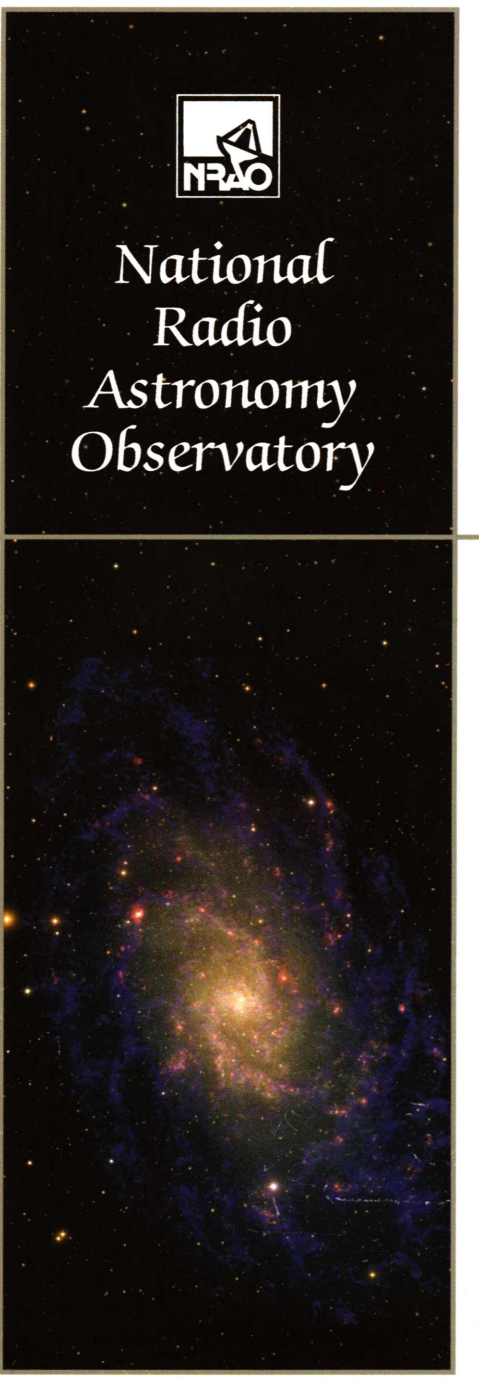

Quarterly Report

October - December 2002

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Quarterly Report October - December 2002

Executive Summary

ALMA

An internal review of the Front End activities was completed, and a number of action items were identified to improve the efficiency of both development and production tasks. Richard Sramek has assumed the position as IPT Lead of the North American System Engineering organization. Assembly of the VertexRSI antenna at the Antenna Test Facility has been completed, and commissioning activities have progressed well.

EVLA

A highlight was the start of the fiber installation on schedule on November 1. A problem with a manufacturing flaw has been resolved.

In the systems design emphasis has been on the minimization of self-generated Radio Frequency Interference. A contract has been awarded for MMIC's and multifunction circuit boards for the EVLA receivers. A consultant in the local oscillator design has been able to develop cost savings by avoiding the use of expensive commercial components. The design of the correlator continues, but the issue of the Canadian funding for the construction has not yet been resolved. The Monitor and Control (M/C)group is focusing on the Module Interface Board which bridges the M/C network and various electronic modules; fabrication of a complete board began in December. A detailed Scientific Software Requirements document for the EVLA has been generated and will be used to define deliverables and milestones for the project.

Green Bank Telescope

A highlight during the past quarter was the successful implementation of a new software management system for GBT development.

A GBT Internal Review conducted in November resulted in defining new priorities: azimuth track work, spectral baseline improvements, and the Precision Telescope Control System (PTCS). To support this, a new system of project management was put in place that provides several tiers of planning and scheduling.

As previously reported, the GBT azimuth track is exhibiting serious, premature wear. In late October a panel of experts was convened to review the data on the track and to make recommendations on remediation. The panel recommended an analysis of several aspects of the structure, a retrofit of the existing rail, and a study of new rail concepts.

A working group has made excellent progress in isolating the causes of spectral baseline curvature in most of the receiver bands in use on the GBT. Sources of baseline curvature include standing waves in various parts of the optics path, and gain and temperature instabilities both in the low noise amplifiers and

in the IF down-conversion system. Some of these effects can be reduced by modifications to the hardware, while others may require a different observing strategy.

With the added emphasis on the PTCS given in the November review, the group has been developing the first draft of a high level architecture block diagram, refining the scientific requirements, and working on the Engineering Measurement System.

The Software Development Division initiated a process for developing and running unit tests leading to a marked improvement in the reliability of the code. The group implemented multi-beam capabilities in antenna software and the existing Observer's interface, reintroduced multi-bank capabilities for the spectrometer, and added several enhancements for observing procedures and calibration.

Very Large Array & Very Long Baseline Array

The VLBA has obtained its first fringes with the Mark 5P recording system, a prototype of a disk-based recording system under development at Haystack Observatory. This will facilitate plans for a change-over from tape recording systems that are becoming obsolescent. Measurement and re-working of the spare VLBA subreflector was completed in the quarter; that subreflector will be mounted on the Pie Town VLBA antenna and tested in early 2003. The new subreflector correction capability may enable a substantial increase in aperture efficiency at a few of the antennas (e.g., Brewster, Washington) that have the poorest performance at 86 GHz, significantly improving the sensitivity of the VLBA at its highest frequency. A skeptical review was held for the first two "large" (more than about 300 hours) VLBA proposals that have been received, on the topics of pulsar astrometry and the monitoring of extragalactic radio jets. Some time was granted to both; a new web page providing access to results for all accepted VLA and VLBA large proposals now has been created.

The newly defined "World Coordinates System," under development for about a decade, has been approved by various regulatory bodies; the first two papers describing its characteristics now have been published. This new framework is necessary for useful implementation of the National Virtual Observatory. A routine color plotting capability has been installed in AIPS to facilitate attractive display of scientific results for both scientific and general use.

At the VLA, the final antenna has been re-painted, completing a project that has stretched over approximately nine years. Installation of special-purpose narrow-band filters at 1612 MHz was completed on all antennas, in order to block out the strong signals emitted by Iridium satellites. After a full scientific test is completed, it is expected that observation of the 1612 MHz OH line will be possible once again. A committee with both NRAO and outside membership was formed to study the issue of Target-of-Opportunity observations, and recommendations were made that would improve access to the VLA for time-critical

events. These recommendations will become part of the framework of an NRAO-wide study on telescope time allocation.

Central Development Laboratory

This quarter saw the first volume production and delivery of the latest generation of Low Noise Amplifiers employing TRW Cryo-3 wafer devices. These amplifiers are yielding minimum noise temperatures of better than 0.25 K per GHz. The evaluation of HFET's of various gate widths is continuing.

Tests of a superconducting (SIS) mixer for the frequency range 84-116 GHz continued, with different on-chip tuning. When integrated with a 4-12 GHz amplifier, and used at 100 GHz with a room temperature feed horn, the mixer met the ALMA specifications for receiver noise temperature and instantaneous IF bandwidth. Fabrication of a single-ended mixer test block of a new design, intended for the 211-275 GHz band, has been completed, and fabrication of a two-chip unbalanced sideband-separating mixer for the same band has begun.

The design of the low-noise element for the 21-cm beam-forming array for the GBT is continuing. A second type of antenna, the crossed sleeve dipole, is being considered because of its good impedance characteristics.

Data Management

A highlight of the e2e (End-to-End) project has been the implementation of the NVO conesearch protocol to make accessible the several radio catalogs now in the NRAO e2e archive.

The second development cycle of the e2e project reached the midway point in this quarter. By the end of the cycle there will be either designs or prototypes for all deliverables to a level of detail sufficient to allow definition of project scope and schedule. Work on the scientific requirements for both the GBT and EVLA has been aided by the formation of Science Software Requirements groups for each.

The archive of data from the VLA and VLBA continues to grow, and all of the historic VLA data should be loaded by the end of the next quarter. The user interface is under internal testing. Purchase of the GBT archive hardware awaits clarification of the NRAO budget.

Several staffing changes have occurred in the management of the AIPS++ project, most notably the appointment of J. McMullin as Project Manager. The AIPS++ single-dish staff have continued their close collaboration with GBT Operations in order to support the scientific and technical needs of telescope commissioning. AIPS++ has also retained a focus on meeting ALMA needs, primarily by completing the early

phases of the AIPS++/IRAM end-to-end tests. In general, there has been continued improvement in the scientific completeness, usability, and performance of the AIPS++ package.

Computer security has been augmented with the deployment of anti-virus email gateways. Work has begun on a VPN (Virtual Private Networking) system needed for employees who work for extended periods away from the Observatory, and to support telecommuters during construction at Edgemont Road. The focus of the effort of the Common Computing Environment group has turned to identifying the set of core applications that should be available on all desktop and public systems.

Education and Public Outreach

Much of the education effort during this quarter involved submittal of proposals for a NASA IDEAS workshop, a five-year Research Experience for Teachers program, and a renewal of the successful Research Experience for Undergraduates. School groups visited Green Bank and the VLA in good numbers, and comprised 30% of tour groups at the VLA.

The construction of the Green Bank Science Center is 91% complete at the end of the quarter, and is expected to be complete late in February, apart from landscaping. Prototypes and production stages of the exhibits have been reviewed. The expectation is that the center should be open on an "advance preview" basis in the spring. A new presentation video has been introduced at the VLA Visitor Center, and plans for a gift shop at the Center have been let for bid.

Following the successful launching of the new NRAO image gallery, work began on a redesign of the NRAO website. The redesign includes a new home page with updated navigation tools and information areas, customer- specific second level pages to facilitate use of the website, and updated common elements for all of the web pages.

A number of press releases were issued, and stories were posted on the NRAO website, including the winning of the Nobel Prize in Physics by the President of AUI, R. Giaconni. A small film-making group from Albuquerque visited the VLA as part of the making of a film about the interface between ancient Native American astronomy and modern science.

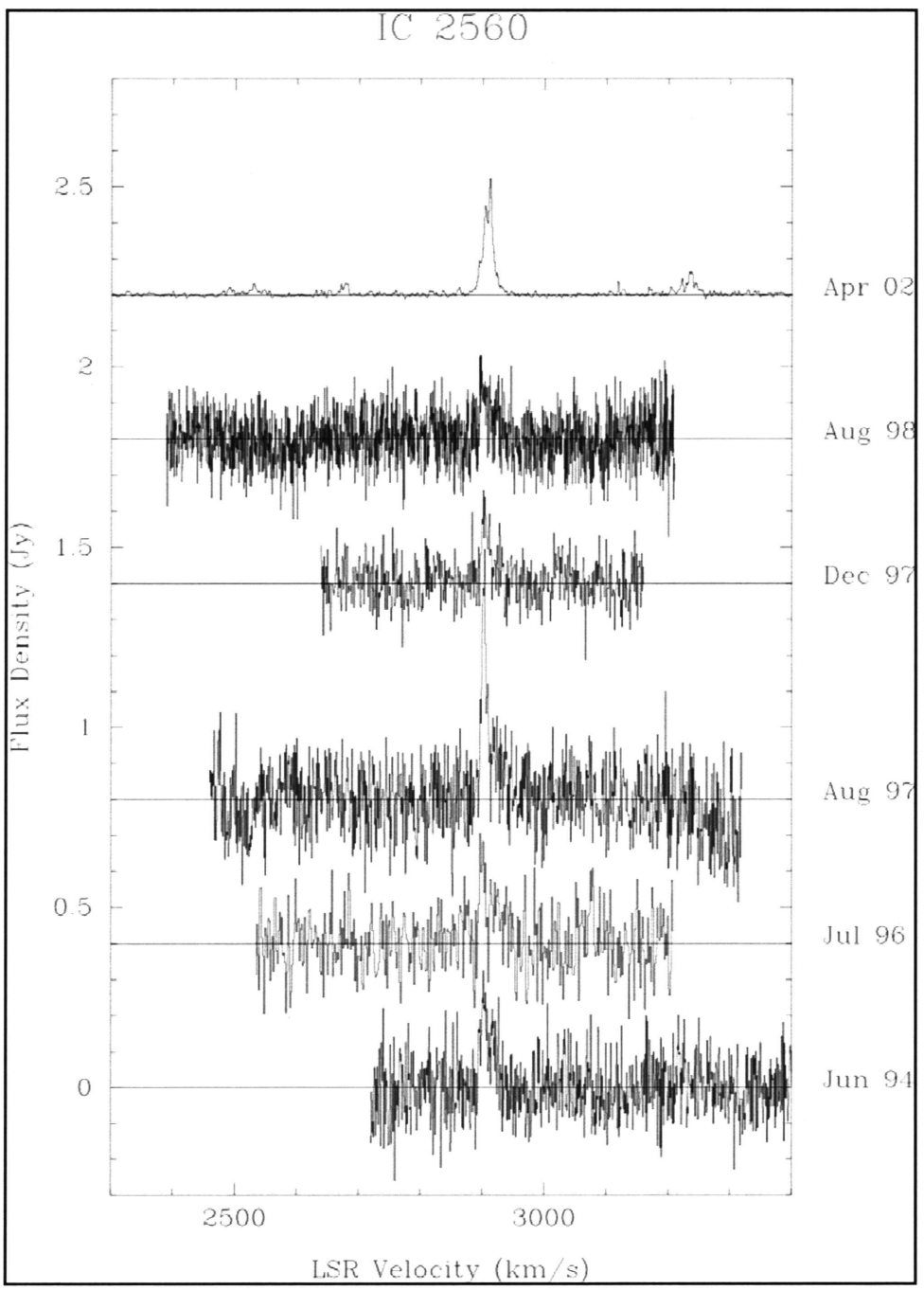

Figure 1. The maser in IC 2560 shows the GBT spectrum at the top, compared to spectra taken between 1994 and 1998 with the NRAO 140 Foot or Parkes telescopes.

Green Bank

Water Masers about Active Galactic Nuclei - We have demonstrated some of the K-band capabilities of the GBT by observing 22 GHz water maser emission towards the nuclei of 16 known sources in AGNs. The resulting spectrum, in almost every case, is the most sensitive taken to date. Data were obtained in April and December 2002. The high quality GBT spectra make it possible to distinguish some features which appear blended in spectra from other telescopes. By tracking the velocities of these maser features over several epochs, it will be possible to study the dynamics of molecular gas within a parsec of the central engine. New maser features are revealed in most of the new GBT spectra, and in a couple of galaxies (e.g. NGC 1386, NGC 5506) a weak, broad base of H_2O emission is detected under previously identified narrow components. Some of the GBT spectra cover >10,000 km/s of velocity space, though maser features are generally seen within a few hundred km/s of the systemic velocity of the host galaxy. In addition to testing the K-band system, this project marks the initial scientific application of the active surface, the 200 and 800 MHz spectrometer modes, and beam-switched observing procedures. The attached figure of the maser in IC 2560 shows the GBT spectrum at the top, compared to spectra taken between 1994 and 1998 with the NRAO 140 Foot or Parkes telescopes.

Investigators: J. Braatz (NRAO), L. Greenhill (CfA), A. Wilson (U. Maryland), C. Henkel (MPIfR)

Very Long Baseline Array

Measurement of the Speed of Gravity - Using the VLBA and Effelsberg, researchers have made independent measurement of the propagation speed of gravity. The measurement resulted from extremely precise VLBI observations when Jupiter passed nearly in front of a bright quasar. Analysis of the displacement of the apparent position of the quasar by the gravitational effect of Jupiter produced the result for gravity's speed of propagation. The results indicate that gravity propagates at the speed of light, within about 20 percent. The observations in any case rule out an infinite speed for gravity, and can provide constraints for aspects of superstring and brane theories.

Investigators: S. Kopeikin (Missouri) and E. Fomalont (NRAO).

Very Large Array

Young Star Probably Ejected from Triple System -Analyzing nearly 20 years of data from the VLA, researchers conclude that a young, low-mass star passed within about 2 AU of a more-massive, close binary system in the 1995-1998 time frame, causing a dramatic change in its orbit, probably leading to its ultimate gravitational escape from the system (see Figure 2). The result supports longstanding indications from computer simulations that such ejections occur in multiple-star systems. Ejections of low-mass protostars from their parent systems, and the resultant halt to accretion, could provide one explanation for the formation of brown dwarfs.

Investigators: L. Loinard, L. Rodriguez and M. Rodriguez (all of UNAM).

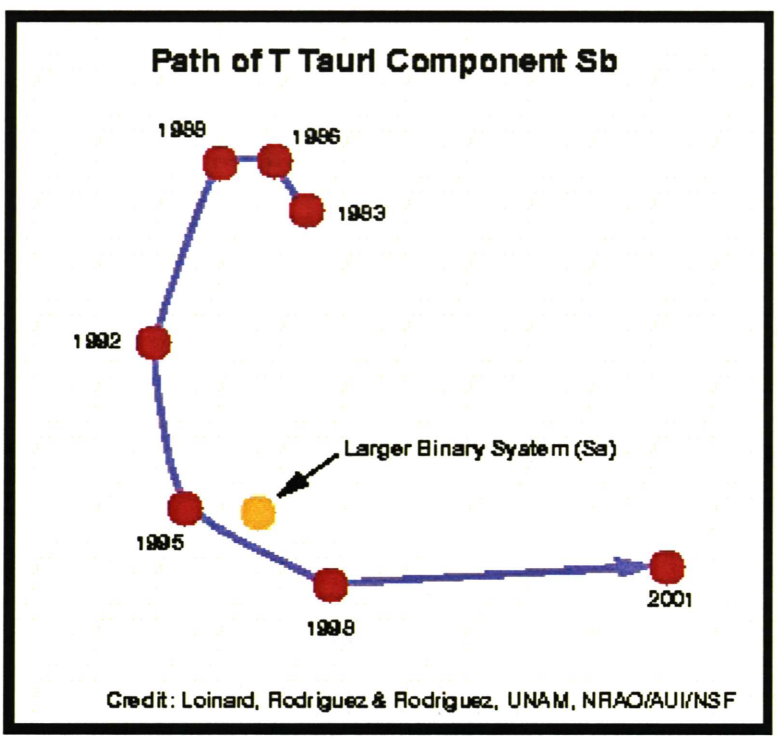

Figure 2. Path of T Tauri Component Sb. The VLA astrometry map show strong acceleration of Component Sb in triple protostellar system.

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

The Director of the National Radio Astronomy Observatory (NRAO) convened an internal review of the Front End (FE) activities within NRAO. The two day review covered technical, organizational, and planning aspects of the FE work carried out in Charlottesville and Tucson. A number of action items were identified to improve efficiency of both the development and production tasks. A prime area of revised planning will be an increased emphasis on commercialization of production tasks.

