDL staff from the Dynamics Building to the new NRAO Technology Center (NTC). The wiring plan is complete. To communicate between the Edgemont Road Stone Hall (SH) building and the NTC, a contract has been let for a DS3 (45Mbps) link. This will carry both data and voice services. For network support within the NTC, a contract has been let to Cisco Systems for Ethernet

switches and routers. Cisco will also provide 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 will be 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.

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

The basic network to support the Science Center at Green Bank (SCGB) is installed and operational. The more advanced components to support live video casts, streaming video, etc. was to have been completed during the summer. However, there has been an unpredicted delay in obtaining the new data circuit between Green Bank and Charlottesville.

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

Both the Science Center at Green Bank and the Visitor Center at the VLA reported healthy attendance and strong gift shop sales despite reports of lagging visitation by other "attractions" in the area during their first full period of operations in their new and renovated facilities. Installation and upgrading of exhibits at the Science Center as well as construction of the student dorm continued and made significant progress during this period. The interest in Mars during August generated a crowd of approximately 125 people for a Green Bank August Star Party compared to a typical attendance of on the order of 20. A similar event in Socorro, for which the NRAO provided support, had a turnout of 300 people.

Informal Education

Attendance at both the Science Center at Green Bank and the Visitor Center at the VLA was good despite reported lower than usual attendance at "attractions" near Green Bank. Prior to the opening of the new Science Center at Green Bank, attendance numbers were based mainly on tour participant numbers, while at the VLA estimates were even less accurate based on a visitor guest book at what was then an unstaffed facility. In the future, attendance numbers, although not based on an official admissions fee count, should be considerably more reliable.

Although start-up staffing issues were an issue at both the Science Center at Green Bank and the new gift shop at the VLA Visitor Center, both facilities had a very successful summer. Gift shops at both facilities finished the fiscal year exceeding revenue predictions which had been made, despite the fact that both gift shops opened later than had been initially expected.

Gift Shop	Predicted	Actual
Green Bank	$80,000	$87,391
VLA	$23,500	$47,281

Education and Public Outreach

The new Science Center in Green Bank with construction complete.

The doors to the Science Center in Green Bank opened to the public on Memorial Day weekend, yet installation, improvement, and refinement of new exhibits continued through the summer months in the 4,000 square foot exhibit gallery. Exhibit topics covered include pulsar simulation, light waves, Doppler effect, spectrum, mirror shapes, image generation, how mirrors focus energy, a 3D constellation, radio astronomy discoveries, Green Bank astronomy history, a model of the Milky Way Galaxy overhead, and a working small-scale replica of the Robert C. Byrd Green Bank Telescope. The majority of the exhibits are hands-on interactive exhibits, drawing visitors of all ages into the process. The total attendance numbers below include 446 for school groups and 314 for private groups at Green Bank plus 385 attending 18 private tours at the VLA.

Site	July	August	September
Green Bank	6,707	5,493	2,875
VLA	2,363	1,813	1,470

Education and Public Outreach

The view from the entrance into the Exhibit Hall of the Science Center at Green Bank.

Café revenue at the Science Center at Green Bank did not do as well as the Gift Shop, producing somewhat more than 25% of the predicted revenue. At this time, the result is neither surprising, nor an immediate cause for concern as food service tends to be less predictable and usually takes longer to garner clientele. On the optimistic side, per person expenditure at the café increased by about 60% compared to those revenues in July and August.

In a cooperative effort, the Pocahontas County Convention & Visitor Bureau provides a receptionist at the Science Center, who also imparts information about Pocahontas County for visitors. In addition to assisting with staffing the Science Center, this situation creates additional incentive for stopping at the Observatory and the Science Center for a visit. Construction of the dorm building that will house visiting student, youth, and other educational groups during visits to the Observatory proceeded, with expected completion now in late autumn.

Formal Education

Summer time is a busy time for many formal programs. In Socorro, the Chautauqua program, Interferometry in Radio Astronomy, was held in July. Green Bank was particularly busy with a week long NRAO/NASA Goddard teacher workshop on Living with a Star, the Single Dish Summer School, and a workshop on High Frequency Science with the GBT. The Single Dish Summer School is a partnership with NAIC, held every other year alternating between Green Bank and Arecibo, and is focused strongly on students interested in doing radio astronomy. The High Frequency Science with the GBT workshop's focus was discussion of the possibilities becoming available as the GBT attains its high frequency capabilities.

Education and Public Outreach

Visitors from the National Youth Science Camp both toured much of the Observatory and some did observing with the 40-foot telescope at Green Bank. The week long ERIRA (Education Research in Radio Astronomy – a cooperative effort of the NRAO, the University of Chicago, and Ohio State University) workshop was held with tours and observing projects for high school and undergraduate students. Penn State visited Green Bank for their own version of a Single Dish Summer School for high school and undergraduate students.

The two RET teachers and six of the REU students at Green Bank

Summer saw the completion of this year's summer programs for teachers (NSF Research Experience for Teachers). All three teachers who participated in the program this summer have indicated an intention to present a paper at AAS conferences, with two in January and one in spring. One teacher was in Socorro and the other two were in Green Bank.

Community Relations

The NRAO was again one of the sponsors of the Enchanted Skies Star Party. In addition to considerable support from Dave Finley and John Spargo, Chris Carilli was one of the primary speakers. A tour of the VLA site was a highlight of the first day of the star party.

Green Bank hosted the county 4H fair. Star Parties are held monthly at Green Bank from June through October and the August event coincided with the close approach of Mars, producing an attendance of about 125 people, about six times the typical attendance. A similar event at the Etscorn Observatory on the New Mexico Tech campus drew about 300 people with NRAO staff helping to operate the telescopes.

Education and Public Outreach

Astronomy Community

NRAO press releases and stories this season covered narratives about CO in the distant universe as evidence for the first stars, ALMA partners (NRAO and ESO) being ceded the land to use for the ALMA site, a pulsar location mystery (which also became a last minute news brief story for Nature), the Jansky lectureship announcement, and expansion of the NRAO Jansky Fellowship program.

As the date for the Conference on Communicating Astronomy approached efforts became more intensive. Instead of the 60 to 70 participants, the program committee had anticipated, the registration swelled to over 130, and it was necessary to create a waiting list with another 20 people. Conference calls were held individually with the panelists groups (six) to discuss the issues expected to be covered. A meeting facilitator was also arranged, so that the conference would be kept running on time and on target. The poster session was doubled in size to accommodate most, though not all, who wanted to participate in this aspect. The post conference plans call for a tour of the NRAO Green Bank facilities on the Saturday following the meeting by attendees. A request for NSF support for this conference was approved.

To meet the continuing needs of the Observatory, significant EPO staff effort was provided for producing the new AUI Management Proposal, the 2004 Program Plan, the October Newsletter, the Point Source, various NRAO brochures, plus images and mats for retirement and award ceremonies.

Media Relations

The educational display in the baggage claim area of the Charlottesville Airport continues to attract notice as visitors and residents obtain their luggage. Notice of the display is essentially unavoidable for anyone waiting there.

Education and Public Outreach

One of the two new I25 signs (northbound & southbound) alerting travelers to the existence of the NRAO, the VLA, and the Visitor Center.

A long-awaited and anticipated pair of signs was installed outside Socorro. Success in the distribution of NRAO pamphlets by the Albuquerque Convention and Visitors Bureau (which the NRAO recently joined), has led to the pleasing problem of having to reprint that pamphlet. During the summer, the VLA made the front cover and was also featured in the AAA New Mexico magazine. In early August the Education Alliance of West Virginia requested and held a signing ceremony at Green Bank to mark the agreement of the NRAO with the Education Alliance partnership to enhance education efforts in West Virginia. The NRAO is the Education Alliance's first state wide partner.

Education and Public Outreach

Mike Holstine of the NRAO and Randy Shillingburg of the Education Alliance.

Filming continues to keep us busy. At the VLA there were shoots arranged for a story on pulsars, a commercial ad, and a British music program using a shot of the VLA for Holst's The Planets. National Geographic in August ran an article, "The Driest Place on Earth," about the Atacama Desert. Though it did not mention ALMA, we did secure permission to link to their on-line information for an upcoming web page about the region where ALMA will be built.

Environment, Safety, and Security

ALMA Test Facility

During this quarter, the ALMA Safety Officer participated in an ALMA Safety Standards meeting at the AOC. ES&S worked with the AEC Antenna group for a redesign of the Lockout/Tagout system for the AEC antenna, and on the Vertex antenna tested new procedures for use of the platform hoist.

NRAO-NM

During this quarter ES&S worked on the planning of an Emergency Preparedness Plan tabletop exercise. In providing community liaison for the NRAO, Jon Spargo was elected Vice Chair of the Socorro County Local Emergency Planning Committee (LEPC) which is responsible for getting the LEPC By-Laws approved by the Socorro County Commission. The LEPC will write an All Hazards Disaster Plan for Socorro County. Emergency Services at the VLA is considered a part of that Plan.

During this quarter the annual inspection and testing of the sprinkler systems and devices was initiated. The annual inspection and testing was conducted on September 17-18 and 19. Because of a main water line break the testing of the hydrants was terminated. It will be re scheduled later in the year. Also during the quarter the State Fire Marshall conducted a fire inspection of the new VLA Visitor Center Gift Shop. ES&S organized all work needed to complete the inspection punch list and bring the Gift Shop into compliance with the National Fire Codes. This included a follow up inspection, which was passed with no problems.

ES&S worked with the EVLA Data Acquisition Group to develop procedures for splicing fiber optic cables in remote locations along the arms of the VLA. This included the writing a new Job Safety Analysis (JSA) for group members that will do the splicing operation. This also involved working out a procedure to insure employee safety in remote splicing locations, which necessitated a variance to the VLA Two Person Rule.

NRAO-GB

The NRAO GB site was inspected for hazardous chemicals. This was the annual inventory and included lab use as well as warehouse storage of chemicals. In conjunction with the inventory, the database of hazardous materials safety data sheets was updated. The chemicals in use in the former photo lab were included in the inventory and preparation made for the disposal of all waste chemical materials. The GB rescue team conducted additional periodic training at the 140 foot telescope. ES&S is currently assisting in identifying safety issues associated with the possible future use of the 140 foot telescope.

Environment, Safety, and Security

NRAO-CV

Work at the CV Edgemont Road site includes the removal of asbestos containing materials. Proper safety measures were implemented by the contractor to ensure NRAO staff safety during the asbestos removal. ES&S participated in the planning for the move from the Ivy Road facility to the NTC and advised on issues including fire and life safety as well as the transport of hazardous materials. 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.

General

During this quarter, 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. In addition, the Business Continuity Plan was worked on and the Hurricane Isabel provided an unplanned testing of the communications at the CV facilities. Due to the loss of power during this hurricane, several areas for improvement were identified. These include communication with employees, emergency power backup, and computer/telephone services. ES&S is continuing to work with the Administrative Division to ensure a proper and prompt response to emergency situations.

Telescope Usage

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

	VLA	**VLBA**	**GBT**
Scheduled Observing (hrs)	1678.4	1076.6	1013
Scheduled Maintenance and Equipment Changes	238.3	248.4	599
Scheduled Tests and Calibration	297.4	278.8	595
Time Lost	101.2	38.8	79
Actual Observing	1577.2	1037.8	1071

GBT Observing Programs

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

No.	Observer(s)	Programs
BM193	Momjian, E. Romney, J. Carilli, C. Troland, T. (Kentucky)	Multi-frequency continuum observations of the LIRG NGC 7674. 3.5, 6 cm
BP107	Philstrom, Y. O'Dea, C. (STScI) Bechtold, J. (Arizona) Conway, J. (Onsala Space Observatory)	Distribution of HI absorbing gas in the compact radio source OQ208. 21 cm
GBT01A-007	Heiles, C. (UC, Berkeley)	Direct measurement of the magnetic field in M31 using Zeeman splitting. 21 cm
GBT01A-057	Chatterjee, S. (Cornell) Cordes, J. (NAIC and Cornell) Lazio, T. J. W. (NRL) Goss, W. M. Fomalont, E. Benson, J. Stairs, I. (U. of British Columbia) Brisken, W. Thorsett, S. (UC, Santa Cruz)	Neutron star kinematics: VLB pulsar parallaxes with the GBT. 21 cm
GBT02A-002	Turner, B. Heiles, C. (UC, Berkeley)	A search for the C4H Zeeman effect in dense molecular clouds as a test of polarization characteristics of the GBT. 3.5 cm
GBT02A-012	Minter, A. Balser, D.	Probing HI structure on sub-A.U. - A.U. scales: Hydrodynamical or MHD turbulence? 21 cm
GBT02A-028	Braatz, J. Langston, G. McMullin, J. Garwood, R.	Exploring the radio spectrum of Orion A and W51. 90, 21, 11, 6, 2, 3.5 cm