Richard Sramek, formerly the Back End IPT Lead, has been appointed North American System Engineering IPT Lead replacing Peter Gray. Peter has left NRAO to join the Gemini Project. A search for a new North American Back End IPT Lead has begun. Clint Janes has been appointed (acting) Lead during the search. Clint was formerly head of VLA and EVLA electronics. He will join the ALMA System Engineering IPT full time as soon as a new Back End IPT Lead is in place. This will complete a major restructuring of the North American System Engineering organization. In addition to the personnel mentioned above, the group now includes Larry D' Addario (System Architect), John Payne (IO Prototype Development), Jeff Zivick, Jeff Mangum, and Stacy Oliver.

Assembly of the VertexRSI antenna at the Antenna Test Facility (ATF) located at the VLA is now complete. The contractor is completing commissioning activities and will begin acceptance tests beginning in early January. The scheduled handover of the antenna is 30 March 2003, contingent on successful completion of the commissioning activities. During this period, ALMA staff are already sharing access with the contractor. During the evenings, integration of ALMA supplied measurement devices, instruments and ALMA software is being completed ahead of antenna acceptance.

Foundations for the AEC antenna supplied by the Europeans and the Mitsubishi antenna supplied by the Japanese are under construction at the ATF. Both foundations will be completed early next year. Erection activities for these two antennas are scheduled to begin in February.

Expanded Very Large Array Highlights

The fiber installation crew has been hired and fiber optic installation classes were held in November. Utilities have been located and potholed and trenching to install the fiber began on schedule. The fiber has been pulled into the Control building and drawings detailing the installation are being made. The fiber optic installation was delayed due to a manufacturing flaw in the armor of the fiber cable. The inner armor shield has separated and tests were run by the manufacturer to determine if the cable needs to be replaced. The cable has passed all testing and installation has resumed.

Expanded Very Large Array

Full details of the EVLA Project, including schedule and budget status can be found in the document "EVLA Progress Report – 1 July, 2002 to 31 Dec, 2002". A summary of progress over the last quarter is provided below.

In the area of overall systems design there was continuing emphasis on designing to minimize self-generated Radio Frequency Interference. It was found that adequate shielding can be obtained provided that a layer of microwave absorbing foam is included on the inside of the rack. A test area for the bench integration of the new EVLA electronics system was established in the laboratory and by the end of the reporting period is beginning to be populated with prototype electronic systems.

Installation of the fiber-optic cable along the array arms of the VLA began on schedule on 1 November and good progress was initially made. In late November installation was suspended while a manufacturing flaw in some of the cable was investigated. This situation was resolved with the cable manufacturer by the end of the year and installation resumed at the beginning of 2003. Outfitting of a fiber termination room in the VLA Control Building began.

The primary activity in the antenna area was the construction of new structure in the middle of the VLA reflectors to support the new suite of feeds and receivers. This structure, which sits on top of the receiver cabin, is called the feed cone. A prototype feed cone was completed in November. This prototype was mounted on top of a mockup of the receiver cabin and was outfitted with mockups of the new receivers, in order to check the general arrangement of new equipment in the antenna.

In the receiver area a contract was awarded to Dr. S. Weinreb's Monolithic Microwave Integrated Circuit (MMIC) group in the EE Dept at Caltech for MMIC's and multifunction circuit boards for EVLA receivers. Students in Dr. Weinreb's group will design and fabricate circuits that will save the EVLA significant costs compared to providing the same equipment by connecting together discrete commercial components. Fabrication of 1.5 GHz and 6 GHz prototype corrugated feed horns began. These feeds will be constructed using a novel fabrication technique in which sheet metal components are assembled using

fiberglass lamination. This process is much cheaper than conventional fabrication where corrugated horns are machined from solid pieces of metal. The construction schedule for the EVLA receivers was revised so as to advance the schedule for the 26-40 GHz receiver, a new band for the VLA, and allow new science as soon as a few antennas are equipped with receivers. This band will be provided early in preference to the 12-18 GHz band which is an existing VLA band that receives less use than other bands.

In the local oscillator (LO) area prototyping continued on all LO modules. Some technical details of the frequency synthesizers have proved particularly difficult and a purchase order was issued to an expert consultant (Dr. S. Wetenkamp) to assist in the designs of the LO system. This will lead to significant cost savings in this area of the project because Dr. Wetenkamp has been able to show us ways of avoiding expensive commercially available components. A prototype of the downconverter used to produce the 2-4 GHz baseband signals was completed and provided to the bench test integration area.

In the correlator area detailed correlator design continued at the facilities of the Canadian partner, Herzberg Institute of Astrophysics (HIA). HIA has not yet received full funding approval for construction of the correlator, but there is optimism at the highest levels of the NRC (HIA's funding agency) that this funding situation will be resolved in the first quarter of 2003.[1]

The primary focus of the Monitor and Control (M/C) Group during the reporting period was continued work on the Module Interface Board (MIB) which is the interface between the M/C network and the individual electronic modules that are to be monitored and controlled. Early design of the MIB is required to allow design of the electronics subsystems to progress. Initial quantities of the microprocessors for the MIB's (Infineon TC11IB) were received and the selected real time operating system(RTOS), Nucleus by Accelerated Technology (AT), was successfully ported for the TC11IB platform by AT. Also, a software emulator for Nucleus was delivered which will allow MIB code to be developed on a platform running Windows. The MIB circuit board was designed and fabrication of the complete board began in December.

The principal activity in the area of Data Management was the generation of a detailed scientific software requirements (SSR) document by a group of experienced astronomers. The EVLA SSR was completed in December. This document will be used, in negotiation with End-to-End (e2e) Project management, to define formal deliverables and milestones which the e2e Project will deliver to the EVLA Project.

[1]The first increment of funding for the EVLA correlator is included in the annual budget statement of the Canadian Finance Minister issued on 17 February 2003.

Green Bank Highlights

The development highlight in the past quarter was the successful implementation of a major, new software management system for GBT development. This new system has already resulted in an excellent record of on-time delivery of new releases, and in a number of quality and performance enhancements that have directly improved GBT observing capabilities. A key feature of the new system has been the development of a "Project Office" concept that allows development requests to be submitted and tracked and project status and priorities to be managed. The software development group has also greatly increased the number of unit tests that evaluate the performance and accuracy of individual software modules before they are released for use. These tests, together with a number of refactoring exercises, have greatly reduced the number of build warnings in GBT Monitor & Control system code. This will remain a continuing, active area of development. The software group has also successfully worked to improve interoperability with AIPS++ software. The general concepts for project management developed by the GBT software development group may serve as a useful model for other projects and groups within the Observatory.

GBT Antenna & Operations

Milestone	Original Deadline	Revised Deadline	Date Completed
GBT Azimuth Track Review Meeting	10/31/02		10/31/02
Expansion of Cable Building Complete	07/01/02	10/31/02	11/30/02
Six-month structural inspection plan for the GBT	07/30/01	01/31/03	
Six-month inspection of GBT welds/structure	06/30/02	09/30/03	
Repair bowed GBT BUS member	09/01/02	02/28/03	
Continue site access improvements	12/31/02	deferred	

GBT Electronics

Milestone	Original Deadline	Revised Deadline	Date Completed
K Band receiver upgrade	10/30/02		11/12/02
Spectrometer paddle board replacement	11/30/02		11/19/02
Spectrometer sampler rework	01/30/03		
Spectrometer Spigot card completion	02/28/03		
X Band receiver upgrade	01/30/03	02/28/03	
C Band receiver upgrade	02/28/03	02/15/03	

GBT Mechanical Engineering and Central Instrument Shop Work

Milestone	Original Deadline	Revised Deadline	Date Completed
K band OMT's for VLA (6)	12/06/02		11/29/02
Q band feeds for VLA (3)	10/25/02		12/03/02
EVLA L band Feed	08/30/02	02/13/03	
Ka band feed for GB	12/02/02	04/01/03	
ALMA Dewar Vessel and Heat Shields	04/01/03		

GBT Software and Computing

Milestone	Original Deadline	Revised Deadline	Date Completed
M&C V3.8: Antenna Improvements Phase 0 Spectrometer Phase 2	10/30/02 10/30/02 10/30/02		10/31/02 10/31/02 10/31/02
M&C V3.9: IF Mgr Improvements Phase 0 LO Phase II Antenna Phase 1 Spectrometer Improvements Phase 3 Q-band Receiver checkout	12/11/02 12/11/02 12/11/02 12/11/02 12/11/02 12/11/02		12/19/02 12/19/02 Dropped 12/19/02 12/19/02 Deferred
Visiting observers infrastructure & facilities	06/30/01	8/31/03	
Project Office Rollout	12/05/02	01/31/03	
Integration of AIPS++ group into Proj. Office	03/31/03		
M&C V3.10: Dual DCR data collection Spectrometer Improvements	01/15/03		
M&C V3.11: Active Surface, Antenna Improvements, Spectrometer Improvements	02/12/03		
M&C V3.12: Active Surface, Multi-IF, Q-band receiver checkout	03/12/03		
Configurator V1.3: K and Ku band, multi-IF, direct command line access	03/12/03		

GBT Projects

Milestone	Original Deadline	Revised Deadline	Date Completed
PTCS: First draft high-level system architecture	01/31/03		
PTCS: LRF calibration problem resolved	01/31/03		
PTCS: Active Surface code review complete	02/28/03		
PTCS: EMS algorithm development platform	03/31/03		
PTCS: Ready for initial design review	03/31/03		

Astronomy Education Center Project

Milestone	Original Deadline	Revised Deadline	Date Completed
AEC dormitory start of construction	07/01/02	11/04/02	11/04/02
AEC main building construction complete	10/15/02	02/28/03	
AEC Dedication	05/26/03	08/29/03	
AEC dormitory construction complete	07/18/03		

GBT Commissioning and Observing Activities

On 12 November, a GBT Internal Review was held in Green Bank. Scientific and engineering staff from all Observatory sites participated, either in person or by video conferencing. The goals of the review were to update the staff on the status of GBT commissioning and operations, to invite comment on priorities and long-term objectives, and to involve the Observatory staff as a whole in GBT work. The review achieved all of its objectives. As a result of the review, priorities were set in each major activity area. For commissioning: the top priority is spectral baseline improvements; for project development, Precision Telescope Control System work; and for telescope engineering, azimuth track work. Continued K-band commissioning was also seen as a priority. Work activities were quickly oriented toward these priorities and are described in more detail in the following sections of this report.

The review was also quite successful in involving more Observatory staff in GBT activities. Since the review, several scientific staff members from Charlottesville have participated in commissioning runs, and others from the Socorro site are expected in the next quarter. Some staff are contributing to Spectrometer testing and evaluation, and others are becoming familiar in the use of the GBT with an eye toward visiting observer support in the future.

The thorough assessments prior to and following the review presented an opportunity to strengthen the overall project management system in place for GBT activities. A new system was put in place that provides

several tiers of planning and scheduling: a long-range (multi-year) plan with global development priorities for the GBT; a 6-Month Forward Look for intermediate-term planning; Monthly targets consistent with the Forward Look; and a short-range, detailed schedule covering the following two weeks. A planning group was established consisting of the GBT technical division heads, site director, deputy director, commissioning lead scientist, and the telescope scheduler. J. Ford, Electronics Division Head, was named the GBT Program Manager and is responsible for maintaining the plans and chairing planning meetings. The GBT Scheduler, C. Bignell, is assisting with scheduling tools and documentation. The group meets each Monday morning to review the weekly schedule and to resolve priority matters. A monthly meeting is held to set monthly goals and assess the success of the goals from the previous month. A weekly activity calendar with task reservation tools has been placed on the web. Long-range schedules and targets will be on the web during the next quarter.

Commissioning activities in the 4th Quarter concentrated on Spectrometer checkouts and preparations for K-band observing. K-band activities will continue in the next quarter. General commissioning work for frequencies through 26 GHz should be largely completed in the second quarter of 2003.

Azimuth Track

As described in several previous Quarterly Reports, the GBT azimuth track is exhibiting serious, premature wear. The wear is primarily on the interior surfaces between the upper wear plate, and the base plate below it, and is a type of high-stress wear known as fretting. The most serious and consequential fretting is occurring in the region near the joints between segments. This is resulting in tilting of the azimuth wheels as they pass over the joints. The wheel suspension is designed to accommodate a certain amount of tilting, but if this amount is exceeded, the suspension could be over-stressed and subject to failure. Since the wear is a progressive phenomenon, it must be arrested before the tilts reach the structural safety limits. We have presently reduced the wind speed limits for operation to ensure that we remain within the safe operating limits. Although the fretting wear and resultant wheel tilting is the most significant problem, gouging of the upper surface near the joints and a possible change in the wheel profile are also observed.

On 31 October and 1 November, a panel of experts was convened in Green Bank to review the data on the azimuth track and to make recommendations on how to remedy the problem. The panel was chaired by Prof. Karl Frank of the University of Texas. Other members of the panel were Dr. Joseph Antebi (Simpson, Gumpertz & Heger), Dr. Justin Greenhalgh (Rutherford-Appleton Laboratory), Dr. John Kulicki (Modjeski & Masters), Prof. William McGuire (Cornell Univ.), Dr. David Smith (MERLAB), Mr. Thomas Taylor (Parsons-Brinkerhoff), Dr. Joseph Vellozzi (Ammann & Whitney), Dr. David Hogg (NRAO), Mr. Jim Ruff (NRAO), and Mr. Jon Thunborg (NRAO). On the first day of the review, the panel heard presentations on the track from NRAO engineers and conducted an on-site inspection of the track. The panel deliberated on the second day and made a follow-up visit to the telescope.

Just after the panel departed, another problem with the track was discovered: 10 wear-plate hold-down bolts were found broken around the track. Following initial operation of the GBT in the spring of 2001, numerous bolts were found broken. The contractor tripled the number of bolts and installed larger diameter

bolts. No broken bolts had been found since that retrofit. Investigation of the most recent discovery is now underway.

The azimuth track panel provided an preliminary exit report before adjourning, and a written report on 19 November. The panel affirmed the findings of the NRAO engineers and recommended a remediation program consisting of three, main task areas, summarized, as follows:

Task 1: *Analytical Effort.* (a) Perform a detailed analysis of the flex plate capacity to determine the acceptable wheel tilt and wind speed relationship; (b) measure the wheel load (i.e., the weight of the antenna); (c) investigate the feasibility of installing a stop to limit the tilt of the wheel assembly; (d) analyze the track structure including the foundation and rail anchor bolts to determine their ability to withstand the thermal forces generated by a continuous track; (e) refine the finite element analysis of the rail joint to include the interfaces between the wear and base plate and the retrofit geometries; (f) analyze the shear forces at the wear plate / base plate interfaces and the necessity of additional interface connections. (g) investigate the impact on bolt bending caused by the wear voids between the plates; (h) analyze the effects of increasing the bolt preload or effective length of the bolt to reduce stress and fatigue.

Task 2: *Retrofit of existing rail and data gathering.* (a) Continue monitoring the tilt of the wheels; shim as required to remain within tilt limits; remove remaining Cortec compound and clean; apply zinc-rich paint to increase of coefficient of friction or a lubrication compound, and evaluate results. (b) develop and implement a joint stiffening and bridging through use of welds or bolted attachments on the base plate, and possible bridging at one joint on the wear plate. (c) remove two 14-foot sections of the existing wear plate and replace with two 7-foot and one 14-foot section that bridges the gap over the base plate; the center base plate joint must be stiffened by the methods described in (b). (d) measure and monitor the wheel profile, and measure the hardness of the wheels and wear plates.

Task 3: *Development of New Rail Concepts.* (a) Conduct a thorough review of the design and construction of the existing azimuth wheel and track system in order to develop a basis for the design of a new rail system. (b) using the guidance in the panel report, the performance retrofits in Task 2, and the analysis of Task 1, continue the development of a criterion and design concept of a new rail.

The Observatory staff is undertaking a vigorous program to address the panel's recommendations. After instituting the retrofits on the trial segments of the track and evaluating their performance, we will then decide the best approach: retrofits to the existing track or installation of a new track. We will probably not have enough information to make this decision for another year or more. In the meantime, through shimming and the application of anti-fretting materials, the GBT remains in operation. It is expected that we can mitigate the wear and avoid a significant loss in observing time for a period of 1-2 years, and perhaps longer, although this situation is under continual re-evaluation. It is unlikely that stop-gap measures could be used indefinitely, as the procedures are labor-intensive and there is a limited number of times the track can be taken up before problems with thread stripping will likely appear.

Spectral Baseline Improvement Program

One of the present priority activities at the GBT is the improvement of spectral baselines. The GBT Spectrometer offers very wide spectral bandwidths – up to 800 MHz in a single bandpass, which is much wider (by a factor of 10-20) than available at older generation telescopes such as the 140 Foot. A number of important science projects, such as searches for high-redshift CO lines, require very flat spectral baselines. Although the wide bandwidths enable important science, they are much more demanding on system performance.

A work group (Fisher, Norrod, and Balser) has undertaken a systematic program to characterize spectral baselines and improve performance as required. The group has made excellent progress in isolating the causes of spectral baseline curvature in most of the receiver bands at use at the GBT. Several sources of baseline curvature have been identified: optical standing waves between the edge of the subreflector and the feedhorn or from the main reflector panel gaps and the feed; impedance mismatches between the feed and low noise amplifier (LNA); cryogenic temperature gain stability in the LNA; standing waves in the fiber optic modulator; gain and temperature instabilities in the IF down-conversion system; and digital anomalies in the autocorrelation Spectrometer. Work is underway to correct a number of these problems in a fundamental way (e.g., reducing temperature sensitivity and other gain instability problems). Other effects may be solved by implementing observing strategies, such as focus modulation. Major progress is expected during the first quarter of 2003.

GBT Student Support Program

Two awards were made in December as part of the GBT Student Support program. This program is designed to support GBT research by graduate or undergraduate students, and strengthens the proactive role of the Observatory in training new generations of telescope users. The awards in December were in conjunction with observing proposals submitted at the October deadline. Awards were made to J. Swift (UC Berkeley) in the amount of $4,000, and to J. Martin (U. Virginia) in the amount of $15,700. Swift's proposal is entitled, "Will L1551-C_2S Form the Next Star in Taurus?", and Martin's proposal is "The HI Environment of Early-Type Galaxies with Anomalous Light Profiles."

GBT Operations and Maintenance

Telescope Operations Activities

The GBT has completed a year of operation and commissioning activities, and now some annual inspections and preventive maintenance activities have come due. The Telescope Operations Division has begun inspecting the drive motor brake systems, and has changed grease in several of the wheel bearings. Although this is a straightforward and familiar task for automobile wheel bearings and brakes, it is rather more complicated for a "vehicle" that weighs 17,000,000 pounds. Weather also is a factor – we cannot allow rain or snow mixing into the grease or wetting the brakes, and we have had much of both in the past 3 months. The maintenance crew has also accomplished their more frequent tasks, including elevator safety

checks, and routine greasing and servicing. Track wear mitigation also continues. In one day, when faced with snow coming in, the maintenance crew, augmented by employees from the machine shop and the "office duty" operator, shimmed three track splices and changed the grease in an azimuth wheel bearing – an example of excellent teamwork.

We have also begun some modifications to the telescope to improve safety, work efficiency, or equipment performance. These include an access ladder to the quadrant detector, a heater in the Prime Focus service area, and new drives on the air intake louvers on the emergency generators.