GBT Observing Programs

GBT02A-030	Nord, M. (NRL) Lazio, T. J. W. (NRL) Kassim, N. (NRL)	Imaging the galactic center at 330 MHz. 90cm
GBT02A-031	Lockman, F. J.	Galactic HI mapping of X-Ray, UV, and optical deep fields. 21 cm
GBT02A-062	Camilo, F. (Columbia) Halpern, J. (Columbia) Stairs, I. (U. of British Columbia) Backer, D. (UC, Berkeley) Arzoumanian, Z. (NASA/GSFC)	Studying PSR J2229+6114: an energetic Gamma-ray emitting young pulsar. 21 cm
GBT02B-006	Yusef-Zadeh, F. (Northwestern) Roberts, D.(Northwestern) Maddalena, R.	A survey of supernova remnant masers at OH (1720, 1665/67 MHz). 18 cm
GBT02C-007	Dickey, J. (Minnesota) Kavars, D. (Minnesota) Lockman, F. J. Martin, P. (U. of Toronto) McClure-Griffiths, N. (CSIRO) Rothwell, T. (U. of Toronto) Stil, (U. of Calgary) Taylor, R. (U. of Calgary)	A quick GBT HI survey of the inner galactic plane. 21 cm
GBT02C-009	Heiles, C. (UC, Berkeley) Robishaw, T. (UC, Berkeley)	The global galactic magnetic field inside the solar circle. 21 cm
GBT02C-010	Heiles, C. (UC, Berkeley) Robishaw, T. (UC, Berkeley)	Zeeman splitting of the 21 cm emission line of the warm neutral medium. 21 cm
GBT02C-013	Crutcher, R. (Illinois, Urbana) Troland, T. (Kentucky) Sarma, A. (Illinois, Urbana)	Magnetic fields in high-density cores: excited OH Zeeman observations. 6 cm
GBT02C-023	Lockman, F. J.	A study of the HI clouds in the galactic halo. 21 cm

GBT Observing Programs

GBT02C-034	Camilo, F. (Columbia) Stairs, I. (U. of British Columbia) Lorimer, D. (Manchester) Backer, D. (UC, Berkeley) Ransom, S. (McGill)	Timing observations of the young pulsar in supernova remnant 3C58. 38, 21 cm
GBT02C-046	Troland, T. (Kentucky) Heiles, C. (UC, Berkeley)	The strength and structure of the galactic-wide magnetic field (HI Zeeman). 21 cm
GBT02C-056	Kaspi, V. (McGill) Lyutikov, M. (McGill) Ransom, S. (McGill) Kouveliotou, C. (MSFC/NASA)	GBT observations of SGR 1806-20 or SGR 1900+14 during outburst. 21, 11 cm
GBT02C-059	Wannier, P. (JPL) Vastel, C. (Caltech Submillimeter Obs.) Brogan, C.	HI spin temperature determination towards W49N and W31C. 21 cm
GBT02C-060	Nice, D. (Princeton) Stairs, I. (U. of British Columbia) Arzoumanian, Z. (NASA/GSFC)	Pulsar orbital velocities from scintillation measurements. 90 cm
GBT03A-006	Kronberg, P. (Los Alamos Labs) Perley, R. Giovannini, G. (Istituto di Radioastronomia) Ensslin, T. (MPIR) Kassim, N. (NRL)	Proposal to search for diffuse low frequency synchrotron-radiating extensions of the Coma cluster. 90 cm
GBT03A-014	Lockman, F. J.	Halo HI clouds: distribution and properties. 21 cm
GBT03A-016	Stairs, I. (U. of British Columbia) Manchester, R. N. (Australia Telescope) Lyne, A. (NRAL)	The physics of a massive pulsar system. 21cm
GBT03A-023	Stairs, I. (U. of British Columbia) Thorsett, S. (UC, Santa Cruz) Arzoumanian, Z. (NASA/GSFC)	Timing binary pulsars at the GBT. 21 cm

GBT Observing Programs

GBT03B-013	Yun, M. (Massachusetts) Schneider, S. (Massachusetts) Brinks, E. (INAOE) Bravo-Alfaro, H. (Universidad de Guanajuato, Mexico)	An unbiased HI survey of the Coma cluster and beyond. 21 cm
GBT03B-014	Stairs, I. (U. of British Columbia) Ransom, S. (McGill) Kaspi, V. (McGill) Hessels, J. W. T. (McGill) Backer, D. (UC, Berkeley)	Confirming the pulsar candidate in the globular cluster M80. 38, 21 cm
GBT03B-015	Ransom, S. (McGill) Stairs, I. (U. of British Columbia) Kaspi, V. (McGill) Hessels, J. W. T. (McGill) Backer, D. (UC, Berkeley)	Timing the pulsars in the globular cluster M30. 38, 21, 11 cm
GBT03B-022	Roberts, M. (McGill) Ransom, S. (McGill) Kaspi, V. (McGill) Hessels, J. W. T. (McGill) Backer, D. (UC, Berkeley)	Deep pulse searches of galactic gamma-ray sources. 38, 21 cm
GBT03B-026	Roberts, M. (McGill) Hessels, J. W. T. (McGill) Ransom, S. (McGill) Kaspi, V. (McGill) Tam, R. (McGill) Livingstone, (McGill) Backer, D. (UC, Berkeley) Crawford, F. (Haverford College)	Timing of a millisecond pulsar discovered in a survey of mid-latitude EGRET error boxes. 38, 21 cm
GBT03B-030	Benjamin, R. (Wisconsin, Madison) Lockman, F. J.	High velocity clouds interacting with the Milky Way? 21 cm

GBT Observing Programs

GBT03B-038	Beaulieu, S. (Universite Laval) Freeman, K. (Australian National U.) Lockman, F. J.	Observations of HI in two dwarf spheroidal galaxies. 21 cm

VLA Observing Programs

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

No.	Observer(s)	Programs
AA278	Anderson, J. (NMIMT) Ulvestad, J.	Estimating LLAGN sizes using intraday variability. 3.6 cm
AA289	Araya, E. (Puerto Rico)	Formaldehyde maser in IRAS 18566+0408. 6 cm
AB1085	Bower, G. (UC, Berkeley) Falcke, H. (MPIR, Bonn)	Polarimetry of LLAGN. 0.7, 1.3, 2 cm
AB1086	Bower, G. (UC, Berkeley) Muno, M. (MIT) Baganoff, F. (MIT)	Chandra X-ray sources in central 17 arcmin of the Galaxy. 1.3, 3.6 cm
AB1089	Brogan, C. Kassim, N. (NRL) Lazio, T. J. W. (NRL) Gaensler, B. (CfA) Devine, K. (Carleton College)	Low frequency galactic plane observations. 90 cm
AB1092	Beck, S. (Tel-Aviv U.) Turner, J. (Calif., Los Angeles)	Compact infrared sources in starburst galaxies. 3.6, 6, 20 cm
AB1094	Bik, A. (Amsterdam) Kurtz, S. (Mexico/UNAM) Kaper, L. (Amsterdam) Waters, R. (Amsterdam) Lenorzer, A. (Amsterdam)	Emission line objects in massive star forming regions. 3.6, 6 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

VLA Observing Programs

AB1099	Brookes, M. (Edinburgh) Best, P. (Edinburgh) Rottgering, H. (Leiden) Peacock, J. (Edinburgh) Dunlop, J. (Edinburgh)	Spectral indices of sources from EIS-NVSS survey. 90 cm
AC628	Castelletti, G. (IAFE) Kassim, N. (NRL) Dubner, G. (IAFE)	Supernova remnant W44 at low frequency. 90 cm
AC631	Claussen, M. Sahai, R. (JPL) Sanchez-Contreras, C. (JPL)	The 1667 MHz OH masers in the proto planetary Nebula He 3-1475. 20 cm
AC647	Clarke, T. (Virginia) Neumann, D. (CNRS, France) Kassim, N. (NRL)	Low frequency observations of cooling flow clusters. 90 cm
AC675	Curiel, S. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Trinidad, M. (Mexico/UNAM) Loinard, L. (Mexico/UNAM) Torrelles, J. (IAA, Andalucia) Canto, J. (Mexico/UNAM) D'Alessio, P. (Mexico/UNAM) Raja, A. (Mexico/UNAM)	Orbital motions in L1551 IRS5 binary system. 0.7, 2 cm
AC676	Capetti, A. (Torino) Santantoni, L. (Torino)	Radio structure of galaxies with type Ia supernovae. 20cm
AC677	Coker, C. (NRL) Lazio, T. J. W. (NRL) Rickard, L. (NRL)	Simultaneous radio and optical observations of the ionosphere. 400 cm

VLA Observing Programs

AC680	Carilli, C. Cox, P. (IAP, Paris) Bertoldi, F. (MPIR, Bonn) Walter, F. Djorgovski, G. (Caltech) Mahabal, A. (Caltech) Petric, A. (Columbia) Beelen, A. (IAP, Paris) Lewis, G. (Sydney Univ.)	Imaging the most distant Einstein ring at 1.4 GHz. 20 cm
AC682	Clarke, T. (Virginia) Kempner, J. (Virginia)	Radio X-ray power relation for cluster radio halos. 90 cm
AC683	Cohen, A. (NRL) Lane, W. (NRL) Kassim, N. (NRL) Lazio, T. J. W. (NRL) Cotton, W. Condon, J. Perley, R.	Ultra-steep spectrum sources. 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
AD483	Darling, J. (Cornell)	OH megamaser galaxies – line and continuum observations. 20 cm
AF400	Fontani, F. (Arcetri) Beltran, M. (Arcetri) Cesaroni, R. (Arcetri) Testi, L. (Arcetri) Walmsley, C. (Arcetri)	Water masers in candidate massive YSOs. 1.3 cm
AF403	Fender, R. (Amsterdam) Migliari, S. (Amsterdam) Blundell, K. (Oxford)	Simultaneous Chandra and VLA images of SS433's jets and wind. 6 cm

VLA Observing Programs

AG650	Golden, A. Muxlow, T. (Manchester) Brisken, W. van der Saluw, E. (Utrecht)	Shock structures within PSR B1951+32's Plerion and CTB 80. 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
AH812	Hagiwara, Y. (ASTRON)	Water maser emission in a Seyfert 1 galaxy. 1.3 cm
AH813	Hardcastle, M. (Bristol, UK) Kraft, R. (CfA) Worrall, D. (Bristol, UK)	Proper motion and variability in the jet of Cen A. 3.6 cm
AH817	Higdon, J. (Cornell) Weedman, D. (Cornell) Jannuzi, B. (Inst. Advanced Studies) Dey, A. (NOAO) Rieke, M. (Arizona) Soifer, B. (Caltech)	Star formation history of the high-z universe: A Deep 20 cm survey of the NOAO Bootes field. 20 cm
AH820	Hyman, S. (Sweet Briar) Lazio, T. J. W. (NRL) Neureuther, J. (Sweet Briar) Nord, M. (NRL) Kassim, N. (NRL)	Galactic center radio transient monitoring program. 90 cm
AH821	Hardcastle, M. (Bristol, UK)	Physical conditions and emission mechanisms in 3C351 hotspots. 0.7, 1.3, 2 cm
AH823	Hynes, R. (Texas) Rupen, M. Charles, P. (Southampton) McClintock, J. (CfA) Fender, R. (Amsterdam)	Accretion geometry of a quiescent black hole. 2, 3.6, 6 cm

VLA Observing Programs

AH824	Harper, G. (Colorado) Brown, A. (Colorado) Guinan, E. (Villanova) Brown, J. (Caltech)	Evolution of Betelgeuse's extended atmosphere. 0.7,1.3, 2, 3.6, 6, 20 cm
AH825	Hofstadter, M. (JPL) Butler, B.	Seasonal variations and depth probing of the Uranus atmosphere. 2, 6, 20 cm
AI108	Ivison, R. (Royal Obs) Dunlop, J. (Edinburgh)	Deep imaging of the SHADES survey: the SCUBA population. 20 cm
AJ298	Johnson, K. (Wisconsin) Seth, A. (Washington)	Massive star formation in magellanic irregular NGC6822. 6 cm
AK509	Kulkarni, S. (Caltech) Frail, D. Galama, T. (Caltech) Bloom, J. (Caltech) Berger, E. (Caltech) Harrison, F. (Caltech)	Radio afterglows from gamma-ray bursts. 0.7, 1.3, 2, 3.5, 6, 20 cm
AK550	Kulkarni, S. (Caltech) Edo Berger (Caltech) Soderberg, A. (Caltech) Chevalier, R. (Virginia)	Type Ibc supernovae. 1.3, 3.6, 6, 20 cm
AK560	Keto, E. (CfA)	Continuing accretion in massive star formation 1.3 cm
AK569	Kaaret, P. (Columbia) Corbel, S. (CNRS, France) Rupen, M.	Radio counterparts to ultra-luminous X-ray sources.3.6, 6, 20 cm
AL560	Lazio, T. J. W. (NRL) Fabian, A. (Cambridge) Kassim, N. (NRL) Perley, R.	Old radio lobes in the intra-cluster medium of the Perseus cluster. 400 cm