Operators, engineers, and the maintenance crew also continue to complete checkout of some of the telescope systems. A big effort this quarter has focused on the Auto Stow function, which starts the emergency generator and places the telescope in a safe position automatically when normal electrical power is lost. The telescope operators also continue to refine existing operating procedures, and develop new ones for special operations. The operators also look for ways to better support the work of all the divisions during maintenance days, as well as monitoring weather and safety.

In addition to work on the GBT, the 85-3 antenna feed supports and other areas received a coat of paint this quarter. This will help preserve the antenna and allow its continued use as a pulsar monitoring facility. More painting on it and the GBT will occur this coming summer.

GBT Electronics

GBT Spectrometer Hardware - Detailed testing, debugging, and repair of the spectrometer continues. To date, twenty-three 50 MHz, twenty-seven 12.5 MHz, eight 200 MHz, and nine 800 MHz modes have passed engineering checkout. Modifications to the 1600 MHz phase-locked loops in the high speed samplers were designed and tested more than a year ago. A PC board was designed, and implementing these fixes remains as a task to be done.

The Low Speed Samplers were modified to improve bandpass flatness. The modified sampler has been tested in the system and met with the approval of the project scientist, R. Fisher. The other samplers were modified and tested.

The Spectrometer Pulsar Spigot card, a device that allows fast, wide bandwidth dumps of the Spectrometer, was again tested this past quarter, and more of the Spigot card personalities verified. More testing remains to be completed. In order for general users to use the spigot card, though, an extensive software development effort is required. This will require the support of electronics personnel to help sort out the requirements, as well as software personnel to do the work. For the immediate future, a set of shell scripts will be developed to set up the machine for testing and initial observations by experts.

The Spectrometer system has been plagued by intermittent bad connections between a tin-plated pin and gold-plated connector. This galvanically incompatible pairing was fixed by using tin-plated connectors along with the tin-plated pins. A solvent was found to clean the oxide off the tin-plated pins before the installation of the new connectors. The connectors were all replaced with tin plated connectors. To date, no

further paddle board failures have occurred. The source of 1000 lag pulses in some auto-correlation functions was traced to improper "ground bounce" compensation. This, in turn, was traced to a Long Term Accumulator (LTA) firmware problem which is now fixed, installed, and tested on all LTAs. More problems in the Spectrometer lags are being addressed at this time.

Front-ends - The Prime Focus (PF1), L-band, S-band, C-band, X-band, Ku-band, and K-band receivers all were used, and several problems with them were addressed. The PF1 receiver was removed from the telescope for repair of several accumulated minor problems, and reinstalled. The X and C-band receivers have amplifiers that are unusually sensitive to temperature. This causes gain fluctuations at a much higher level than is acceptable. A new amplifier design from the CDL was fitted into the X band receiver, and this solved the problem. The C Band receiver will be reworked in the next quarter. The K band receiver was reinstalled with its new beam arrangement and re-commissioned. Construction of the new PF2 receiver (920-1230 MHz) nears completion. Commissioning of the receiver was deferred due to pressure from high-frequency commissioning.

LO/IF Systems - Investigations into a 2.4 MHz ripple in the fiber optic system culminated in the finding that the ripple is an inherent "feature" of the modulators. The vendor produced another version of the modulator that has this ripple much reduced. This version was purchased and evaluation of its performance continue.

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

RFI Mitigation - A great deal of time (about five FTEs) was spent this quarter mitigating RFI. We have large projects underway to suppress RFI from the laser rangefinder systems, the GBT feedarm servo systems, and the Jansky Lab Addition shielded rooms. The engineering package and one prototype of the Laser Rangefinder RFI mitigation project have been completed. Testing is underway, and should be finished this quarter. Work will begin on retrofitting the remaining 19 systems as technician time and priorities allow.

The GBT feedarm servo RFI re-work is nearly complete. A problem was found in the retrofit that caused the servo system to fail to work properly with the RFI filters in place. The filters caused noise to be induced on the resolver lines, causing faults in the motor controllers. This problem is being investigated. Once this is overcome, a two-day telescope shutdown will be required to complete the project.

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

RFI mitigation engineering support at the level of ~0.25 FTE is being supplied to the AEC construction project, due to a lack of shielding expertise on the part of the architect and the contractor.

NRQZ Management - We continued support of the National Radio Quiet Zone (NRQZ) administration through application processing, site visits, and consulting with potential applicants. The NRQZ group monitors FCC Notices of Proposed Rulemaking (NPRMs) for changes that may adversely affect the Quiet Zone. Working with NRQZ counsel, the group is presently preparing responses to several NPRMs.

GBT Mechanical Engineering Development

During the fourth quarter of 2002 the Mechanical Engineering Division participated in the GBT track review conducted in late October. The final draft of the GBT Structural Inspection Plan has been received and reviewed by both the Mechanical Engineering Division and the Operations Division. The plan has been accepted and we expect the contract to be closed out in the first quarter of 2003. A study investigating electroslag welding as a method of stabilizing the base plate sections of the GBT track was conducted and completed for the Mechanical Engineering and Operations Divisions by EST&D, a company affiliated with Portland State University.

Green Bank Software Development and Computing

GBT Software Development

During Q4 2002, the Software Development Division (SDD) focused on implementing multi-beam capabilities in antenna software and the existing Observer's Interface (GO), reintroducing multi-bank capabilities for the Spectrometer, and performing a complete overhaul of Spectrometer software to alleviate reliability issues that have, in the past, had a negative impact on observing, commissioning, and electronics work. The group continued to refine its internal methodology, the efficiency of its operations, and its relationship to and interoperability with the AIPS++ team. The Project Office concept that the SDD had been working towards throughout 2002 was presented to the NRAO community during this time, and a web infrastructure was built to facilitate community interactions with the group. This is intended for general availability in early 2003 at http://projectoffice.gb.nrao.edu.

The SDD continued regular, monthly releases of its key product, M&C, with v3.8 on October 31, 2002 and v3.9 on December 19, 2002. A special update release (v3.8.1) was released on November 7, 2002. The following features were released: addition of multi-bank capabilities to the Spectrometer manager, addition of multi-beam capability to antenna manager, addition of default behavior to the antenna manager for handling multi-beam receivers, GO updates for multi-beam, new nod procedure in GO to support beam switching, IF manager enhancements to support multi-beam, correction of Tsys calculation in the DCR, scan start efficiency in GO reduced from 15 sec to 1 sec, improvements to PointMap, RALongMap and DecLatMap procedures in GO, new algorithms for Tsys/gain/switched power, reliability overhaul for Spectrometer software, balancing ability prior to scan, and default switching signals were established for the Spectrometer.

A full suite of astronomical regression tests was developed in Q4 in conjunction with the AIPS++ group. These tests will be used to validate all releases of M&C in 2003, starting with v3.10 in January. To better accommodate astronomical and other scheduling, new M&C releases can be anticipated +/- 1 day from the posted release date.

Software operations continued to evolve during Q4 2002. In the previous quarter, the SDD took steps to improving software quality and team effectiveness: software engineers initiated a process for developing and running unit tests, and identified a way to track the results from code refactoring. Building upon the framework that was established during Q3 2002, the SDD expanded its unit tests for the M&C product from 9 tests at the beginning of the quarter to 67 tests by the end of the period. Continuously refactoring production code resulted in a reduction in build warnings of 80%, from 2480 to 474; eliminating these warnings suppresses the potential for unexpected system failures in the future. The primary outcome of these refactoring exercises is a more solid software product. Figures 3 and 4 show the results of these activities to date; this continuous improvement effort will continue throughout 2003 and into 2004.

One of the SDD's key organizational goals during Q1 2003 is to improve responsiveness to small, high impact task requests. For this purpose, a small proportion of staff utilization has been reserved. The SDD began taking a more active role in the PTCS project at the beginning of December, with the launch of the Active Surface Improvements work package, for which a Project Charter was initiated. Additionally, analysis began on the software component of the EMS, focused on building a unified platform for algorithm investigation using commercial packages.

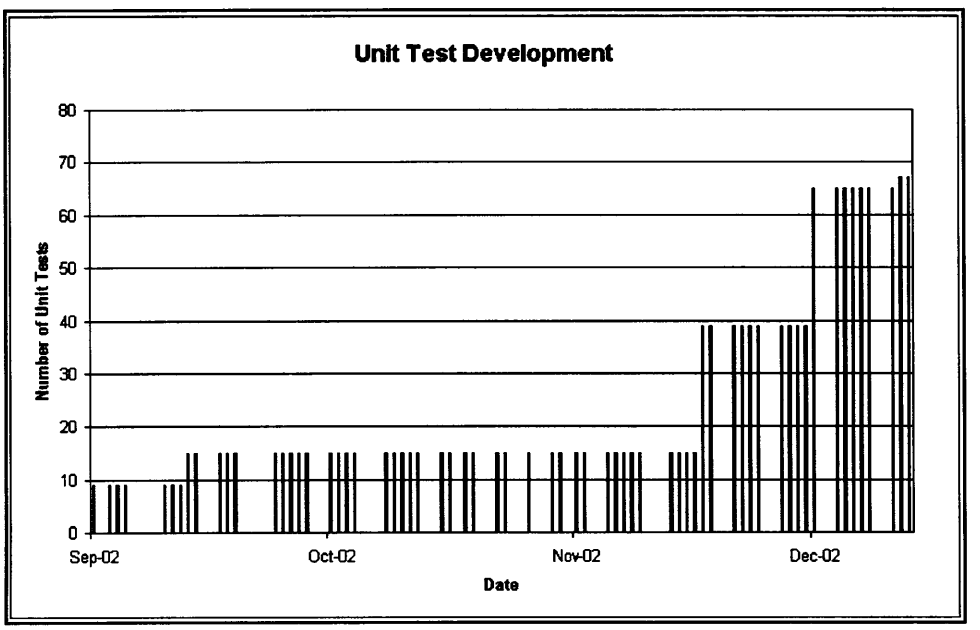

Figure 3. Unit test development as a function of time.

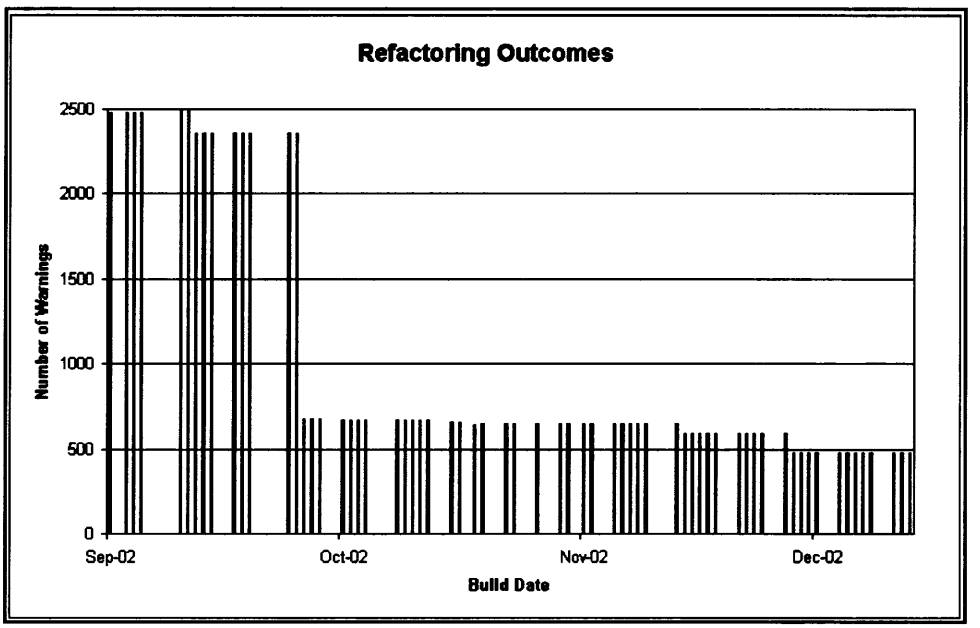

Figure 4. Build warnings as a function of time.

Green Bank Computing

During this quarter work has continued on improving the organization of servers, disk space and network services. One milestone achieved was finally moving all users home directories to the same server. This has allowed us to completely automate our routine backups, which saves much time and avoids trips up and down the corridor to load tapes.

Another benefit of centralizing user data and applications has been the consolidation of samba services, where before we were running three separate servers we now have just the one. Users no longer have to remember which server a particular share is located on.

This quarter also saw the deployment of two new network services, a caching web proxy and mailscanner. The web proxy acts as an intermediary between users' browsers and the Internet, by keeping copies of all web pages accessed in a central store it speeds up access to the web as well as reducing overall bandwidth consumption. For more information on how this works see http://www.squid-cache.org/FAQ. The other service, mailscanner is an important security tool that is now checking all incoming and outgoing mail for viruses. Another more visible part of the mailscanner is Spamassassin which tries to identify spam email and mark it as such. As part of the common computing initiative we have also reconfigured our email services, separating the gateway and delivery functions and running them on different machines. The new mail servers are fast Linux machines rather that the older, less capable Solaris machine.

Work has also been done on reducing the interdependence of the general computing and the telescope control networks. In time it is hoped that the telescope network can run entirely independently of the general computing services.

Progress continues to be made on the Windows 2000 domain. With the Green Bank domain controller now up and running further testing can take place. Migration to the new domain is scheduled to begin late next quarter.

GBT Development Projects

Precision Telescope Control System (PTCS)

The months of October and early November saw extensive, high-pressure efforts to characterize the behavior of the antenna, and especially the feed arm, using the Quadrant Detector, structural resonance monitoring, and traditional surveying techniques.

The hysteresis, linearity and repeatability of position of the GBT feed arm tip was measured on 5 October as part of a set of experiments that were designed to probe indications of structural anomalies, arising in part from the increased level of structural and performance investigations (described in the Q3 report). In brief, the indications were that the GBT pointing model showed large and asymmetric pointing residuals (after application of the traditional pointing model), that the Quadrant Detector indicated position of the feed-arm tip was non-linear and hysteretic, that structural resonant frequencies shifted in the 60-75 degree elevation range, and that a feed arm survey on May 30, 2002 indicated feed arm non-linear motions as a function of elevation, considerably at variance with a previous survey performed in the summer of 2000. Initial analysis of the 5 October survey data also indicated significant out-of-plane motions of the feed arm tip; as a result of this and the other evidence described above the telescope was closed on 11 October while yet further tests and data analysis were performed. The additional tests included a "yield test", in which the antenna was driven repeatedly to elevations of 15 to 85 degrees while surveying a target on the feed-arm tip, and additional structural resonance tests.

In the end, the anomalous behavior was explained as follows. First, there had been an error in the traditional pointing model analysis. The signs of the track tilt terms had been correctly fitted, but had been flipped in applying them in the Antenna Manager. This meant that this term, instead of being removed, was doubled. This was the cause of the asymmetric nature of the pointing residuals on either side of transit. Second, closer inspection revealed that the antenna had accidentally been moved in azimuth during the 5 October feed arm survey. Once this effect had been accounted for, a re-analysis of the unaffected data demonstrated that the feed arm tip behaved in accordance with a linear structure model to within the surveying instrument repeatability. This result discredited the Quadrant Detector and the May 2002 feed-arm survey indications of non-linearity. The Quadrant Detector was removed from the antenna and was subsequently discovered to have some instrumental problems; the latter data may have been corrupted by environmental influences, e.g. wind.

The yield test showed no evidence for any anomalous behavior. Finally, the initial indications of structural mode frequency shifts in the 60 to 75 degree elevation range were resolved by further experiments using passive and impulsive excitations of the structure and measurements of feed arm tip accelerations. These results demonstrated that what was previously seen as a sudden shift in structural mode (as a function of elevation angle) was in fact a preferential excitation of different modes close in frequency at different elevation angles. Given the positive results of these re-analyses and more detailed investigations, the telescope was returned to operation on 20 October.

The events of this period, while rather harassing, have resulted in a number of lessons learned. Perhaps the primary amongst these is the importance of having a simple, turnkey structural performance measurement system. Kim Constantikes set up a baseline for such a system in early November. Unfortunately, the GBT Internal Review held on 12 November, and the subsequent reorganization of the PTCS Project temporarily usurped the priority of this work. However, at the time of writing we have employed a Master's level EE Student for a four-month internship, with the intention that he completes the system.

As noted, the GBT Project underwent an internal review on 12th November. One of the main outcomes of this process was that the PTCS project priority was significantly increased; together with baseline investigations and AZ track work it is now one of the three top priority GBT projects. Together with the increase in priority, there has been a modest increase in staffing resources available to the project, which will effectively be available as of the start of 2003. These include approximately half of Jim Condon's time to provide scientific input, an increased fraction of Richard Prestage's time, and approximately 2.5 FTEs from the Software Development Division. We also plan to make more focused use of Fred Schwab, Lee King and Srikanth in Charlottesville as necessary. On the negative side, the effort of Dana Balser has been completely lost to the baselines project, at least for the foreseeable future.

With this change in priorities and resource levels, we have set ourselves the following goals to be achieved by 1 March:

- to integrate the new manpower into a core group that will focus intensively on the project;
- to generate an accurate project plan and work breakdown structure for the project;
- to prepare for a Conceptual Design Review, to be held after 1 March (perhaps late March or early April). The goal of the review would be to convince the panel that the Project Team (as now constituted, or with clearly identified additional resources) is competent, and our plans achievable. Only after this stage will we propose specific implementation milestones.

The bulk of the efforts since mid November have been to work towards these goals. This has included developing the first draft of a high level system architecture block diagram, refining the scientific requirements, and re-starting work on the Engineering Measurement System. At the same time, we have commenced work on re-commissioning the K-band receiver, including a more complete implementation of multi-beam observing, and have brought the open-loop Active Surface back into operation.

Finally, work continues on the Laser Rangefinder Units. We are continuing to work on the LRF calibrations, but are having some problems measuring the mirror and back prism offset from the mirror axis to better than about 50 microns. Some additional fixtures that will be available mid January will facilitate this. We are also looking into options for replacing the replicated mirrors while fine-tuning the calibration of all instruments, experimentally checking the glass offset calculation versus a hollow retro reflector. Work at Triad on the laser shelters is proceeding well, and the first prototype should be ready by early February.

New Receivers

1 cm and 3 mm receivers: Receiving and acceptance testing of components for the 1 cm (Ka-Band) and 3 mm (W-Band) receivers continued in the fourth quarter, and the Central Instrument Shop completed fabrication of some parts. Engineering work during this period was minimal in order to give priority to support of GBT operational systems and commissioning activities.

Caltech Continuum Backend: Readhead's group at Caltech is building a fast-switching digital continuum backend for the 1cm and 3mm receivers. A Preliminary Design Review was held on 06 September 2002 and the MOU signed at the end of the month. Caltech has proceeded into the detailed design phase and a Critical Design Review is planned for the first quarter of 2003.