VLA Observing Programs

AL591	Lazio, T. J. W. (NRL) Dietrick, J. (NRL) Greenlees, E. (NRL) Hogan, E. (NRL) Jone, C. (NRL) Hennig, L. (NRL) Farrell, W. (NASA/GSFC) Desch, M. (NASA/GSFC)	Search for coherent cyclotron emission from extrasolar. 400 cm
AL595	Lacy, M. (UC, Davis) Laurent-Muehleisen, S. (UC,Davis) Becker, B. (UC, Davis)	Radio-intermediate quasars from FIRST bright quasar survey. 20 cm
AL596	Lee, T-H. (Calgary) Kwok, S. (Calgary)	Dust distribution and morphology of Pne. 1.3, 2 cm
AL597	Laing, R. (Oxford) Bridle, A. Parma, P. (Bologna)	Spectrum of 3C31 from 74 to 8400 MHz. 90, 400 cm
AM723	Marscher, A. (Boston) Jorstad, S. (Boston) McHardy, I. (Southampton)	VLA/Chandra imaging of quasar jets. 6 cm
AM760	Miller, N. (NASA/GSFC)	Unusually compact galaxy in A2255: starburst or AGN? 3.6, 6 cm
AM766	Monnier, J. (Michigan) Greenhill, L. (CfA) Ribo, M. (Barcelona) Tuthill, P. (Sydney) Danchi, W. (NASA/GSFC)	Monitoring colliding wind binary WR112. 3.6 cm
AM768	Momjian, E. Romney, J. Carilli, C. Troland, T. (Kentucky)	LIRG NGC 7674. 1.3 cm

VLA Observing Programs

AM780	Moscadelli, L. (Bologna) Furuya, R. (Arcetri) Claussen, M. Kitamura, Y. (ISAS, Japan) Testi, L. (Arcetri) Wootten, H.A.	Selecting YSOs for watermasers proper motion studies. 1.3 cm
AN107	Neff, S. (NASA/GSFC) Ulvestad, J	High resolution imaging of the young merger NGC 3395/6. 3.6, 6 cm
AN115	Neff, S. (NASA/GSFC) Ulvestad, J.	Survey of AGN in galaxy mergers. 3.6 cm
AP457	Perlman, E. (Maryland) Ebeling, H. (Hawaii) Scharf, C. (STScI) Horner, D. (NASA/GSFC)	Evolution of cluster radio galaxies at the highest redshifts. 20 cm
AR514	Romani, R. (Stanford) Brisken, W.	In-beam calibrator survey for astrometry of PSR J0538+2817. 20 cm
AR517	Romani, R. (Stanford) Ulvestad, J. Michelson, P. (Stanford) Sowards-Emmerd, D. (Stanford)	Flat spectrum source survey of candidate EGRET blazers. 3.6 cm
AS761	Sjouwerman, L. Dickel, J. (Illinois) Kong, A. (CfA) Johnson, K. (Wisconsin) Williams, B. (Delaware) Dyer, K.	Polarization measurements of the center of M31. 6 cm
AS764	Spangler, S. (Iowa)	Coronal magnetic fields on scales 1000 to 50000 km. 20 cm

VLA Observing Programs

AS767	Schinnerer, E. Carilli, C. Scoville, N. (Caltech) Vettolani, P. LeFevre, O. (Marseille Obs) Ciliegi, P. (Bologna) Bondi, M. (Bologna)	COSMOS deep 1.4 GHz imaging survey: probing cosmic evolution. 20 cm
AS769	Stairs, I. (British Columbia) Brisken, W. Manchester, D. (CSIRO) Lyne, A. (Manchester)	Precise position for the massive binary pulsar J1740-3052. 20 cm.
AU094	Ulvestad, J. Barger, A. (Wisconsin) Steffen, A. (Wisconsin) Condon, J.	Accretion history of the universe from survey of Lockman Hole NW. 6 cm
AU095	Umana, G. (Bologna) Trigilio, C. (Bologna) Leone, F. (Catania) Cerrigone, L. (Catania)	Morphologies of young planetary nebulae. 3.6 cm
AV268	deVries, W. (LLNL) van Breugel, W. (LLNL) Kassim, N. (NRL) Cohen, A. (NRL) Dawson, S. (UC, Berkeley) Lacy, M. (UC, Davis) Rottgering, H. (Leiden)	Obervations of SIRTF First-Look field. 90 cm
AW605	Walter, F. Brinks, E. (Guanajuato U.) de Blok, E. (Cardiff) Thornley, M. (Bucknell) Kennicutt, R. (Arizona)	HI structures of nearby galaxies. 20 cm

VLA Observing Programs

AW607	Winn, J. (CfA) Rusin, D. (CfA) Kochanek, C. (CfA) Lovell, J. (CSIRO) Fassnacht, C. (UC, 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. (Penn State)	ToO observations of supernovae. 1.3, 2, 3.6, 6, 20, 90 cm
AZ143	Zhao, J-H. (CfA) Herrnstein, R. (CfA) Goss, W.M. Bower, G. (UC, Berkeley) Pegg, J. (CfA)	Monitoring quasi-periodic oscillations of Sgr A*. 0.7, 1.3, 2 cm
BC137	Cesaroni, R., et al. (See VLBA Observing Program)	Water and OH masers tracing bipolar outflows in G24.78+0.08. 1.3 cm
BC139	Claussen, M., et al. (See VLBA Observing Program)	Tests of water maser phase referencing. 1.3 cm
BF073	Fomalont, E., et al. (See VLBA Observing Program)	VLBI/INTEGRAL observations of Sco X-1. 3.6 cm
BG129	Greenhill, L., et al. (See VLBA Observing Program)	SiO proper motions in Orion KL. 0.7 cm
BH102	Hoffman, I., et al. (See VLBA Observing Program)	Full Stokes observations of the W44 OH (1720 MHz) masers. 20 cm

VLA Observing Programs

BH116	Homan, D. Cheung, T. (Brandeis) Wardle, J (Brandeis)	Small to large scale radio jet structure in the 180 degree misaligned blazar PKS 1510-089. 90 cm
BM193	Momjian, E., et al. (See VLBA Observing Program)	LIRG NGC 7674. 3.6, 6, 90 cm
BM196	Mioduszewski, A., et al. (See VLBA Observing Program)	Movie of the precessing jet and equatorial outflow in SS 433. 20 cm
BR088	Ratner, M ., et al. (See VLBA Observing Program)	Astrometry of HR 8703 in 2003 for gravity probe-B mission. 3.6 cm
BS130	Stockdale, C., et al. (See VLBA Observing Program)	Polarimetric and spectral-index mapping of J0253+3835. 20 cm
BW067	Walker, R. C., et al. (See VLBA Observing Program)	Patterns in the 3C120 jet from 0.5 to 6 arc seconds. 90 cm