Penn Array. Devlin's group continues to make good progress with the Penn Array. The fourth quarter saw successful cryogenics tests in the test dewar built at Green Bank; mechanical detector array prototypes at Goddard; a prototype (nearly final) optics design; and progress with filters and other components for on-the-bench detector and cold electronics tests. A CDR is planned for the first half of 2003.

Mechanical Engineering and the NRAO Central Instrument Shop

This quarter the Central Instrument Shop successfully completed the fabrication of 6 K-band OMT's and 3 Q-band feeds for the VLA. The shop began work in the EVLA L-band prototype and is expected to complete it next quarter. The shop also continued work on GBT 1 cm and 3 mm receivers and OMT's as well as parts for the GBT Prime Focus 2 receiver and the Beam Forming Array.

Next quarter, work will begin on a dewar vessel for ALMA and work will continue on the K and L band OMT's and receivers for the VLA as well as parts for the GBT advanced receiver programs.

VLA Highlights

During the fourth quarter, various FITS (Flexible Image Transport System) oversight bodies voted to approve the new formulation of a World Coordinate System (WCS), whose development has been the responsibility of a number of individuals and institutions. The WCS standard is an essential underpinning for the National Virtual Observatory, and will enable interchange of data obtained in many different wavebands with a common understanding of the definitions of spatial, frequency, and other coordinates. The most significant technical leadership has been supplied by personnel at NRAO and at the Australia Telescope National Facility, who were the authors of the first two of the primary technical papers defining the new WCS standard; these papers were published in *Astronomy & Astrophysics* during the quarter.

VLBA Highlights

Prototype Mark 5P disk-based recording systems were received from Haystack Observatory in the third quarter of 2002, and temporary software modifications were put in place to enable direct recording and correlation of VLBA data using these disk systems. Direct recordings to disk were made at the Pie Town VLBA station during observations of a galactic pulsar, in parallel with tape-based recordings at other VLBA stations. The computer disks from Pie Town then were transported to the Array Operations Center, where they were played back into the VLBA correlator. The processing against the tapes from the other stations resulted in high-quality fringe detections, and a useful data point for a scientific program of pulsar astrometry.

After more than 20 years, a significant color-plotting capability now has been implemented in the standard AIPS software package. Previously, many scientific publications have used topographic-style black-and-white contour plots or grey-scale images to represent radio intensity, polarization vectors, velocity fields, spectra indices, and other scientific quantities. The advent of routine color plotting in AIPS will make it much simpler for the many users of the VLA and VLBA to produce much more attractive images, and to convey more easily a wide variety of information, both for scientific publication and for more general audiences. Figure 5 shows an example of an image produced with the new capability.

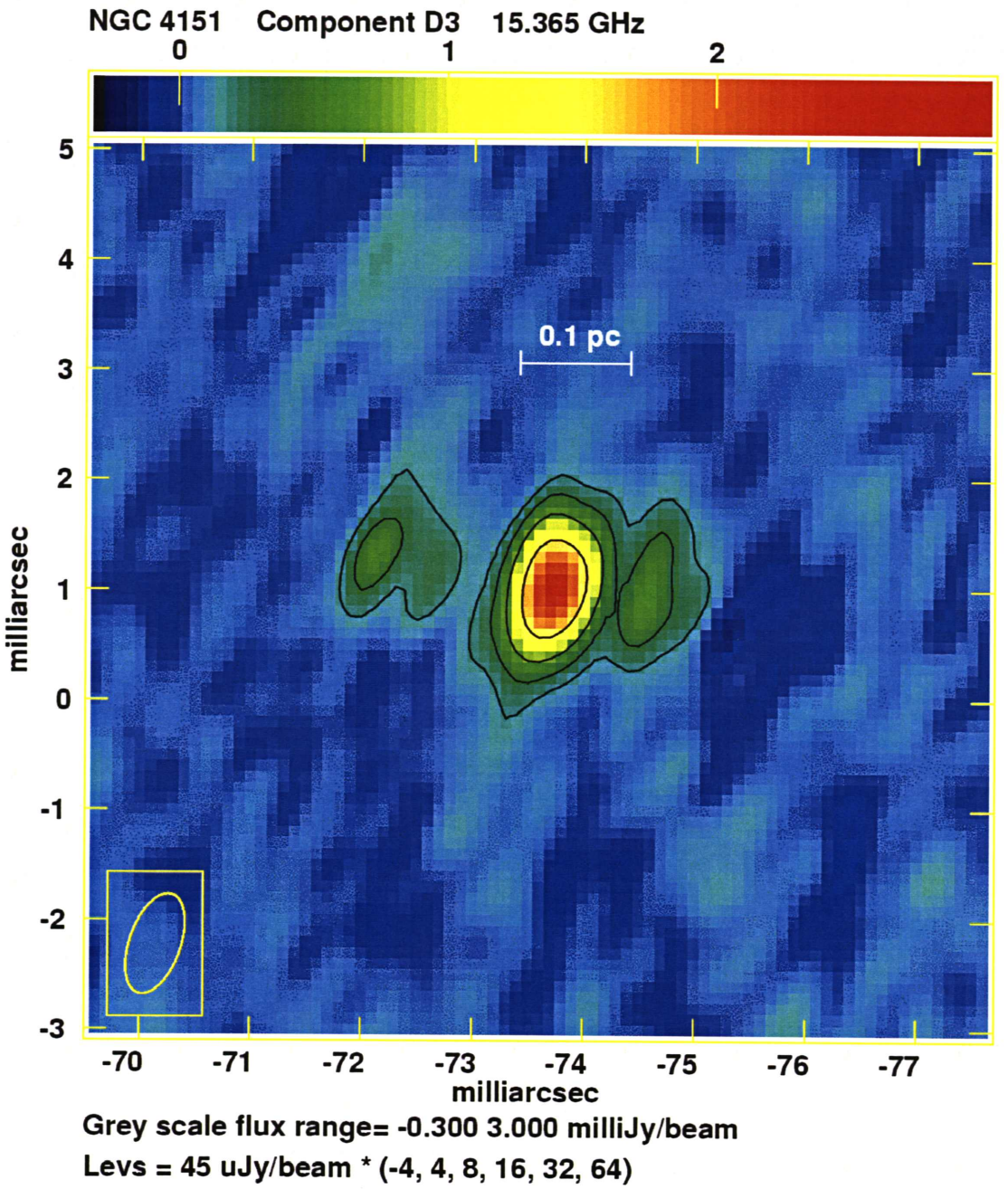

Figure 5. An image made using the VLBA + Y27 + GBT + Eb at 2cm reveals a flat-spectrum nucleus and the start of a two-sided jet in the Seyfert galaxy NGC4151

Management and Scientific Services

Milestones	Original Date	Revised Date	Date Completed
VLA Public Tour	10/06/02		10/6/02
Debut New VLA Visitor Center Film	10/31/02	10/06/02	10/6/02
First Fringes on Mark 5 Recorder Prototypes	11/30/02		10/10/02
Update VLA Astronomer Information on Web	09/30/02	10/30/02	10/30/02
18th Annual New Mexico Symposium	11/01/02		11/01/02
43 GHz JVAS Survey Complete	12/01/02		11/30/02
VLBA Large Proposal Review Complete	12/20/02		12/08/02
AIPS++ VLA Data Reduction Cookbook-Version 2	12/20/02		12/20/02
Release frozen 31DEC02 AIPS version; begin 31DEC03	01/02/03		12/26/02
Automated Monitoring of AIPS Software Downloads	06/30/02	01/31/03	
EVLA Completion Plan Science Case-Version 1	10/31/02	01/31/03	
VLA Public Tour	02/1/03		
VLA/VLBA Proposal Deadline	02/03/03		
VLA Skeptical Review Committee Meets	02/22/03		
Iridium OH Filters Available for VLA Observers	02/28/03		
EVLA Completion Plan Finished	03/31/03		
Jobserve Cookbook Revision	11/23/02	3/31/03	
VLA Public Tour	04/06/03		
VLA/VLBA Proposal Deadline	06/02/03		
Begin Third Session of VLA-Pie Town Link Observing	06/10/03		
VLBA 10th Anniversary Symposium	06/30/03	06/12/03	
VLA Visitor Center Gift Shop Opening	02/28/03	06/30/03	
Modular Office Space Occupied	05/10/03	07/01/03	
VLA/VLBA Target of Opportunity Implementation	10/31/03		
Release frozen 31DEC03 AIPS version; begin 31DEC04	01/02/04		
Synthesis Imaging Summer School	06/30/04		

Electronics

Milestones	Original Deadline	Revised Deadline	Date Completed
VLA/VLBA Pie Town Link (LO/IF)			
Complete construction & checkout of spares	01/31/01	05/30/03	
Receivers (FE)			
Build and install three more 86 GHz receivers	10/31/01	11/15/02	09/30/02
Build and install one more 86 GHz receiver for a total of nine	12/30/02	09/30/03	
Install 1st prototype LDPE L-band window	Open ended		12/02/02
Install 2nd prototype, LDPE L-band window	01/15/03		
VLBA Improvements			
Design for servo system enhancements	02/15/03		
Lightning Protection System (LPS) Improvements	05/30/03	Pending funding	
VLA Improvements			
Install Iridium Filters at 1.6 GHz	12/31/01	11/30/02	12/5/02
EVLA Related Tasks			
Operational bench integration of the IF data path	06/15/03		
Complete antenna outfitting	07/25/03		
Start 2nd antenna outfitting	12/15/03		

86 GHz receivers

The ninth receiver is slated for use at VLBA Brewster. Since the receiver cannot be effectively used at this site until the subreflector is refigured, the completion of the receiver is delayed to allow resources to be used on more immediate projects.

Engineering Services

Milestones	Original Deadline	Revised Deadline	Date Completed
Complete C array reconfiguration	10/11/02		10/10/02
Complete DnC array reconfiguration	01/17/03		
Complete D array reconfiguration	02/07/03		
Mechanical Group			
Paint Antenna #26	10/08/02		10/08/02
Kitt Peak maintenance visit	04/07/03		
Resurface Pie Town subreflector	04/30/03		
Mauna Kea azimuth rail repair	06/16/03		
Fort Davis maintenance visit	06/16/03		
Paint Transporter #2	07/31/03		
North Liberty maintenance visit	08/18/03		
Antenna #15 azimuth bearing change	09/01/03		
Electrical Group			
Prototype VLBA tachometer	12/31/02	01/31/03	
ALMA European Foundation Pwr and Fiber	03/30/03		
ALMA Japanese Foundation Pwr and Fiber	05/30/03		
Site & Wye Group			
Complete track repairs between BN6-AN5	12/31/02	01/31/03	
Complete finish grade at ALMA Site	02/28/03		
ES Engineering Group			
VLBA subreflector re-work	12/31/02		12/06/02
VLBA subreflector painting	12/31/02	01/30/03	
VLBA subreflector installation at Pie Town	02/28/03		

VLBA Tachometer prototype delayed due to problems with PC board fabrication. The Drive Cabinet Hasp installation has been transferred to the Electrical group and will be completed during the overhaul cycle. Track repairs between BN6-AN5 are delayed due to foul weather and equipment failure.

EVLA Related Tasks			
Start fiber installation	08/01/02	11/04/02	11/04/02
Start EVLA fiber trenching	09/01/02	11/04/02	11/04/02
Build two feed housings	02/28/03		
Complete Feed horn ring machine	02/28/03		
EVLA feed horn assembly structure	03/31/03		
EVLA antenna outfitting	04/14/03		

The feed cone prototype along with the vertex room mockup are complete and mock receivers and feeds are being installed for trial fitting. The L and C band feed cone ring machine is being developed and should be ready to fabricate the prototype feed cones in time for the first test antenna. There will be 2 test antennas with antenna #13 being the first antenna to be converted.

Computing Division

Milestones	Original Deadline	Revised Deadline	Date Completed
Foreign Monitor Data Loading	09/30/02	On Hold*	
Migrate Solaris Servers to Linux	10/31/02		10/31/02
Local release JObserve 1.7.0	12/01/02		12/23/02
Streamline VLA observe file submission	12/31/01	On Hold**	
VLBA Recorder Test Software	01/31/02	Pending software update	
Activate Sophos Antivirus Gateway	10/31/02	01/10/03	
Transcribe VLA Observe/System Files	11/30/02	01/15/03	
Radio Telescope at Visitors Center	11/01/02	01/30/03	
Mark VB software options document	01/31/03		
Ingres Conversion to Oracle	08/13/02	02/01/03	
Master Address Database	02/15/03		

Milestones	Original Deadline	Revised Deadline	Date Completed
Upgrade Ftp Server	08/31/02	02/28/03	
Correlator Controller Support Line Mode	12/31/02	02/28/03	
VLBA MV 331 replacement evaluation	02/28/03		
Configure/Build Filehost Replacement	11/30/02	03/01/03	
Move VLA software to standard area	03/30/03		
Plan Alternative to 9 track at VLA	03/31/02	06/30/03	
Correlator Controller Bug Fixes	03/31/03		
Phase 1 AOC Rewire	03/31/03		
Plan Alternative to 9 track at VLA	03/31/02	06/30/03	
Correlator Controller Integrate line/continuum	06/30/03		
Migration to Windows 2K domain	07/30/03		

* On hold due to reassignment of duties. A manual method exists.

** Part of new duties for staff member, Target date still TBD

Milestones	Original Date	Revised Date	Date Completed
EVLA Related Tasks			
Update Operations Requirements	08/20/02	10/01/02	09/30/02
Upgrade Linux cluster to more nodes	09/15/02	10/31/02	10/31/02
EVLA network security	11/04/02		11/04/02
MIB communications protocol selection	07/31/02		11/05/02
Antenna MIB development environment	08/05/02		11/11/02
Wiring AOC test antenna mock up	11/20/02		11/20/02
Operating system on CMP processor	11/30/02		11/30/02
Draft Correlator M&C requirements	11/30/02		11/30/02
Antenna RTOS on development board	06/19/02	09/30/02	12/04/02
Initial Backend Prototype	12/31/02		12/06/02

Milestones	Original Date	Revised Date	Date Completed
GBT design study	09/30/02	12/20/02	12/20/02
Backend Requirements Update	12/31/02		12/20/02
Backend Functional Design Revision	12/31/02		12/31/02
Install Java Virtual Machine on CMP	12/31/02		12/31/02
Complete Backend prototype code	12/31/02		12/31/02
MIB Bootloader/Flashloader Application	01/17/03		
MIB RTOS on prototype MIB board	01/31/03	02/17/03	
Correlator Review Penticton	02/28/03		
Begin MIB/module integration H/W & S/W	02/24/03		
Draft Correlator M&C software design	02/28/03		
MIB->technical screens	01/01/03	03/10/03	
Rudimentary VLA M&C from CMP	03/31/03		
Overall EVLA M&C architecture/design	01/06/03	05/31/03	
AMCS MIB Client-side S/W development	06/30/03		
Start new M&C system on test antenna	07/16/03		
M&C test ant. from Control Building	08/29/03		
M&C test ant. as part of hybrid Array	10/31/03		

AIPS

Distribution and Versions

The 31DEC02 version of AIPS was frozen in late December, and the frozen version now is available for download. The new test version, 31DEC03, was started and now is available via the standard midnight job. Unfortunately, the lack of systems support for AIPS has prevented the re-institution of monitoring of ftp downloads of the frozen version, though it is known that over 50 different sites are running the midnight job.

Key Developments

1. A major multi-task development has been the institution of full color-plotting capabilities in AIPS. The standard contouring tasks such as KNTR, GREYS, and PCNTR can produce grey-scale images that can be converted to pseudo-color or to standard true-color (*rgb*) images with a color table (OFM, or "output-function-memory"). The standard plotting task, LWPLA, has various levels of control enabling the specification of the conversion from grey-scale to color scales. Based on user specifications, contouring,

labeling, and polarization vectors can change "automatically" between light and dark colors based on the brightness of the underlying background. In addition to the *rgb* (red-green-blue) color representation, a *cmyk* (cyan-magenta-yellow-black) capability also exists, which enables the direct production of color postscript files that can be used directly by many of the standard research journals.

2. The VLBA data reduction pipeline, previously called as a stand-alone script, now has been incorporated into the standard AIPS release, and is included both in the frozen version of 31DEC02 and the updated version 31DEC03.
3. The UVCON task used to simulate (u,v) data has been given additional capabilities in order to support configuration studies for the VLA Expansion Project. The simulation of random phases added by RFI sources in antenna sidelobes now is possible, and large-angle data shifts can be made.
4. For a number of years, definition of a new "World Coordinate System" (WCS) standard has been sought under the auspices of both international and national FITS working groups, with major participation and leadership from within the AIPS group. This standard is critical for the ultimate goal of full data specification and interchange under the auspices of the planned National Virtual Observatory. We are pleased to report that the WCS standard has been approved by a vote of the appropriate FITS working groups, and the two papers defining the basic WCS specifications now have been published in *Astronomy & Astrophysics.*
5. A number of changes were made to the installation procedures for AIPS, to make it more robust for the many users and maintainers of AIPS at remote installations.
6. A new task, LOCIT, was added to enable the data analysts to fit for antenna positions after VLA reconfigurations.
7. The planned guide to low-frequency imaging depends on postdoctoral fellows, one of whom has finished the postdoctoral appointment. This item is still on the target /"hope" list.

Goals for First Quarter 2003

- Continue user support and bug fixes, as the major portion of AIPS effort.
- Add monitoring of ftp downloads of frozen AIPS version (delayed from previous reports due to lack of systems support).
- Port AIPS to McIntosh OSX operating system
- Upgrade smoothing and blanking methods in SNSMO, CLCAL, and related tasks.
- Complete low-frequency/wide-field cookbook appendix.

Central Development Laboratory Highlights

World record low noise temperatures for cooled HFET amplifiers were obtained: 7K at 22 GHz, 8 K at 32 GHz, 10 K at 40 GHz and 31 K at 80 GHz. Regular production of amplifiers using the TRW Cryo-3 wafer devices used for these record temperatures began.

An SIS mixer for 84-116 GHz was demonstrated with a record 4-12 GHz IF bandwidth and about 10K of mixer noise, as low as has ever been seen for this band, even with a narrowband IF. The first chips using a new SIS mixer design for 211-275 GHz, specifically targeting a 4-12 GHz IF band, were received from the University of Virginia foundry. A reduced-size 4-12 GHz amplifier to be used with this mixer was designed and fabrication began. A preliminary design showing how to fit a feed, orthomode transducer, and two SIS mixer-preamps into the tight volume of an ALMA cartridge was completed.

A broadband tunerless frequency multiplier for ALMA Band 6, supplied by Virginia Diodes, Inc. to NRAO specifications, was successfully tested in a cryogenic environment and shown to satisfy ALMA requirements. Multiplier-driver chains for Bands 3 and 6 were demonstrated. Designs for custom MMIC frequency multipliers, mixers, and power amplifiers were completed for use in custom wafer runs by UMS and HRL.

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	04–01-02	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	04-01-02	04-01-04	
Study use of overmoded w/g in LO transmission	03-16-01	02-28-03	
Electromagnetic Support:			
1) G/T optimization of feed taper at 30 GHz	03-31-02	03-31-03	
2) Feed pointing optimization of the VLA antenna	06-30-02	03-31-03	
3) Testing of EVLA L-band and C-band prototype feeds	03-31-03		
4) Testing of GBT Ka-band and W-band feeds	03-31-03		
5) GBT L-band pattern simulations	03-31-03		

Milestone	Original Date	Revised Date	Date Completed
ALMA Correlator:			
1) Start and complete PCB layout of correlator interface board	09-30-02	10-31-02	11-30-02
2) Develop FPGA designs for and test interface boards	09-30-02	03-31-03	
3) Complete design of quadrant control card	09-30-02	12-01-02	11-30-02
4) Start PCB layout of quadrant control card	09-30-02	01-31-03	
5) Start minor layout changes for all 2-antenna prototype correlator PCB cards	09-30-02	11-01-02	11-01-02
6) Start testing of prototype interface cards	12-31-02	01-31-03	
7) Complete design of the quadrant control card	12–01-02		11-15-02
8) Start PCB layout of the quadrant control card	12-01-02	03-31-03	
9) Start PCB layout of the front panel data port logic card	12-31-02		12-20-02
10) Complete design and start PCB layout of the correlator motherboard	12-31-02		12-20-02
11) Complete all mechanical design of the 2-antenna prototype correlator	12-31-02		12-31-02
12) Complete GBT spigot card project	12-31-02		12-31-02
13) Complete VLBA data recoding project	12-31-02	06-30-03	
14) Initial test of prototype ALMA correlator	12-21-02		12-31–02
15) Completion of the PCB layout and layout modification of all circuit cards required for the prototype correlator	03-31-03		
16) Completion of the assembly of all circuit cards required for the prototype correlator	03-31-03		
17) Substantial progress in system testing of the prototype correlator	03-31-03		
18) Substantial progress in the development of software for the prototype correlator	03-31-03		
19) Complete initial study of a new advanced digital filter for the ALMA correlator	03-31-03		
ALMA Frequency Multipliers:			
1) Band-6 frequency tripler evaluation	12-16-02		12-16-02
2) Band-7 frequency tripler evaluation	02-15-03		
3) Band-9 frequency quintupler evaluation	03-31-03		

Amplifier Design and Development

The evaluation of HFET's of different gate widths (40μm, 60μm, 80μm, 100μm, 200μm, 300μm) from TRW wafer #4044-041 (Cryo-3 lot) continues. The best noise temperatures observed so far, measured in a receiver setting with horn and amplifier at about 19 K temperature, are: 7K at 22 GHz, 8 K at 32 GHz, 10 K at 40 GHz and 31 K at 80 GHz. It has been determined that only minor modifications are required in the current designs of K-, Ka- and Q-band amplifiers. Previously developed 8-12 GHz amplifiers using 200μ—wide devices typically exhibit less than 3 K noise temperature in the center of the band. Work continues on the evaluation of Cryo-3 devices, especially from the point of view of W-band applications. New L-, S-, C- and W–band designs are being developed. Also, the modification of the 12–18 GHz design utilizing Cryo-3 devices is under way.

Amplifier Production

The fourth quarter of 2002 saw our first volume production and delivery of the latest generation LNAs, employing TRW Cryo-3 wafer devices. These amplifiers are yielding minimum noise temperatures of better than 0.25 K per GHz. A total of 13 Cryo-3 amplifiers was produced, including two 3-13 GHz LNAs for the GBT, four K-bands for JPL and the VLA, three Ka-band units for the GBT and four Q-band LNAs for JPL and the VLA. An additional ten "old" design InP (non Cryo-3) amplifiers were delivered, including eight coaxial 3-13/8-18 GHz LNAs for the VLA and Cambridge and two broadband W-band amplifiers for Tucson's ALMA test receivers. Eight integrated ALMA IF amplifiers were also completed this quarter. There are ongoing builds of 3-13/8-18 GHz, K-, Ka- and W-band amplifiers.

Five Ka-band amplifiers were retrofit with Cryo-3 devices and returned to Caltech for their CBI project. Six damaged or failed amplifiers from various users were repaired, tested, documented and shipped during the quarter.

Other Projects

The amplifier group continues with its support of the electroplating lab, repairing and replacing pumps, filters and other equipment as needed. The electroforming process has been running at full capacity for several quarters, producing, on average, four finished components every two weeks. All plating needs (primarily gold-plating) of the CDL have been met, including amplifier and mixer bodies, finished electroforms, miscellaneous waveguide structures and test fixtures.

Superconducting (SIS) Millimeter-Wave Mixer Development

ALMA SIS Mixer Development

Band 3 (84-116 GHz) SIS Mixer: Last year we completed the design of a tunerless DSB SIS mixer for Band 3 capable of operation with a 4-12 GHz IF. Recently, funding for wafer fabrication at UVA was provided by the Herzberg Institute as part of the Canadian contribution to ALMA. This quarter we continued testing

mixers from the same wafer but with different on-chip tuning. Because a large test dewar capable of accommodating the mixer and feed horn is not available, measurements are being done in a small dewar with a stainless-steel input waveguide between a room temperature feed horn and the mixer. Previous calibration at 114 GHz showed that the effective noise temperature of the warm waveguide components ahead of the mixer is 38 K ± 7 K and the input waveguide loss 0.5 ± 0.06 dB (both numbers will be slightly larger at lower frequencies).

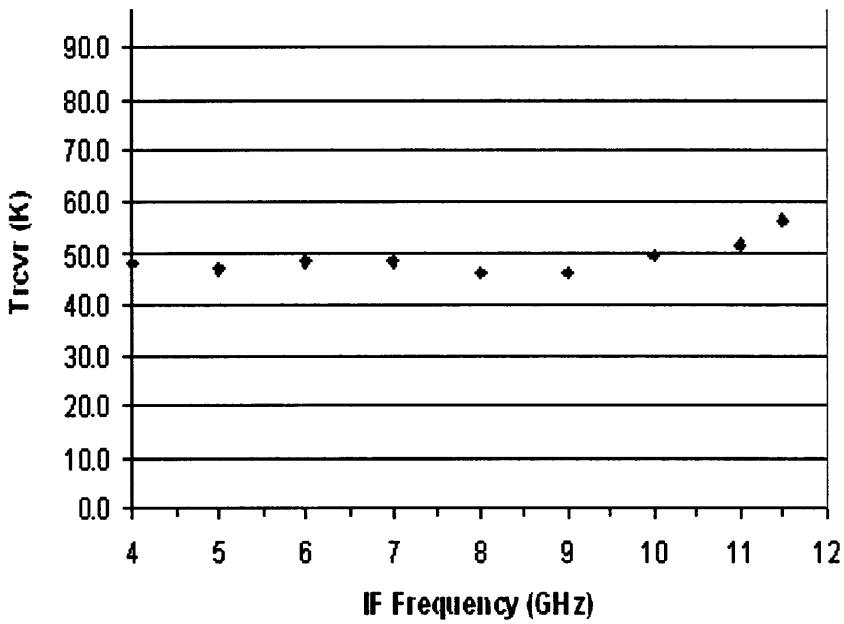

Figure 6. Overall DSB receiver noise temperature (with the same room temperature feed horn) as a function of intermediate frequency, at an LO frequency of 100 GHz,. when the mixer is integrated with a 4-12 GHz amplifier.

The Figure 6 shows the overall DSB receiver noise temperature (with the same room temperature feed horn) as a function of intermediate frequency, at an LO frequency of 100 GHz,. when the mixer is integrated with a 4-12 GHz amplifier. It is clear from these measurements that the receiver noise temperature at the input of the mixer is ~10 K DSB which is within the ALMA specification. The instantaneous IF bandwidth of 8 GHz also meets the ALMA specification. The immediate application for this mixer-preamplifier is measuring the sideband noise of the YIG-tunable LO drivers for ALMA.

Band 6 (211-275 GHz) Building Block SIS Mixer: We have received from UVA the first wafer of a newly designed single-ended SIS mixer. The new design has the following improvements: (i) The new mixer is optimized for the actual ALMA frequency band, which had not been decided at the time of the earlier design. (ii) A shorter RF choke circuit is used; this will improve operation with the wideband 4-12 GHz IF, and the shorter chip size results in more mixers per wafer. (iii) Only four designs are included on the wafer (compared with 12 designs on earlier mask sets) which will result in a larger percentage of usable mixers per wafer. A single-ended mixer test block for evaluating the new design has been fabricated in the CDL shop.

Band-6 (211-275 GHz) Prototype Single-Ended Sideband-Separating SIS mixer: This two-chip unbalanced sideband-separating design, integrated with a pair of 4-12 GHz IF preamps, is a prototype for Band 6. The mixer design is of the split-block type, using the waveguide quadrature hybrid described in ALMA Memo 343 and other waveguide elements described in ALMA Memo 381. The integral LO coupler (required in unbalanced mixers) is described in ALMA Memo 432. These are being fabricated in the shop.

Band-6 (211-275 GHz) Final ALMA Single-Ended Sideband-Separating SIS Mixer: This will be the final design for Band 6. It is essentially the same as the above prototype but uses a physically smaller mixer block designed to mate with the OMT and feed horn in the limited space of the ALMA cartridge. It requires a smaller preamplifier than the current test mixers. Both mixer block and preamplifier are awaiting fabrication in the shop.

Magnetic Circuits for SIS Mixers: It was noticed that the magnetic circuits used in our SIS mixers always produced a much lower field than expected for a given current -- in fact it was often impossible to obtain sufficient field without using a permanent magnet to supplement the field of the coil. Investigation using commercial magnetic circuit analysis software indicated that the part of the magnetic circuit inside the coil was saturating [EDTN 190]. We have redesigned the complete magnetic circuit and evaluated a number of magnetic alloys. It was found that, for the highest flux density with low hysteresis and low drive current, annealed Consumet should be used. This work is reported in ALMA Memo 438.

Gain Compression in SIS Mixers: It was pointed out in ALMA Memo 401 that saturation of SIS receivers by a warm calibration load may cause an error in amplitude calibration which is not negligible if ALMA's stated amplitude accuracy of 1% is to be achieved. Measurements with precision of a few tenths of a percent were completed during the quarter, and these confirm the mixer saturation predictions given in Memo 401. A memo is in preparation.

Receiver Sensitivity to LO Power Variation: Measurements were made quantifying the effect of LO power on receiver gain, noise temperature, and total noise power. A memo "Gain vs. LO Power of SIS Mixer-Preamps for ALMA Band 6" is available at: http://www.cv.nrao.edu/~jeffland/GainVsLO.pdf

SIS Mixer Testing: A memo documenting the database schema to support both mixer and cartridge measurement data was completed during the quarter and is available at http://www.cv.nrao.edu/~jeffland/dbSchema3.pdf.

ALMA 4-12 GHz IF Preamplifier Development

The design of a reduced-size version of the current prototype 4-12 GHz preamplifier is now complete and awaiting fabrication. The size reduction of the preamp (and mixer) was necessary to allow the assembly of two mixer-preamps, OMT and feed horn to fit within the limited space of the ALMA cartridge. The compact design has components on both sides of the amplifier, and its output connector is on the bottom of the amplifier. The bulky 15-pin DC bias connector (conductors for three amplifier stages and one mixer stage) has been eliminated in favor of a pigtail cable.

To simplify construction of the preamplifiers, we have ordered the mixer bias-T (which is contained within the preamplifier) as a monolithic chip from Mini-Systems, Inc., a commercial silicon component fabricator. This RC network uses TaN resistors which, from this manufacturer, have been found to change by < 1% on cooling to 4 K (this is not true of all TaN resistors -- some are quite temperature-dependent at ~ 4 K due to the presence of superconducting Ta_xN_y components).

We have contacted two companies concerning commercial fabrication of preamplifiers in the quantities required for ALMA. Both companies are experienced in MIC technology, and have built space-qualified components. We are waiting for quotes to decide whether it is more economical to construct these amplifiers in-house (in either case, we will still have to perform the cryogenic testing of the amplifiers in-house).

ALMA Band-6 Cartridge

Schedules have been created in Gantt chart format detailing all tasks involved in construction of the ALMA Band 6 cartridge. Each party responsible for a particular subsystem can now periodically update a personal Gantt chart and track progress. Considerable time was also spent developing Interface Control Documents with our co-respondents at other sites/institutions. ICDs have now been completed and forwarded to the ALMA front-end system engineering group. Wiring diagrams that include the proposed cartridge wiring harnesses have also been completed.

The new Band-6 optics design from IRAM has now been verified at Cambridge, using a physical optics program, at three frequencies. We have designed and ordered feed horns and focusing mirrors for measurement (at IRAM) of the beam patterns and for use in the Band 6 mixer production test set.

Currently, the mirror and horn mounts for the cartridge are being designed.

Characterization of high-efficiency modular heat sinks for dewar wiring has now been completed and is reported in ALMA Memo 437. Thermal equivalent circuits are given at several heat-sink temperatures.

Software requirements for the cartridge test system have been documented and reviewed at a Preliminary Design Review (PDR) meeting for that system. The requirements document is at: http://www.cv.nrao.edu/~jeffland/CartSWSpecs.pdf.

CDL Shop

A web-based system to track the progress of jobs in the CDL's machine shop was deployed during the quarter. Details are at: http://www.cv.nrao.edu/~jeffland/ShopTrackingSystem.pdf

Publications & Memos

[1] E. W. Bryerton, S.-K. Pan, D. L. Thacker and K. Saini, "Band 6 Receiver Noise Measurements Using a Pre-Prototype YIG-Tunable LO," ALMA Memo 436, 27 Oct. 2002.

[2] D. Koller, J. Effland, A. R. Kerr, K. Crady and F. Johnson, "Miniature, Modular Heat Sinks for ALMA Cryostats," ALMA Memo 437, 2 Dec. 2002.

[3] G. A. Ediss and K. Crady, "Measurements of Materials for SIS Mixer Magnetic Circuits," ALMA Memo 438, 14 Nov. 2002.

[4] J. E. Effland, "ALMA Band 6 Cartridge Measurement System Software Specifications," NRAO, 18 Dec. 2002, http://www.cv.nrao.edu/~jeffland/CartSWSpecs.pdf.

[5] J. E. Effland and R. Groves, "Gain vs. LO Power of SIS Mixer-Preamps for ALMA Band 6," NRAO, 13 Dec. 2002, http://www.cv.nrao.edu/~jeffland/GainVsLO.pdf.

[6] J. E. Effland, "Database Design for Cartridge and Mixer Test Data," NRAO, 17 Oct. 2002, http://www.cv.nrao.edu/~jeffland/dbSchema3.pdf.

[7] J. E. Effland, "System to Track the Progress of Jobs in the CDL Machine Shop," NRAO, 15 Nov. 2002, http://www.cv.nrao.edu/~jeffland/ShopTrackingSystem.pdf.

Electromagnetic Support

EVLA

An analysis of Gain/System temperature (G/T_{sys}) for the VLA antenna, as a function of feed taper at the edge of the subreflector at 10 GHz, was completed. G/T_{sys} peaked at -14 dB feed taper. A preliminary design of feeds, having an edge taper -14 dB at the edge of the subreflector, was completed for the 8-12 GHz and 12-18 GHz bands. A design of a Ka-band feed (26-40 GHz) was also completed this quarter. This feed will have a taper of -13 dB at the edge of the subreflector.

Spectrometers/Correlators

ALMA Correlator

The major effort for the ALMA correlator group in the last quarter was the completion of PCB layouts for the remaining logic cards. Completion of minor layout changes to logic cards with working prototypes also occupied the correlator group. New PCB layouts include: the correlator interface card, the correlator motherboard, and the Front Panel Data Port (FPDP) card.

Minor PCB layout changes were made to the following: the filter card, the station card, the 6U power supply card, the 9U power supply card, and the correlator card power mezzanine board. Changes to the LTA PCB are about 1/2 complete.

Design of the last logic card, the Quadrant Control Card (QCC), needed for the prototype correlator was completed in November.

An RFQ for the assembly of prototype correlator logic cards was issued in November, resulting in a purchase order to the successful bidder in December. Parts and blank cards for four logic designs were sent to the assembler in December.

The mechanical design and assembly of the prototype correlator rack were completed in December. Power was applied to the rack before year's end with one station motherboard and a few cards installed.

An ALMA memo suggesting a performance upgrade path for the baseline ALMA correlator was released. The upgrade required only the design of a more advanced digital filter card.

Other Projects

The developmental phase of the GBT spectrometer spigot card project was completed in December and responsibility was transferred to Green Bank. Additional support for this card, and the GBT spectrometer in general, will still be required of the Charlottesville correlator group.

The VLBA data translation project progressed to the point of testing the system on an actual VLBA transport in Green Bank, but completion of the project is still pending.

ALMA LO Source

The purpose of this project is to develop a series of electronically-tunable, phase-locked sources operating near 100 GHz. These sources will be used to drive millimeter- and submillimeter-wave frequency multipliers that produce the first-LO signal for the ALMA receivers.

MMIC multipliers and mixers from UMS are presently in fabrication. Three extra development designs were placed on the wafer in the final weeks before mask fabrication: two doublers to use for Bands 4 and 5 cold multipliers and a comb generator. InP MMIC power amplifier designs are finished, and the reticle is being layed out with mask fabrication in one month.

The Band 3 lab LO prototype was built, tested and shipped to HIA. Before shipping, sideband noise measurements were performed using this LO to pump an SIS mixer. Significant excess sideband noise was measured similar in nature to what was seen with the Band 6 lab prototype LO. Bandpass filters were found to eliminate this problem. This same solution will be attempted soon with the Band 6 LO.

ICDs were drafted and submitted for the LO interfaces to the cartridges, M&C, and bias electronics.

ALMA Frequency Multipliers

The purpose of this project is to develop millimeter- and submillimeter-wave frequency multipliers for use in laboratory experiments and receiver systems associated with ALMA. A series of multipliers using varactor and varistor circuits operating in the 50 to 950 GHz range are being developed.

Virginia Diodes, Inc. Frequency Multiplier Evaluation

Designs of the input and output waveguide assemblies required for evaluation of the Band-6 cold frequency tripler (VDI) were finalized and fabrication completed. Subsequently, the 77 K Dewar was readied and characterized for cryogenic testing of frequency multipliers. Mylar windows were evaluated and found suitable for use. Support software for testing was prepared.

Extensive evaluation of the first Band-6 cold frequency tripler prototype (VDI 3.7x3 C10), including burn-in, output power performance evaluation as well as temperature and RF cycling, was performed. (A detailed report is available in test memo dated 11/15, titled "Evaluation of Band-6 Frequency Triplers (80/240 GHz) for the ALMA Local Oscillator System.") VDI 3.7x3 C10 is a low input power (10 mW) design.

Tests on a similar fixed-tuned multiplier from Millitech, Model FTT-03-3, were performed for comparison of output power variation with that seen in the VDI frequency tripler. A comparable output power variation was seen in this case as well.