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VLBA Observing Programs

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

No.	Observer(s)	Programs
BA053	Attridge, J. (Haystack) Homan, D. (Brandeis) Phillips, R. (Haystack) Wardle, J. (Brandeis)	86 and 43 GHZ linear polarization of five AGN with the VLBA, 0.3, 0.7 cm
BB159	Bachiller, R. (OAN) Codella, C. (Arcetri) Desmurs, J. (OAN) Marvel, K. (AAS) Rioja, M. (OAN) Santiago-Garcia, J. (OAN)	Precession and outbursts in protostellar outflows. 1 cm
BB166	Bower, G. (UC, Berkeley) Baganoff, F. (MIT) Dhawan, V. Muno, M. (MIT)	Observation of X-ray point sources in Galactic Center 17′ field. 3.6cm.
BB171	Beswick, R. (Manchester) Pedlar, A. (Manchester)	Multi-frequency radio continuum observations of the core components in the steep spectrum core radio galaxy 3C293. 0.4, 2, 13 cm
BC120	Chatterjee, S. (Cornell) Backer, D. (UC, Berkely) 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. J. W. (NRAL) Lyne, A. (Manchester) McKinnon, M. Thorsett, S. Wong, D. (Cornell)	Pulsar astrometry with the VLBA. 20 cm

VLBA Observing Programs

BC127	Cawthorne, T. (Lancashire) Gabuzda, D. (Cork) Jorstad, S. (Boston) Marscher, A. (Boston) Stirling, A. (Lancashire)	Precessing jet in BL lacertae. 0.4, 0.7, 1.3, 2 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. J. W. (NRL) Arzoumanian, Z. (NASA/GSFC)	Proper motion of a faint anomalously-located pulsar. 20 cm
BC137	Cesaroni, P. (Arcetri) Beltran, M. (Arcetri) Codella, C. (Firenze) Furuya, R. (Arectri) Moscadelli, L. (Cagliari) Testi, L. (Arcetri)	Study of H20 and OH masers tracing two bipolar outflows in the high mass cluster G24.78+08. 1.3, 20 cm
BC138	Cheung, T. (Brandeis) Taylor, G. Wardle, J. (Brandeis)	Three lobe-dominated quasars with radio/optical hotspots. 90 cm
BC139	Claussen, M. Goss, W. M. Beasley, A. (OVRO) Moellenbrock, G.	Tests of water maser phase referencing for astrometry of galactic water masers. 1.3 cm
BC141	Claussen, M. Morris, M. (UCLA) Sahai, R. (JPL) Sanchez-Contreras, C. (OVRO)	Magnetic fields in bipolar preplanetary nebulae. 20 cm

VLBA Observing Programs

BD097	Dhawan, V. Fomalont, E. Lestrade, J. (Obs. de Paris) Mioduszewski, A. Rupen, M.	Astrometry of X-Ray binaries. 6, 20 cm
BE025	Engels, D. (Sternwarte) Brand, J. (Bologna) Perez-Torres, M. (Bologna)	Imaging the putative disk of the transvestite star V778 Cyg. 1.3 cm
BE029	Edwards, P. (ISAS) Falcone, A. (Purdue) Horan, D. (CfA) Kataoka, J. (Tokyo Inst.) Piner, B. (Whittier College)	Structure and evolution. TeV gamma ray source H1426+428. 0.4 cm
BE031	Edwards, P. (ISAS) Piner, B. (Whittier College)	Better determination of the apparent jet speed in PKS 2155-304. 2 cm
BF073	Fomalont, E. Bradshaw, C. (George Mason) DiSalvo, T. (Amsterdam) Fender, R. (Amsterdam) Geldzahler, B. (NASA/GSFC) Stella, L. (Milan) van der Klis, M. (Amsterdam)	OVLBI/INTEGRAL observations of Sco X-1. 0.4 cm
BG116	Geldzahler, B. (NASA) Bradshaw, C. (George Mason) Fomalont, E.	Astrometric observations of the compact radio source G127.11+0.54. 0. 4 cm
BG129	Greenhill, L. (CFA) Chandler, C. Reid, M. (CFA) Moran, J. (CFA) Diamond, P.	SiO proper motions in Orion KL. 0.7 cm

VLBA Observing Programs

BG131	Gabuzda, D. (Cork) Croke, S. (Cork) Vetukhnovskaya, Y. (ASC)	Nature of variable sheath structures surrounding the jets of compact AGN. 04., 1.3, 2, 6 cm
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 H20 masers in the planetary nebula. K3-35. 1 cm
BG136	Giroleti, M. (Mexico/UNAM) Giovannini, G. (Inst. d'Radio Astronomia) Taylor, G.	Phased referenced observations of low power radio galaxies with sub-arcsecond structure. 20 cm
BG137	Gabuzda, D. (Cork) Murray, E. (Cork)	Searching for Toroidal B fields I the jets of three BL Lac objects. 0.4, 2 cm
BH102	Hoffman, I. (New Mexico) Goss, W.M. Brogan, C. (Univ. Hawaii) Claussen, M.	Full Stokes observations of the W44 OH (1720 MHz) masers. 18 cm
BH105	Hough, D. (Trinity) Aars, C. (Texas Christian)	Variability in the nuclei of lobe-dominated quasars. 0.4, 2 cm
BH107	Horiuchi, S. (JPL) Kameya, O. (NAO) Migenes, V. (Guanjuato)	Highly polarized water masers in Orion KL. 1.3 cm
BH111	Horiuchi, S. (JPL) Lister, M. Piner, B. (Whittier College) Preston, B. (JPL)	Magnetic field orientation around polarized core of superluminal quasar 1642+690. 0.4, 0.7, 1.3, 2, 6 cm