The VDI 3.7x3 C10 block was later strapped into a 15 K dewar and thermal cycled 3-4 times. Subsequent performance evaluation revealed no noticeable performance degradation.

Jeffrey Hesler of Virginia Diodes reported that rework was required on the Band-9 quintupler. The first prototype is not expected before the end of February 2003. Delivery of the Band-7 frequency tripler, originally scheduled for the end of December, is now expected by mid-January 2003.

Designs of the input and output waveguide assemblies required for evaluation of the Band-7 cold frequency tripler (VDI) and Band-9 frequency quintupler (VDI) have been completed and fabrication is under way.

JPL/University of Michigan Collaboration

This is a summary progress report for the first year of the project and outline of the proposed plan for the following year.

There were two main efforts in the first year of the project: development of micro-machined probe structures and fabrication of diodes based on the mask design provided to UM by NRAO.

Micro-Machined Probes: The micro-machined probe development effort yielded probes fabricated on 100-micron silicon substrate with a worst case insertion loss of 1.9 dB in the WR-10 waveguide band for two back-to-back probes with a short waveguide in the middle. (The waveguide was a DRIE micro-machined structure in a silicon block, a result of DARPA Micro machining work. See Dr. Jack East's reports dated 21 Oct. 2002 and 17 Dec. 2002 for further details.) Efforts are currently under way to fabricate DRIE micro-machined WR-5 and WR-3 waveguides. Micro-machined probes for these waveguides will then be designed, fabricated and evaluated.

Diode Fabrication: The first set of devices was fabricated on a wafer from an outside vendor. The process yield was good, but the CV characteristics showed almost no capacitance variation with bias voltage when tested at NRAO. CV testing at UM showed that the wafer active layer doping was much lower than specified. The device was punched through. A second wafer was grown with similar results. At this point, it was decided to grow a set of wafers for doping calibration. A third and fourth wafer was obtained from a second vendor. These wafers have dopings of 10E+17 cm^{-3} and 2*10E+17 cm^{-3}, values that cover the expected range of NRAO requirements. A first batch of devices have been fabricated, and the processed wafer received at NRAO. This wafer needs to be thinned and diced to produce usable devices. A second wafer has been processed and is being thinned and diced at UM. Individual diodes from this wafer are expected to be received shortly by NRAO for evaluation.

Other: The JPL wafer thinning (membrane) process was studied and procedures modified to enable removal of almost all of GaAs from a MMIC except in the vicinity of diodes. This process would be available, if required, for projects outlined for next year.

The development of polyamide-backed thinned GaAs MMICs was explored but abandoned since it does not appear that the thinned structures need any mechanical support.

Plan Outline for 2003: The goal of this year's effort will be to get a frequency tripler with output in the WR-3 waveguide band. This will incorporate matching circuitry fabricated on micro-machined substrates. Toward that end, the micro-machined probe fabrication process needs to be extended and verified for its suitability for smaller structures. The frequency tripler will take the form of passive input/output matching circuitry (including waveguide probes) fabricated on thinned silicon with micro-machined pockets for incorporating GaAs based diodes. It could also be realized as a single integrated GaAs circuit (this to be determined). These circuits would then be seated into appropriately fabricated DRIE silicon blocks or metal housing assemblies. All this development will take place at UM.

Concurrently, at NRAO, the UM diode model will be incorporated into microwave Office and then used to design the frequency tripler circuitry using both the Finite Ground Plane Coplanar as well as Micro strip transmission lines. These designs will then be fabricated at UM.

Beam-Forming Array

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

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

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

Low-Noise Element Design: Work continues with the low-noise element design. A second type of antenna, the crossed sleeve dipole, is still being considered for use in the array since its impedance is a close match to that required by the low-noise amplifiers.

Antenna Test Range Project: Slip rings, an absolute optical encoder, and a stepping motor for the turret have been received, and the optical encoder and stepping motor have been installed. Work continues on the RF switching manifold.

With the helpful addition of interfacing documentation, the SDD is now well positioned to complete Phase 1 of the antenna test range project in the spring of 2003 for deployment by summer, when it is required by the receiver engineers.

Outstanding Achievement in Data Management

A number of radio source catalogs (NVSS, FIRST, and WENSS) have been placed online in the NRAO e2e archive. As part of our NSF-funded NVO development, we have made these catalogs accessible via the NVO conesearch protocol. This protocol allows access to the results of a query to the catalog concerning a given direction and search radius (a cone). The request is issued in an HTTP format to a specific URL. The search can also be triggered from an HTML page at:

http://www.aoc.nrao.edu/e2e/java/vocone.html

The answers are returned in the form of a VOTable – an XML-based format. AIPS++ can now issue and process these queries. For example, a user can ask for all sources overlapping a given image. Using AIPS++ tools, the result can be easily overlaid on an image or used to start an imaging or self-calibration process. In the image below, we show NVSS catalog sources overlaid on the corresponding NVSS image.

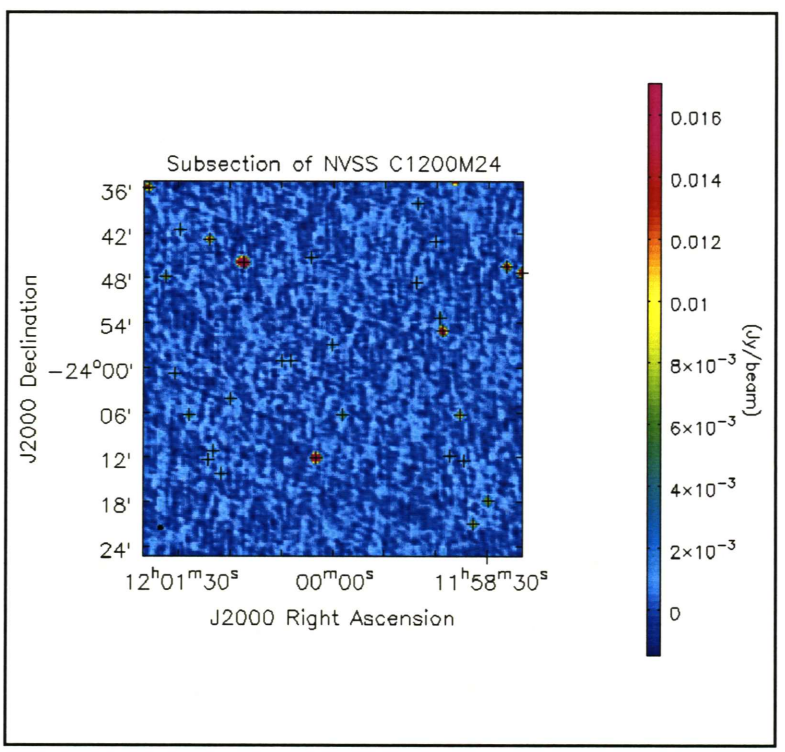

Figure 7 NVSS catalog sources overlaid on the corresponding NVSS image.

e2e Project

Milestone	Original Deadline	Revised Deadline	Date Completed
Internal tests of VLA interim archive	01-15-02	02-15-03	
External tests of VLA interim archive	03-15-02	04-01-03	
Announce VLA interim archive server	06-01-02	05-01-03	
Purchase GBT archive hardware	09-15-01	03-01-03	
Initial EVLA scientific requirements	11-01-02		12-09-02
Initial tests of proposal toolkit	12-01-02	02-01-03	
Deploy GBT server	01-15-03	04-01-03	
End of second development cycle	04-15-03		
e2e Advisory Group meeting	05-15-03		

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

Work on scientific requirements for the EVLA and GBT has been aided by the formation of Science Software Requirements groups for each. The first version of the EVLA SSR was delivered to e2e on Dec 9, 2002, and replies and requests for clarification issued on Jan 6, 2003. A first draft of the GBT SSR document is now under discussion by the GBT group.

The VLA/VLBA archive continues to grow. At the current rate of tape loading (about 0.6TB per month), we expect to fill the existing disk storage by mid March 2003. Within this time, we will have loaded all of the historical VLA archive and will be about 25% into the VLBA archive. We will then switch to loading the VLBA archive and would expect to have loaded all of that by mid-late 2004. The user interface to the archive is under internal testing and we expect to make it available to users once that and some external testing is complete, probably within 2-3 months. We have moved to use an Oracle database for the archive tables in place of AIPS++ tables. This has resulted in speed improvements and quicker development times. The archive tables are still generated in AIPS++ from MeasurementSets created from the original data files.

Purchase of the GBT archive hardware has been delayed by the lack of an NRAO budget. However, testing of the software continues – projects are loaded into the archive at the AOC as they occur.

A prototype proposal submission and handling system is being developed in Java using an Oracle database. We expect to proceed to initial user testing as soon as a testing server has been acquired and installed (early February). We anticipate a substantial revision of the prototype following comments by testers.

E2e and AIPS++ staff participated in the ALMA Interim Design Review held in Garching during December 2002. A design for the ALMA pipeline was delivered prior to the IDR and reviewed at the IDR. The design is now being revised accordingly and will be presented again at the ALMA Preliminary Design Review to be held in March 2003. At the IDR, initial discussions were held between e2e and ALMA management concerning the adoption of the ALMA technical and functional architecture. If this can be done, it will result in substantial savings for both parties. Further discussions are planned for a visit of e2e staff and management to ESO in late January 2003.

Our NVO work has focused on the conesearch capability described above, though we also contributed via the specification of the Simple Image Access Protocol and to overall architectural discussions.

Technology Development

Milestone	Original Deadline	Revised Deadline	Date Completed
AIPS++ booth and demo at ADASS '02 Baltimore, MD	10/16/02		10/16/02
AIPS++ Stable Snapshot I	11/15/02		11/15/02
AIPS++ Revised WBS for v2.0	11/30/02		11/30/02
AIPS++ Stable Snapshot II	12/15/02		12/15/02
AIPS++ booth and demo at AAS, Seattle, WA	1/6/03	(no booth)	
AIPS++ external users' workshop	1/15/03	(cancelled)	
AIPS++ Stable Snapshot III	1/15/03		
AIPS++ External Review	2/1/03		
AIPS++ Stable Snapshot IV	2/15/03		
ALMA AIPS++ tests - Phase II	2/28/03		
AIPS++ release v2.0	4/1/03		

The DM Technology Development division is concerned primarily with management of the AIPS++ project. This package is developed by a consortium of participating observatories, and is the next-generation data reduction package for a wide range of radio telescopes. The package is currently in an active integration phase, with increasing use at many sites. The current focus reflects the overall project status, and is concerned

primarily with scientific completeness, ease of use and enhancements in robustness and performance. The project planning is based closely on these priorities. The current release of AIPS++ is v1.7, and is available on CD-ROM or by network download. The next release of AIPS++ will be named v2.0, and will be issued in April 2003.

During this quarter, several staffing changes occurred. Athol Kemball stepped down as Project Manager and joined the NRAO Basic Research staff. Eric Sessoms (GB) transferred to the GBT M&C project. Joe McMullin became the Project Manager and Kumar Golap became the Deputy Project Manager subject to confirmation by the AIPS++ Executive Committee. Due to these changes and the overall net loss in resources, a revision to the development plan was required. In addition, the development cycle was broken into several "Stable Snapshots" throughout the cycle in which specific functionality/enhancements would be available. A mechanism for updating to these installations was also implemented.

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

AIPS++ single-dish staff have continued a close collaboration with GBT Operations, aimed at meeting the scientific and technical needs of telescope commissioning. Following the GBT review in November 2002, this coordination has been improved and includes weekly meetings on status and close liaison on planning priorities and single-dish development. In addition, the on-site AIPS++ developer in Green Bank assists directly in user support and telescope commissioning activities. These activities have continued during this quarter. A number of user tutorials on single-dish capabilities have been conducted during this period, particularly focused on involving NRAO-CV staff in the GBT commissioning process.

AIPS++ has also retained a focus on meeting ALMA needs during this quarter. This has primarily concerned completion of phases I and II(a) of the AIPS++-IRAM end-to-end test. The test report was presented by Athol Kemball (NRAO) and Robert Lucas (IRAM) to the ALMA Science Advisory Council (ASAC), at their meeting in early September 2002. This test has shown that algorithms and techniques from a different frequency regime (that what AIPS++ has been handling thus far) can be successfully implemented within the package. Tim Cornwell and Kumar Golap visited IRAM this quarter; tutorials on AIPS++ use were conducted at IRAM during this visit, with a primary focus on synthesis development and reduction.

In general, this quarter has seen continued improvement in scientific completeness, usability and performance of the AIPS++ package. Our collaboration with in-house testers has continued at NRAO. In October, Steve Myers was appointed Project Scientist for AIPS++, unifying the testing efforts and acting as a link to NRAO scientific staff and the user community. An observatory-wide tutorial series on AIPS++ capabilities was initiated in December. These user outreach and training initiatives will continue as a strong priority in the coming quarters.

Central Computing Services

Milestone	Original Deadline	Revised Deadline	Date Completed
Revise Security Policy	2/15/01	3/31/03	
VPN (Charlottesville)	9/30/01	3/31/03	
VPN (NM/Tuc)	6/30/03		
Anti-virus email gateway deployment completed (GB/Tuc)	9/30/01	12/31/02	11/15/02
Anti-virus email gateway deployment completed (NM)	9/30/02	1/31/03	
CCE survey of all NRAO computer users	1/31/03		
CCE design (UNIX application co-ordination processes)	12/31/02	3/31/03	
CCE design (core applications)	3/31/03	3/31/03	
Begin W2K domain client migration	1/31/02	1/31/03	
Begin evaluation of Windows XP	4/30/03		

Security:

In the past quarter, the NRAO experienced no noteworthy computer security incidents, although the Distributed Denial-of-Service (DDOS) attack which was launched against the Charlottesville FTP server in the spring continued at a very low level. Such attacks use numerous compromised systems as simple-minded automatic agents, unknown to their owners. The measures implemented several months ago remain effective at preserving the availability of this service for legitimate users.

The Green Bank and Tucson anti-virus email gateways were both deployed in the fall of 2002, using the same configuration as the original system in Charlottesville. Due to a few problems found during testing in Socorro, production deployment there was delayed. We expect these to be resolved early in 2003. In the first month of operation, the Charlottesville system detected nearly 2,500 viruses in incoming email messages. This is considerably higher than was suspected prior to installing this capability, and indicates that the significant effort invested in this project has been worthwhile. Industry reports indicate that the volume of viral content in email continues to rise rapidly.

VPN (Virtual Private Networking) is needed for employees who are required to work frequently or for extended periods of time at non-NRAO locations, and to support telecommuters during construction at Edgemont Road in Charlottesville. Work on deploying a special-purpose VPN box began with placement of an order for the equipment in early October, but a major delay in delivery prevented doing more than preliminary configuration and testing by the end of the quarter. The experience gained with this system will

be useful in determining how to provide the same capabilities at other NRAO locations, which we intend to do in Socorro and Tucson by mid-2003. Green Bank's Internet connection goes through Charlottesville, so it may not be necessary to install a similar box there.

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

Common Computing Environment (CCE):

The UNIX CCE working group members have recently focused most of their energy on final configuration and deployment of the email gateways. Work on defining the processes by which we will standardize UNIX applications across NRAO sites has continued at a reduced level, primarily in developing a questionnaire which will be sent to all NRAO computer users in early 2003. The goal of the questionnaire is to identify problematic inter-site differences. The resulting information will also be used to help determine the set of core applications that should be available on all desktop and public NRAO systems.

The new Windows 2000 Active Directory domain which was created in September now has three operational domain controllers. Most of the agreed-upon settings have been implemented, which will ensure that policies are applied to all Windows computers as they migrate into the domain. The Windows administration group is now working toward common operating system and application installation techniques for the domain. Once the migration of desktops into the domain is well underway, we will begin evaluating Windows XP. A moratorium was issued on the installation of XP in early 2002, as several licensing and technical issues need to be investigated before we can deploy it for general use.

Web Services:

- Web servers: consolidation of services onto the four main servers continued; the NRAO-wide calendar (webevent) was moved off a desktop and onto the main Tucson web server.
- Web Proxies: these have the potential to significantly reduce our inter-site and internet bandwidth usage by "caching"content that may be viewed by two or more people. Proxies have been set up in Green Bank and Charlottesville, and are pending in New Mexico and Tucson. Use of proxies also potentially improves interactive web browsing.
- Web page redesign: NRAO's main "front" web page is being overhauled; a revised design was finalized in this quarter and is currently being tested. A new look and feel is being achieved via "server side includes", and will help make existing content appear consistent with the revised main page. This redesign is a precursor to a wider, and far more extensive overhaul of NRAO's web presence and functionality. This overhaul will be conducted by a joint group representing Data

Management, EPO, and Scientific Services and is expected to proceed at least through the calendar year (2003).

- An Operations Document for NRAO web servers was finalized during this time. It specifies how the main NRAO servers are configured and operated in fine detail, with separate sections for end users and web/system administrators. Topics covered include the mirroring scheme, backup regimens, services configuration, and more.
- A new version of the NRAO Web Publications Policy was drafted and circulated; the final version is expected to be produced in January and deployed shortly thereafter. A companion Web Design Standards document was also started.
- A concerted effort was made to document and assign responsibility for various parts of the main NRAO web pages (www.nrao.edu). This is now largely complete and will be maintained as a living document.
- A project to create an LDAP-based directory to replace the existing ad-hoc NRAO phone book "database" was started. This directory has the potential to become a single sign-on authority for our Unix, Linux and Windows users, and more.

Observatory-wide Communications

Milestone	Original Date	Revised Date	Date Completed
Complete software upgrade of video conferencing units	11/30/02		11/30/02
Add additional T1 service GB to CV	11/30/02		11/30/02
Deploy networking and phones in OIC	12/31/02		12/31/02
Deploy VPN service in CV	12/31/02	02/28/03	
Upgrade network service to VLBA KP antenna	12/31/02	02/28/03	
Renewal of Intranet contract	02/28/03		
Replacement of Green Bank fiber ring	02/28/03		

The upgrade of the operating software in all ten of the Polycom video conference units has been completed. This includes an algorithm designed to give high prioritization of audio to improve clarity on congested circuits. We believe that we have seen improved reliability since the upgrade. In addition, we now have the capability to manage all of the configurations centrally. We have used this to standardize the configuration of all units.

We are still exploring ways to add additional communication services by reducing costs on our existing intranet contract. This is due for renewal in the next quarter. To provide better access to the Green Bank Telescope, we have completed the installation of a dedicated T1 link between Green Bank and Charlottesville to supplement the existing frame relay connection, thereby doubling the available bandwidth.

When the Edgemont Road building undergoes the planned enhancements, many members of staff will require improved access to the NRAO Charlottesville computer facilities from outside of the NRAO buildings. To prepare for this, we have purchased a Virtual Private Network (VPN) concentrator. Using VPN services, staff will be able to make secure connections to the NRAO network through Internet Service Providers. Unfortunately, this was delivered later than anticipated, and work on its deployment had to be deferred until the next quarter.

The decision was taken to open another office in Charlottesville at the Old Ivy Commons (OIC) building. The communication services are over a newly installed dedicated T1 circuit between the OIC and the Edgemont Road (ER) building. All traffic uses the Internet Protocol (IP). Phone support in the building is handled by a Nortel Remote Office 9150 connected to the main Meridian Option 11 Private Branch eXchange (PBX) in the ER building. This allowed the huge advantage to all staff who moved to the OIC of retaining their business phone numbers and voice mail.

There was an unanticipated delay in the delivery of the modems for the upgrade of the network service to the VLBA Kitt Peak antenna. Deployment will be delayed until the next quarter.

The original fiber ring connecting the buildings in Green Bank was deployed in 1988 as a single 10 Mbps collision domain. We have begun a project to upgrade this link to give improved access to the main network backbone in the Jansky Lab. The original fiber will continue to be used as the main infrastructure between the buildings; the only rewiring needed is the replacement of the Attached Unit Interface (AUI) cables with fiber within the remote buildings. The original Fibercon boxes are to be replaced by six modern Alcatel Ethernet switches, which will provide a 100 Mbps backbone between the buildings. Within the remote buildings, switched 10 Mbps will be available to the individual users.

Education and Public Outreach Highlights

The EPO highlight of the last quarter of 2002 was the Jansky lecture, "The Brightest Explosions in the Universe." Shrinivas Kulkarni of the California Institute of Technology, winner of the Jansky Lectureship, spoke to enthusiastic, capacity crowds during October, November and December in Charlottesville, Green Bank, Socorro and Tucson. In Charlottesville, the lecture was preceded by a well-received showing of the short presentation about the NRAO from the NRAO's CD business card, while in Socorro Shri's lecture capped the day at the New Mexico Symposium. The interest in Kulkarn's Jansky lecture was evidenced by his being later requested to give an encore presentation of his Jansky lecture in Hawaii.

Education

Much of the education efforts this quarter were spent in preparation for future programs. A grant proposal for a NASA IDEAS program workshop was submitted for Socorro. A five-year Research Experience for Teachers (RET) proposal was submitted in conjunction with the Research Experience for Undergraduates five-year renewal proposal. If approved at the levels proposed there would eighteen undergraduate students per summer at the four (Charlottesville, Green Bank, Socorro and Tucson) NRAO sites, while there would be six teachers per summer with four at Green Bank and two at Socorro.

School visitors from Marshall University, the University of Kentucky, University High School, Western Albemarle High School, Lincolnton High School, West Virginia University, Morehead University (KY), and Ohio University came for overnight/in-depth tours at Green Bank. Two presentations were given for Charlottesville area 7th graders attending a Careers Fair at Piedmont Virginia Community College. Approximately, 7% of the visitors taking tours at Green Bank were school or scout groups, while at the VLA school groups represented about 30% of tour groups.

The West Virginia Regional Science Bowl Quiz competition was held at NRAO Green Bank. NRAO staff also participated in the development and organization of the Highlands Regional Math Science and Technology Consortium (covering a multi-county area in the Green Bank region).

Community Programs

The Green Bank Science Center is approaching construction completion. The contractor's finish date was extended until January 24, 2003 and the contractor expects to meet that revised deadline except for landscaping which will be delayed until warmer conditions prevail and will be weather dependent. Aspects of the project either recently completed or 95% completed include exterior glass, aluminum entrances,

drywall, acoustical ceiling grid, bathroom accessories, projection screens, food service equipment, and RF shielding. The project as a whole is deemed 91% complete with painting, carpeting, and other flooring work proceeding rapidly. The Catching the Wave Advisory Committee had the opportunity in Culpeper, Virginia to view prototypes and production stages of exhibits for the Center's exhibit hall. Expectations continue that the Center should open for "advance preview" business in early spring and for an official dedication near the end of May. The new presentation video on the NRAO and radio astronomy for the VLA Visitor Center is now in use and is being well received. A similar presentation video for the Green Bank Science Center is in its final stages and Green Bank employees had the opportunity to view a "beta" version, which was greeted with favorable reviews. The plans for a gift shop at the VLA Visitor Center were put out for bid, with the return bids due in mid-January.

Attendance at Green Bank, based on head counts from the bus tours, was 3,171 for the quarter, which included 235 in organized school and scout groups, and 1,004 in prearranged bus groups. Nine hundred and eighteen people were taken on tours at the VLA, including 286 in school groups, 114 in college groups, and 14 attendees from the December National Science Teachers Association conference in Albuquerque. At both sites, the visitations numbers are lower minimums as the Visitor Center at the VLA is not staffed, and Tour Center (to be replace soon by the Green Bank Science Center) has few open hours during these months. However, the grounds of both sites are still open to visitors during all daylight hours.

The Jansky lectures, featuring Dr. Shrinivas Kulkarni speaking about the "Brightest Explosions in the Universe," were the highlight of this quarter, with large turnouts at all sites including estimates of 80 at Green Bank, 300 at Charlottesville, 350 at Socorro, and 200 at Tucson. In concert with the Jansky lecture in Socorro a highly successful New Mexico Symposium was held with a lively and informative exchange of information about research, instrument development, and EPO activities.

Star parties and observing sessions were also a large part of this quarter's activity with NRAO participation at the annual Enchanted Skies Star Party in New Mexico and the annual Mid-Atlantic Star Party in North Carolina. A scheduled public star party at Green Bank was converted to a special Starlab planetarium show for about two-dozen people when the weather did not cooperate. At least one NRAO staff member, in Charlottesville, held a neighborhood observing session for the Leonid Meteor Storm with about 20 people attending, who also received NRAO promotional material.

The first steps were set in place for an NRAO-sponsored International conference on Communicating Astronomy to the Public. The National Research Council has agreed to co-sponsor this event and host it at the new National Academy of Sciences building in Washington, D.C. An ad hoc planning committee of NRAO staff and outside consultants chaired by Bob Brown is in place, and working to bring this meeting to fruition in October of 2003.

Analysis of surveys of summer visitors to Green Bank Tour Center show results similar previously to those derived from the VLA center. Visitors were surveyed at both the Green Bank and VLA centers in

attempt to gain some understanding of the demographics of our visitors and some notion of where they obtain their information about the sites. These results showed that the typical Green Bank visitor is on an extended vacation averaging nearly one week. Not surprisingly more than half the visitors were from West Virginia and its bordering states, though 37 states were represented for this limited period. Nearly three-quarters of the visitors were at Green Bank for the first time and families with children comprised only about one-third of the visitors. This is a relatively low percentage of children compared to typical demographics at science centers. This difference in expected attendance will be part of future planning for the centers.

NRAO-Socorro EPO staff attended a STARTEC (State-of-the-Art Telescope Educational Collaboration) meeting at McDonald Observatory and participated in hammering out plans for a website and a teacher exchange. In October, contact was initiated with the chairman of the New Mexico state highway commission, and he agreed on the spot to do what he could to get signs put up on I-25 directing tourists to the VLA Visitor center, which is 50 miles from the Interstate. The signs have been ordered and expectations are that installation will occur in late January.

Public Awareness

Following on the successful launching of the new NRAO Image Gallery, the same team began developing a redesign for the NRAO website. This redesign will include a new home page with updated navigation tools and information areas, customer-specific second level pages to facilitate use of the website, and updated "Server Side Includes," which are the automatic common elements on all of NRAO's web pages. This new web site should be "beta" tested early in January, 2003 and deployed by the end the month. Additional refinements and enhancements will be deployed throughout the year.

New Robert Byrd Green Bank Telescope photos were taken by an outside professional photographer and immediately put to use in the 2003 NRAO Calendar and in the Image Gallery. A new poster promoting the VLBA and to be used to target graduate and undergraduate students was developed along with a poster promoting the upcoming conference highlighting the 10th anniversary of the VLBA. EPO staff continued participation in the SCOPE (Southwest Consortium of Observatories in Public Education). The popular NRAO business card with its two-minute video about the NRAO was reproduced in a format more readily useable on most computer systems.

When the planned Gift Shop at the VLA Visitor Center opens, discount offers on purchases will be used to leverage promotion through organizations such as the American Automobile Association. Similar plans exist for the Green Bank Science Center. Ironically, there is more opportunity for promotion if one offers a discount, than if there is no fee at all.

In addition to doing the necessary preparation for arranging for the NRAO display to appear at the January meeting of the AAS in Seattle (shipping, rental, display fees, etc.) arrangements were also made to bring a smaller display to the AAAS conference for the first time.

Media Relations

Press releases this quarter dealt with the discovery of hydrogen clouds in the halo region of our galaxy by Jay Lockman and the death near the end of the year of radio astronomy pioneer, Grote Reber. A local press release in Charlottesville was issued about observing the Leonid Meteor Storm. News stories posted on the NRAO website include the winning of the Nobel Prize in Physics by AUI President, Ricardo Giacconi, his meeting with the president of Chile in connection with the ALMA project, and the VLA being listed among the top five telescopes of all time by Space.com.

A small filmmaking group from Albuquerque came to the VLA as part of making a film about the interface between ancient Native American astronomy and modern science. The film will be completed probably sometime next year. News coverage of the Jansky lecture and associated New Mexico Symposium in Socorro led to several news stories about those activities and interest in other stories about NRAO telescopes. Both the VLA and the GBT were objects of attention with visits by reporters interested in stories about those telescopes.

Telescope Usage

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The NRAO telescopes were scheduled for research and maintenance during the fourth quarter of 2002 in the following manner. Note that time lost and actual observing for the arrays are computer at fractions of the total antenna arrays. For example, losing 27 VLA antennas for one hour counts as 1.0 hours of time lost, while losing one out of 10 VLBA antennas for one hour counts as 0.1 hours of time lost.

	VLA	VLBA	GBT
Scheduled Observing (hrs)	1642.6	1095.0	559.00
Scheduled Maintenance and Equipment Changes	245.3	225.0	422.00
Scheduled Tests and Calibration	267.9	298.5	932.00
Time Lost	37.4	46.0	--
Actual Observing	1605.2	1049.0	574.00

GBT Observing Programs

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

No.	Observer(s)	Programs
BP102	Philstrom, Y. (NRAO - AOC Socorro) Conway, J. E. (Onsala Space Observatory)	Search for excited OH in Cygnus A 2 cm
BT064	Taylor, G.B. Peck, A. (MPIfR) O'Dea, C. P. (STScI) Ulvestad, J.	HI and Continuum Imaging in the Gigamaser Galaxy TXS 2226-184 21 cm
GB045	Bartel, N. (York U.) Bictenholz, M. F. (York U.) Rupen, M. P.	SN1986J The evolution of its complex shell and a search for a pulsar nebula 6 cm
GBT01A-014	Braatz, J. A. Greenhill, L. J. (Harvard-Smithsonian)	Detecting High-Velocity Masers to Reveal Nuclear Disks in Nearby AGNs 1.3 cm
GBT01A-057	Chatterjee, S. (Cornell) Cordes, J. M. (NAIC and Cornell) Lazio, T. J. (NRL) Goss, W. M. Fomalont, E. Benson, J. Stairs, I. (U. of British Columbia) Brisken, W.F. (Princeton U.) Thorsett, S. (UC, Santa Cruz)	Neutron Star Kinematics: VLB Pulsar Parallaxes with the GBT 21 cm
GBT02A-012	Minter, A. Balser, D.	Probing HI Structure On Sub-A.U. - A.U. Scales: Hydrodynamical or MHD Turbulence? 21 cm
GBT02A-018	Churchwell, E. (U. of Wisconsin) Sewilo, M. (U. of Wisconsin) Araya, E. (Arecibo) Hofner, P. (Arecibo) Kurtz, S. (UNAM)	Kinematic Distances to Massive Star Formation Regions in the Inner Galaxy 6 cm
GBT02A-021	Lockman, F. J. Roshi, A.D. (Raman Research Institute) Balser, D.	A Search for Recombination Lines from Diffuse Gas in the Galactic Center

GBT02A-031	Lockman, F. J.	Galactic HI Mapping of X-Ray, UV, and Optical Deep Fields 21 cm
GBT02A-049	Backer, D. C. (UC, Berkeley) Stairs, I. (U. of British Columbia) Nice, D. (Princeton) Lommen, (UC, Berkeley)	Exploration Of Millisecond Pulsar Timing Stability 70, 21, 11 cm
GBT02A-052	Stairs, I. (U. of British Columbia) Manchester, R. N. (Australia Telescope) Lyne, A. G. (NRAL)	Continued Multifrequency Monitoring of a Massive Pulsar System 38, 21, 11 cm
GBT02A-060	Nice, D. (Princeton U.) Stairs, I. (U. of British Columbia) Arzoumanian, Z. (NASA/GSFC)	Timing and Polarimetry of Two Eclipsing Binary Pulsars 50, 21 cm
GBT02A-062	Camilo, F. (Columbia Astrophysics Laboratory) Halpern, J. P. (Columbia U.) Stairs, I. (U. of British Columbia) Backer, D. C. (UC, Berkeley) Arzoumanian, Z. (NASA/GSFC)	Studying PSR J2229+6114: an Energetic Gamma-ray Emitting Young Pulsar 21 cm
GBT02B-009	Roshi, A.D. (Raman Research Institute) Deshpande, A.A. (Raman Research Institute)	AU scale HI structures: a probe using scattering of pulsar signals 21 cm
GBT02B-010	Henkel, C. (MPIfR) Braatz, J. Carilli, C. Lubowich, D. A. (AIP) Millar, T. (UMIST)	The Kinetic Temperature of a Molecular Cloud at z=0.9 (NH3) 2 cm

GBT02B-019	Stairs, I. (U. of British Columbia) Ransom, S. (McGill U.) Kaspi, V. (McGill U.) Hessels, J. (McGill U.) Backer, D. C. (UC, Berkeley) Lorimer, D. (U. of Manchester)	Timing of Newly Discovered Globular Cluster Pulsars 21 cm
GBT02B-021	Chandler, A. (Caltech Physics) Jacoby, B. (Caltech Astronomy) Anderson, (Caltech Physics) Kulkarni, S. R. (Caltech) Prince, T. A. (Caltech) Backer, D. C. (UC, Berkeley)	Timing the Six Millisecond Pulsars in M62 21 cm
GBT02C-003	Camilo, F. (Columbia Astrophysics Laboratory) Halpern, J. P. (Columbia U.) Gotthelf, E.V. (U. of Columbia) Mirabal, (Columbia U.)	RX J1836.2+5925: the next Geminga (this time in radio?) 38, 21 cm
GBT02C-007	Dickey, J. M. (U. of Minnesota) Kavars, D. (U. of Minnesota) Lockman, F. J. Martin, P.G. (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-023	Lockman, F. J.	A Study of the HI Clouds in the Galactic Halo 21 cm
GBT02C-024	Garland, (U. of Florida) Williams, J. P. (Institute for Astronomy) Pisano, D.J. (Australia Telescope National Facility (ATNF)) Guzman, (U. of Florida) Castander, (Yale U.)	An HI survey of Local Luminous Blue Compact Galaxies 21 cm

GBT02C-034	Camilo, F. (Columbia Astrophysics Laboratory) Stairs, I. (U. of British Columbia) Lorimer, D. (U. of Manchester) Backer, D. C. (UC, Berkeley) Ransom, S. (McGill U.)	Timing observations of the young pulsar in supernova remnant 3C58 38, 21 cm
GBT02C-035	Black, G. Campbell, D. (Cornell U.) Carter, L. (Cornell U.) Ostro, S. (JPL)	Bistatic S-Band Radar Observations of Titan. 11 cm
GBT02C-056	Kaspi, V. (McGill U.) Lyutikov, M. (McGill U.) Ransom, S. (McGill U.) Kouveliotou, C. (MSFC/NASA)	GBT Observations of SGR 1806-20 or SGR 1900+14 During Outburst 21, 11 cm
GL026	Lonsdale, C. J. (Haystack Observatory) Lonsdale, C. J. (Caltech IPAC) Smith, H. E. (UC, San) Diamond, P. J. (MERLIN/VLBI National Facility)	High Sensitivy Imaging of Supernovae and Masers in Arp 220 21 cm
GM047	Marcaide, J. M. (Universitat de Valencia) Guirado, J. C. (Universidad de Valencia) Alberdi, A. (Instituto de Astrofisica) Lara, L. (Instituto de Astrofisica) Perez-Torres, M. (Istituto di Radioastronomia) Ros, E. (MPIfR) Diamond, P. J. (MERLIN) Van Dyk, S. (IPAC/Caltech) Weiler, K. W. (Naval Research Lab)	Monitoring the expansion of SN 1979C at 6am and 18cm 21, 6 cm
GV016	Vermeulen, R. (Stichting ASTRON) Ros, E. (MPIfR) Kadler, M. (MPIfR) Zensus, J. A. (MPIfR) van Langevelde, H.J. (JIVE) Kellermann, K. I. Cohen, M. (Caltech)	Co-existence of gas states and velocities in the ineer parsec of NGC 1052 21 cm

No.	Observer(s)	Programs
AA267	Alexander, P. (Cambridge) Riley, J. (Cambridge) Pooley, G. (Cambridge) Fabian, A. (Cambridge) Hardcastle, M. (Bristol, UK) Worrall, D. (Bristol, UK) Cotter, G. (Cambridge) Inskip, K. (Cambridge) Allen, S. (Cambridge) Crawford, C. (Cambridge)	Formation of cold clouds by FRII radio sources. 2,3.6, 6 cm
AA274	Anderson, J. (NMIMT) Ulvestad, J.	Survey of low luminosity active galactic nuclei. 0.7, 1.3, 2, 6 cm
AB1031	Brogan, C. Kassim, N. (NRL) Lazio, J. (NRL)	Low frequency observations of the W51 Complex. 90 cm
AB1038	Bolatto, A. (Calif., Berkeley) Leroy, A. (Calif., Berkeley) Simon, J. (Calif., Berkeley) Blitz, L. (Calif., Berkeley)	Atomic hydrogen in dwarf galaxies. 20 cm
AB1041	Bosma, A. (Marseille Obs) Freeman, K. (Mt. Stromlo) Bureau, M. (Columbia) Athanassoula, E. (Marseille Obs) O'Brien, J. (Mt. Stromlo)	The edge-on barred spiral NGC 5746. 20 cm
AB1053	Brosius, J. (NASA/GSFC) White, S. (Maryland) Gary, D. (NJIT)	Solar coronal magnetography using radio and EUV data. 2, 3.6, 6, 20 cm
AB1056	Blomme, R. (Royal Obs.) Prinja, R. (U. College London) Runacres, M. (Royal Obs.)	Structure in the stellar wind of the BO Ia star Epsilon Ori. 0.7, 3.6 cm