VLBA Observing Programs

BH113	Hong, X. (Shanghai Obs.) An, T. (Shanghai Obs.) Jiang, D. (Shanghai Obs.) Wang, W. (Shanghai Obs.) Zhao, J.H. (CfA)	Millimeter VLBA observations of the core structure on a sub-parsec scale in AGN 1156+295 at z=0.7. 2, 3.6, cm
BH115	Hough, D. (Trinity) Aars, C. (Trinity)	Parsec-scale jet speeds. 4 cm
BI027	Imai, H. (JIVE) Diamond, P. (Manchester)	Evolution of a molecular jet from the AGB star W43A. 1.3 cm
BJ036	Jorstad, S. (Boston) Marscher, A. (Boston) Yurchenko, A. (St. Petersburg)	Magnetic field orientation around polarized core of the core of the superluminal quasar 1642+690. 0.4, 0.7, 1, 2 cm
BK105	Kong, A. (CfA) Dickel, J. (Illinois) Sjouwerman, L.	Spatial extent of Braun-100; a young SNR in M31? 20 cm.
BL104	Hong, X. (Shanghai Obs.) An, T. (Shanghai Obs.) Jiang, D. (Shanghai Obs.) Wang, W. (Shanghai Obs.) Zhao, J. H. (CfA)	Millimeter VLBA observations of the core structure on a sub-parsec scale in AGN 1156+295 at z=0.7. 2, 3.6, cm
BL111	Lister, M. Aller, H. (Michigan) Aller, M. (Michigan) Cohen, M. (Caltech) Homan, D.	Monitoring of jets in AGN with VLBA experiments. 2 cm

VLBA Observing Programs

BL115	Lanyi, G. (JPL) Boboltz, D. (USNO) Charlot, P. (Bordeaux) Fey, A. (USNO) Fomalont, E. Gordon, D. (NASA) Ma, C. (NASA) Sovers, O. (Remote Sensing) Taylor, G. Ulvestad, J.	High precision K/Q band astrometry. 0.7, 1.3 cm
BL116	Lara, L. (Granada) Alberdi, A. (IAA, Spain) Guirado, J. (Valencia) Marcaide, J. (Valencia) Perez-Torres, M. (Bologna) Ros, E. (MPIfR)	Kinematics and rotation measure in the inner jet of 3C 395. 0.7, 1.3, 2, cm
BL118	Loinsard, L. (UNAM/Mexico) Mioduszewski, A. Rodriguez, L. UNAM/Mexico)	An astrometric study of T Tau Sb. 4 cm
BL119	Landes, E. (UC, Berkeley) Brisken, W.	Stellar winds in Arches cluster. 4 cm
BM161	Marecki, A. (TRAO) Barthel, P. (Kapteyn) Falcke, H. (MPIfR) Owsianik, I. (MPIfR) Polatidis, A. (MPIfR)	Testing spectral age derivation assumptions for CSO 1235+676. 7 cm
BM175	Krichbaum, T. (MPIfR) Middelberg, E. (MPIfR) Roy, A. (MPIfR) Walker, R.C.	Beating the sensitivity limits: 3 mm Imaging of NGC 4261. 0.7, 2, 3 cm

VLBA Observing Programs

BM181	Middelberg, E. (MPIfR) Falcke, H. (MPIfR) Krichbaum, T. (MPIfR) Roy, A. (MPIfR)	First 3 mm VLBI imaging of M81. 0.3, 0.7, 2 cm
BM182	Ma, C. (NASA/GSFC) Boboltz, D. (USNO) Johnston, K. (USNO) Fey, A. (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.	Geodesy/Astrometry observations for 2003. 3.6 cm
BM190	Maiolino, R. (Arcetri) Dallacasa, D. (Bologna) Giovannini, G. (Inst. Di Radio- Astronomia) Giroletti, M. (Bologna) Nagar, N. (Arcetri) Schilizzi, R. (Dwingeloo)	Elusive AGN in starburst galaxies. 6 cm
BM191	Marscher, A. (Boston) Aller, M. (Michigan) Gomez, J. (IAA, Granada) Jorstad, S. (Boston) McHardy, I. (Southampton)	Relationship between X-ray events and superluminal ejections in blazers. 0.7, 1.3 90 cm
BM193	Momjian, E. (Kentucky) Romney, J. Carilli, C. Troland, T. (Kentucky)	LIRG NGC 7674. 3.6, 6, 90 cm

VLBA Observing Programs

BM196	Mioduszewski, A. Blundell, K. (Oxford) Rupen, M. Taylor, G. Walker, R. C.	Movie of precessing jet and equatorial outflow in SS433. 20 cm
BM201	Momjian, E. (Kentucky) Romney, J.	VLBA Observations of two possible in-beam calibrators for low frequency observations on the target source NGC 7674. 90 cm
BN021	Nagar, N. (Arcetri) Falcke, H. (MPIfR) Maoz, D. (Tel Aviv) Wilson, A. (Maryland)	Accretion in low-luminosity AGN: A radio, UV and X-ray variability study. 6 cm
BP107	Pihlstrom, Y. O'Dea, C. (STScI) Bechtold, J. (Arizona) Conway, J. (Chalmers, Onsala)	HI absorbing gas in the compact radio source 0Q 208. 20 cm
BR087	Rector, T. (Univ. Alaska) Gabuzda, D. (Cork) Peterson, K. (Yale)	High energy peaked BL Lac objects. 20 cm
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 for gravity probe-B mission. 0.4 cm
BS094	Sudou, H. (Tohoku Univ.) Iguchi, S. (NAO) Kameno, S. (NAO) Murata, Y. (ISAS) Taniguchi, Y. (Tohoku)	Search for an accretion disk and a dusty Torus in NGC 4261. 0.4, 6, 13, 20 cm

VLBA Observing Programs

BS100	Sanchez-Contreras, C. (JPL) Alcolea, J. (OAN) Bujarrabal, V. (OAN) Colomer, F. (OAN) Desmurs, J. (OAN)	Phase referencing mapping of 43 GHz SiO masers in PPN OH 231.8+4 . 2 cm
BS121	Savolainen, T. (Tuorla Obs.) Courvoisier, T. (INTEGRAL) Valtaoja, E. (Tuorla Obs.) Wiik, K. (Tuorla Obs)	Physics of AGN, a deep understanding of the quasar 3C273. 0.3, 0.7, 1.3, 2, 4, 6 cm
BS128	Smith, J. (Hertfordshire) Axon, D. (Rochester) Corbett, E. (Anglo-Australian) Gallimore, J. (Bucknell) Robinson, A. (Hertfordshire)	Radio axes and the optical polarization of Seyfert 1 galaxies. 20 cm
BS130	Stockdale, C. (NRL) Attridge, J. (Haystack) Homan, D. Cowan, J. (Oklahoma)	Polarimetric and spectral-index mapping of J0253+3835. 13, 20 cm
BS131	Shen, Z. (ASIAA) K.Y. Lo Ho, P.T.P. (CfA) Miyoshi, M. (NAOJ)	Observations of Sgr A*. 0.7 cm
BU023	Ulvestad, J. Falcke, H. (MPIfR) Henkel, C. (MPIfR) Peck, A. (MPIfR)	Emerging jet component in Mrk 348. 0.4, 1.3, 2, cm
BU026	Ulvestad, J. Gehrels, N. (NASA) Macomb, D. (Boise State) Michelson, P. (Stanford) Romani, R. (Standford)	Multi-epoch imaging of recently identified EGRET blazars. 2 cm

VLBA Observing Programs

BV048	Vlemmings, W. (Cornell) Cotton, W.D. Diamond, P. (Manchester) Langevelde, H. (JIVE)	Magnetic fields in the envelopes of late-type stars: circular polarization of Si0 masers. 0.7 cm
BW062	Wehrle, A. (JPL) Boboltz, D. (USNO) Fey, A. (USNO) Johnston, K. (USNO) Jones, D. (JPL) Unwin, S.H. (JPL)	How far do radio cores wander? 0.4 cm
BW066	Wiik, K. (Tuorla Obs.) Collmar, W. (MPIfEP) Savolainen, T. (Tuorla Obs.) Valtaoja, E. (Tuorla Obs.)	Hard X-ray and multi-frequency properties of the blazer 3C279. 0.3, 0.7,1.3, 2, 6 cm
BW067	Walker, R.C. Hardee, P. (Alabama)	Patterns in the 3C120 jet from 0.5 to 6 arc seconds. 90 cm
BW068	Wiik, K. (Tuorla Obs.) Baath, L. (Halmstad) Rantakyro, F. (ESO) Savolainen, T. (Tuorla Obs.) Tornikoski, M. (Metsahovi) Valtaoja, E. (Tuorla Obs.)	High frequency monitoring two flaring AGNs. 0.3, 0.7, 1 cm
BX005	Xu, Y. (Nanjing) Greenhill, L. (CfA) Menten, K. (MPIfR) Moscadelli, L. (Cagliari) Reid, M. (CfA) Zheng, X. (Nanjing)	Distance to the Persius spiral arm. 2 cm
BZ030	Zavala, B.	Searching for helical magnetic fields in parsec-scale jets. 0.4, 1.3, 2 cm

VLBA Observing Programs

R1A57	Chatterjee, S. (Cornell) Cordes, J. (Cornell) Lazio, T. J. W. (NRL) Goss, W.M. Fomalont, E. Benson, J. Stairs, I. (British Columbia) Brisken, W. Thorsett, S. (Calif., Santa Cruz)	VLBA pulsar parallaxes. 20 cm
RDB041	Gordon, D. (NASA)	Geodetic observations. 0.4, 1.3 cm

Personnel

NEW HIRES

Chatterjee, Shamibrata	Jansky Research Associate	09/01/2003
Downey, Elwood	Software Engineer II	09/08/2003
Gawande, Rohit	Research Associate, Junior	07/01/2003
Grichener, Alexander	Engineering Associate, Junior	09/01/2003
Guo, Dongshan	Software Engineer II	09/01/2003
Jacques, Christiphe	Electronics Engineer II	08/05/2003
Kern, Jeffrey	Software Engineer III	09/15/2003
Morgan, Matthew	Research Engineer	07/01/2003
Palmer, Patrick	Visiting Scientist	07/01/2003
Parashare, Chaitali	Research Assistant	07/01/2003
Fakes, Troy	Engineering Associate, Junior	08/18/2003
de Guise, Karen	Administrative Assistant, Senior	07/01/2003

TERMINATIONS

Palmer, Patrick	Visiting Scientist	07/31/2003

PROMOTIONS AND APPOINTMENTS

Long, Robert	Electronics Engineer II	07/01/2003
Sullivan, Mark	Designer, Senior	09/01/2003
Hendricks, Mary Jo	Librarian	07/01/2003
Bryerton, Eric	Research Engineer	07/01/2003
Escoffier, Raymond	Electronics Engineer, Sr.	07/01/2003
Baldwin, Thomas	Electronics Engineer II	07/01/2003
Zavala, Robert	NRAO Research Associate	09/01/2003
Milner, Ruth	Deputy Assistant Director	09/01/2003
Butler, Bryan	Scientist	07/01/2003
Anderson, Gary	Electronics Engineer I	07/01/2003
Shelton, John	Electronics Engineer III	07/01/2003
Watts, Galen	Electronics Engineer I	07/01/2003
Barnes, Zachariah	Electronics Engineer II	07/01/2003
Szpindor, Edward	Electronics Engineer II	07/01/2003
Saini, Kamaljeet	Research Engineer	07/01/2003

Publications

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

PREPRINTS RECEIVED, JULY-SEPTEMBER 2003

BERGER, E.; KULKARNI, S.R.; FRAIL, D.A.; SODERBERG, A.M. A Radio Survey of Type Ib and Ic Supernovae: Searching for Engine Driven Supernovae.

BERGER, E.; KULKARNI, S.R.; POOLEY, G.; FRAIL, D.A.; MCINTYRE, V.; WARK, R.M.; SARI, R.; SODERBERG, A.M.; FOX, D.W.; YOST, D.W.; PRICE, P.A. A Common Origin for Cosmic Explosions Inferred from Fireball Calorimetry.

BOWER G.C.; PLAMBECK, R.L.; BOLATTO, A.; MCCRADY, N.; GRAHAM, J.R.; DE PATER, I.; LIU, M.C.; BAGANOFF, F.K. A Giant Outburst at Millimeter Wavelengths in the Orion Nebula.

BRISKEN, W.F.; THORSETT, S.E.; GOLDEN, A.; GOSS, W.M. The Distance and Radius of the Neutron Star PSR B0656+14.

CYGANOWSKI, C.J.; REID, M.J.; FISH, V.L.; HO, P.T.P. Dual Cometary H II Regions in DR21: Bow shocks or Champagne Flows?

DIAMOND, P.J.; KEMBALL, A.J. A Movie of a Star: Multi-epoch VLBA Imaging of the SiO Masers.

ENSSLIN, T.A.; VOGT, C.; CLARKE, T.E.; TAYLOR, G.B. Are the Faraday Rotating Magnetic Fields Local to Intracluster Radio Galaxies?

FISH, V.L.; REID, M.J.; ARGON, A.L.; MENTEN, K.M. Interstellar Hydroxyl Masers in the Galaxy. II. Zeeman Pairs and the Galactic Magnetic Field.

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