AB1058	Benz, A. (SFIT, ETH) Bastian, T. Mann, G. (Ondrejov Obs) Gary, D. (NJIT)	Imaging of electron beam emissions in the solar corona. 20, 90 cm
AB1059	Bastian, T. Gary, D. (NJIT) Lee, J. (Arizona) Benz, A. (SFIT, ETH) Vilmer, N. (Paris Obs) Klein, K. (Paris Obs)	Joint microwave and hard x-ray imaging of impulsive solar flares. 2, 3.6, 6 cm
AB1060	Butler, B. Stern, S. (SWRI)	7mm observations of Pluto/Charon and Triton. 0.7 cm
AB1061	Bolton, S. (JPL) Levin, S. (JPL) Klein, M. (JPL) Bastian, T. Bourdarie, S. (ONERA) Santos-Costa, D. (ONERA) Sault, R. (CSIRO) Gulkis, S. (JPL)	Observations of Jupiter's Synchrotron Emission. 6, 20 cm
AB1078	Barcons, X. (Cantabria) Gonzalez-Serrano, J. (Cantabria) Warwick, R. (Leicester) Carballo, R. (Santander) Carrera, F. (Cantabria) Ceballos, M. (Cantabria)	Morphology of radio- and X-ray-loud QSO RXJ1011.2+5545. 3.6 cm
AC624	Clemens, M. (Cambridge) Alexander, P. (Cambridge) Cotter, G. (Cambridge) Longair, M. (Cambridge) Nikolic, B. (Cambridge)	Comparison of thermal continuum emission with mid-IR PAH features. 2 cm
AC628	Castelletti, G. (IAFE) Kassim, N. (NRL) Dubner, G. (IAFE)	Supernova remnant W44 at low frequency. 90 cm

AC642	Claussen, M. Sahai, R. (JPL) Marvel, K. (AAS) Boboltz, D. (USNO)	Search for OH and H2O maser emission from IRC+10 216. 1.3, 20 cm
AC652	Carilli, C. Petric, A. (Columbia) Cox, P. (IAP, Paris) Bertoldi, F. (MPIR, Bonn) Omont, A. (IAP, Paris)	Imaging the CO emission from the z=4.12 QSO 2322+1944. 0.7 cm
AC654	Cannon, J. (Minnesota) Kunth, D. (IAP, Paris) Leitherer, C. (STScI) Mas-Hesse, M. (LAE, Madrid) Ostlin, G. (Stockholm) Petrosian, A. (ARI, Heidelberg) Skillman, E. (Minnesota)	VLA HI Imaging of HST Selected LyA Starburst Galaxies. 20 cm
AC655	Contreras, M. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Wilkin, F. (Mexico/UNAM)	Survey of T Tauri Stars with Infrared Companions. 3.6 cm
AC662	Claussen, M. Wootten, W. Butler, B. Chandler, C. Rupen, M. Greenhill, L. (CfA)	Attempting to confirm water masers in extra solar planets. 1.3 cm
AD459	Dolag, K. (MPIAP, Munich) Govoni, F. (Bologna) Schindler, S. (Liverpool JMU) Feretti, L. (Bologna)	Faraday rotation in nearby hot galaxy clusters. 3.6 cm
AD470	Dahlem, M. (ESO) Ehle, M. (ESA, Spain)	HI observations of galaxies with radio halos. 20 cm

AD471	Di Francesco, J. (NRC) Webster, Z. (Calif., Berkeley) Welch, W. (Calif., Berkeley)	High resolution continuum observations of the NGC 1333 IRAS 4A envelope. 0.7 cm
AD473	Dunn, D. (Calif., Berkeley) dePater, I. (Calif., Berkeley) Molnar, L. (Iowa)	Observations of Saturn's Rings at large opening angles. 2 cm
AE134	Eyres, S. (Lancashire) Bode, M. (Liverpool JMU) O'Brien, T. (Manchester) Davis, R. (Manchester) Ivison, R. (Royal Obs) Evans, A. (Keele)	Target of opportunity observations of classical novae. 1.3, 2, 3.6, 6, 20 cm
AE148	Edge, A. (Durham) Frayer, D. (Caltech)	Atomic hydrogen in emission in cooling flows. 20 cm
AG592	van Gorkom, J. (Columbia) Bravo-Alfaro, H. (Guanajuato U.) Dwarakanath, K. (Raman Institute) Guhathakurta, P. (Calif., Santa Cruz) Poggianti, B. (Padova) Schiminovich, D. (Caltech) Valluri, M. (Rutgers) Verheijen, M. (Wisconsin) Wilcots, E. (Wisconsin) Zabludoff, A. (Wisconsin)	HI survey of clusters in the local universe. 20 cm
AG618	Giroletti, M. (Bologna) Giovannini, G. (Bologna) Treves, A. (Milano Obs) Falomo, R. (Padova) Dallacasa, D. (Bologna)	A sample of nearby BL lac objects. 3.6, 20, 90 cm
AG626	Gaensler, B. (CfA) Brogan, C. Kassim, N. (NRL) Lazio, J. (NRL)	90 cm survey of the inner galaxy. 90 cm

AG633	Gentile, G. (Bonn U.) Salucci, P. (Trieste Obs) Kalberla, P. (Bonn U.) Pizzella, A. (Padova) Klein, U. (Bonn U.) Jozsa, G. (Bonn U.)	Dark matter in spiral galaxies. 20 cm
AG635	Gross, C. (NRL) Cohen, A. (NRL) Lazio, J. (NRL) Lane, W. (NRL) Perley, R. Condon, J.J. Cotton, W.D. Ensslin, T. (MPIfEP, Garching) Kronberg, P. (Toronto)	Ultra steep spectrum source survey. 20 cm
AH752	Hunter, D. (Lowell Obs) Hunsberger, S. (Lowell Obs) Wilcots, E. (Wisconsin) Simpson, C. (Florida Int) Elmegreen, B. (IBM)	Origin of dwarf galaxies. 20 cm
AH787	Harris, D. (CfA) Kim, D. (CfA) Fomalont, E.	X-ray - radio comparison in Fornax A. 2, 6 cm
AH793	Hogg, D.	Are there HI clouds outside the disks of spiral galaxies? 20 cm
AH794	Henkel, C. (MPIR, Bonn) Nagar, N. (Arcetri) Blocker, T. (MPIR, Bonn)	Sakurai's object: the ionized nebula at radio wavelengths. 1.3, 6 cm
AH795	Hunter, D. (Lowell Obs) Tomita, A. (Wakayma) Sunada, K. (Nobeyama) Elmegreen, B. (IBM) Brinks, E. (Guanajuato U.)	Galaxies with CO J=1-0 observations. 20 cm

AH801	van der Hulst, T. (Groningen/Kapteyn) Sakai, S. (Calif., Los Angeles) Kennicutt, R. (Arizona)	HI in star-forming dwarf galaxies in Abell 1367. 20 cm
AI102	Iono, D. (U. Mass) Yun, M. (Massachusetts)	Galaxies in close collision. 20 cm
AI104	Ivison, R. (Royal Obs) Greve, T. (Edinburgh) Carilli, C. Papadopoulos, P. (Leiden) Lewis, G. (AAO)	Mapping high-z gas-rich mergers via 12CO J=1-0. 0.7, 1.3 cm
AJ291	Johnson, K. Kobulnicky, C. (Wisconsin) Goss, W.M.	Candidate ultra dense extra galactic HII regions. 1.3 cm
AJ293	Johnson, K. Kobulnicky, C. (Wisconsin)	Q-band observations of optically thick free-free sources in He2-10. 0.7 cm
AJ295	Junor, W (New Mexico) Harris, D. (CfA) Biretta, J. (STScI) Perlman, E. (Maryland)	Monitoring M87 jet component HST-1. 0.7 cm
AK509	Kulkarni, S. (Caltech) Berger, E. (Caltech) Bloom, J. (Caltech) Frail, D. Galama, T. (Caltech) Harrison, F. (Caltech)	Radio afterglows from gamma ray bursts. 0.7, 1.3, 2, 3.5, 6, 20 cm
AK549	Kukula, M. (Edinburgh) Dunlop, J. (Edinburgh) Floyd, D. (IfA) McLure, R. (Oxford)	Radio emission from radio quiet quasars with good HST images. 6 cm

AK550	Kulkarni, S. (Caltech) Berger, E. (Caltech) Chevalier, R. (Univ. Virginia) Soderberg, A. (Caltech)	Supernovae with suspect central engines. 1.3, 3.5, 6, 20 cm
AK553	Kenney, J. (Yale) van Gorkom, J. (Columbia) Vollmer, B. (MPIR, Bonn)	HI in highly inclined ram pressure stripped spirals in Virgo Cluster. 20 cm
AK554	Koopmans, L. (Caltech) deBruyn, A. (NFRA) Fassnacht, C. (STScI) Wambsganss, J. (API, Potsdam) Blandford, R. (Caltech)	Compact halo objects at z=0.41 via radio micro lensing in B1600+434. 2, 3.6, 6 cm
AL563	Lu, F. (Massachusetts) Lang, C. (Massachusetts) Wang, D. (Massachusetts)	The Crab-like SNR G54.1+0.3. 3.6, 6 cm
AL575	Lee, J. (Arizona) Impey, C. (Arizona) van Zee, L. (Indiana)	Kinematics of low surface brightness galaxies. 20 cm
AL578	Landt, H. (STScI) Perlman, E. (Maryland) Padovani, P. (STScI)	A faint sample of BL Lacertae objects. 20 cm
AL579	Levinson, A. (Caltech) Ofek, E. (Tel Aviv) Waxman, E. (Weizmann Institute) Gal-Yam, A. (Tel Aviv) Frail, D.	Orphan afterglows from Gamma-ray bursts: candidates from FIRST. 3.6, 20 cm
AL581	Lara, L. (IAA, Andalucia) Giovannini, G. (Bologna) Dallacasa, D. (Bologna) Stanghellini, C. (Bologna)	Old emission from young radio sources. 20 cm

AL583	LaRosa, T. (Kenesaw State) Nord, M. (New Mexico) Lazio, J. (NRL)	Polarimetric study of six candidate nonthermal filaments in the GC. 6 cm
AM702	Markovic, T. (NMIMT) Owen, F. Eilek, J. (NMIMT)	Radio halos in Abell Clusters of galaxies. 20 cm
AM721	McLaughlin, M. (Manchester) Lorimer, D. (Manchester) Cordes, J. (Cornell) Camilo, F. (Columbia) Hankins, T. (NMIMT) Kern, J. (NMIMT)	Search for radio pulsations from the X-ray point source in Cas A. 20 cm
AM727	Monnier, J. (CfA) Greenhill, L. (CfA) Tuthill, P. (Sydney) Danchi, W. (NASA/GSFC)	Colliding wind binary WR 112. 3.6 cm
AM734	Murgia, M. (Bologna) Parma, P. (Bologna) Mack, K-H. (NFRA) deRuiter, H. (Bologna)	Ultra steep spectrum radio galaxies. 6, 20 cm
AM735	Markovic, T. (NMIMT) Owen, F. Eilek, J. (NMIMT)	Central radio sources in cooling core clusters II. 20 cm
AM737	Mundell, C. (Liverpool JMU) Wilson, A. (Maryland) Schinnerer, E. (Caltech) Wilcots, E. (Wisconsin) Ulvestad, J. McKay, N. (Liverpool JMU)	HI imaging survey of Seyfert galaxies. 20 cm

AM740	Morganti, R. (NFRA) Emonts, B. (Kapteyn) Oosterloo, T. (NFRA) van der Hulst, J. (Kapteyn) van Moorsel, G.	Neutral hydrogen and the origin of radio galaxies. 21 cm
AO159	Owen, F. O'Dea, C. (STScI) van der Marel, R. (STScI) Laine, S. (STScI) Postman, M. (STScI) Lauer, T. (KPNO-NOAO)	Radio sources and black holes in brightest cluster galaxies. 20 cm
AO170	O'Dea, C. (STScI) Guerra, E. (Rowan) Daly, R. (Penn State) Donahue, M. (STScI)	Propagation of powerful radio galaxies. 6, 20, 90 cm
AP438	Pisano, D. (CSIRO) Guzman, R. (Florida) Kobulnicky, C. (Wisconsin) Gallego, J. (Complutense) Bershady, M. (Wisconsin)	Dynamics and star formation properties of blue compact galaxies. 6, 20 cm
AP444	Paredes, J. (Barcelona) Ribo, M. (Barcelona) Marti, J. (U. Jaen)	Orbital modulation in the microquasar LS 5039. 3.6, 6 cm
AP448	Pihlstrom, Y. Conway, J. (Chalmers, Onsala) Rupen, M.	Search for water absorption in Cygnus A. 1.3 cm
AR476	Rupen, M. Mioduszewski, A. Dhawan, V.	Galactic X-ray binaries and transients. 0.7, 1.3, 2, 3.6, 20, 90 cm

AR477	Rawlings, S. (Oxford) Willott, C. (Oxford) McLure, R. (Oxford) Mitchell, E. (Oxford) Dunlop, J. (Edinburgh) Jarvis, M. (Leiden) Hill, G. (Texas)	Radio structures over a wide range of luminosities. 3.6, 6 cm
AR491	Rodriguez-Rico, C. (Mexico/UNAM) Goss, W.M. Zhao, J-H. (CfA) Viallefond, F. (Paris Obs)	Recombination line H53 from ULIRG Arp 220. 0.7 cm
AR494	Ratay, D. (Florida) Gottesman, S. (Florida)	HI Observations of barred, flocculent galaxies. 20 cm
AR495	Rupen, M. Homan, J. (Milano Obs) Jonker, P. (Cambridge) Fender, R. (Amsterdam) van der Klis, M. (Amsterdam) Migliari, S. (Amsterdam)	Radio/x-ray connection in the Z source GX 17+2. 0.7, 1.3, 2, 3.6, 6, 20 cm
AR499	Reid, M. (McMaster U.) Wilson, C. (McMaster U.)	Ammonia mapping of massive YSO envelopes. 1.3 cm
AR501	Roberts, M. (McGill) Hessels, J. ((McGill) Ransom, S. (CfA) Kaspi, V. (McGill)	Searching for a nebula around PSR J2021+3651. 20 cm
AS738	Spekkens, K. (Cornell) Giovanelli, R. (Cornell) Haynes, M. (Cornell)	The fastest rotator galaxies. 20 cm
AS741	Saikia, D. (TIFR)	Two candidate double-double radio galaxies. 3.6, 20 cm
AT278	Taylor, G. Chandler, C.	Increasing the sky coverage of VLA calibrators. 0.7 cm

AT279	Takakuwa, S. (SA/IAA, Taiwan) Lim, J. (SA/IAA, Taiwan) Choi, M. (SA/IAA, Taiwan)	Binary low-mass protostellar system L1551 IRS 5. 0.7 cm
AT281	Trung, D. (SA/IAA, Taiwan) Liang, M. (SA/IAA, Taiwan) Lo, K. (SA/IAA, Taiwan) Wang, W. (Hawaii)	Three early merger systems. 20 cm
AT282	Testi, L. (Arcetri) Natta, A. (Arcetri) Wilner, D. (CfA) Shepherd, D.	Herbig Ae stars. 0.7, 3.6 cm
AT284	Thorsett, S. (Calif., Santa Cruz) Fruchter, A. (STScI) Hjorth, J. (Copenhagen) Kouveliotou, C. (NASA-MSFC) Pian, E. (CNR) Rhoads, J. (STScI) Tanvir, N. (Hertfordshire) Wijers, R. (SUNY)	Panchromatic studies of gamma-ray bursts. 2, 3.5, 6, 20 cm
AT285	Thornley, M. (Bucknell) Kennicutt, R. (Arizona) Kewley, L. (CfA) Regan, M. (DTM/Carnegie) Walter, F. (Caltech)	HI in galaxies in the SIRTIF Nearby Galaxies Survey. 20 cm
AT286	Thornley, M. (Bucknell) Kennicutt, R. (Arizona) Kewley, L. (CfA) Helou, G. (IPAC)	Radio-FIR relation on kpc scales in SIRTIF Nearby Galaxy Survey. 20 cm
AT287	Trung, D. (SA/IAA, Taiwan) Lim, J. (SA/IAA, Taiwan)	Equatorial disk and central torus of the Egg nebula. 0.7, 1.3 cm

AT288	Tavarez, M. (Univ. Michigan) Mateo, M. (Univ. Michigan) Dalcanton, J. (Washington)	Late-type galaxies as probes of dark matter halos and MoND. 20 cm
AU092	Udomprasert, P. (Caltech) Mason, B. (Caltech) Myers, S. Pearson, T. (Caltech) Readhead, A. (Caltech)	Radio point sources in Sunyaev-Zeldovich effect clusters. 0.7, 1.3, 3.6 cm
AV259	Vergani, D. (Bonn U.) Aronica, G. (Bonn U.) Pohlen, M. (Inst. De Canarias) Dettmar, R. (Bochum) Klein, U. (Bonn U.)	HI in disk galaxies with merging bulges. 20 cm
AV260	Vogt, N. (NMSU) Adams, C. (NMSU)	Spiral galaxies infalling into hot clusters. 20 cm
AW588	Wilcots, E. (Wisconsin) Sanders, W. (Wisconsin) Doane, N. (Wisconsin)	Searching for "local bubbles" in face-on spirals. 20 cm
AW589	Wilcots, E. (Wisconsin) Westfall, K.(Wisconsin) Prescott, M. (Wisconsin)	High resolution HI study of NGC 2537. 20 cm
AW593	Weiler, K. (NRL) Stockdale, C. (NRL) Sramek, R. Van Dyk, S. (IPAC) Panagia, N. (STScI) Marcaide, J. (Valencia) Lewin, W. (MIT) Pooley, D. (MIT) Immler, S. (Massachusetts)	ToO observations of Supernovae. 1.3, 2, 3.6, 6, 20, 90 cm
AY134	Young, L. (NMIMT) van Gorkom, J. (Columbia) Lamb, S. (Illinois)	Interacting spiral NGC 4647. 20 cm

AY135	Young, L. (NMIMT) van Gorkom, J. (Columbia) Statler, T. (Ohio U.) Rundle, D. (NMIMT) Dijkstra, M. (Columbia)	HI Imaging of two elliptical galaxies and comparison with CO. 20 cm
AZ136	Zhao, J-H. (CfA) McGary, R. (CfA) Goss, W.M. Bower, G. (Calif., Berkeley)	VLA monitoring the 106-day cycle of Sgr A. 0.7, 1.3, 2 cm
AZ141	Zhang, X. (NAO) Jin, C. (Beijing Obs) Reich, W. (MPIR, Bonn) Tian, W. (Beijing Obs) Wu, J. (Beijing Obs)	Observations of four new supernova remnant candidates. 20, 90 cm
BA061	Attridge, J.M. (Haystack) Homan, D.C. Pollack, L.K. (Calif., Berkeley)	Polarimetric imaging of the blazar J1058+0133. 2, 3.6, 6 cm
BB138	Bach, U. (MPIR, Bonn) Krichbaum, T.P. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn)	Subluminal motion in the counter-jet of Cygnus A? 2, 6 cm
BC081	Cotton, W.D., et al. (see VLBA)	Faraday rotation in the core of 3C138. 6 cm
BG129	Greenhill, L. (CfA), et al. (see VLBA)	SiO proper motions in Orion KL. 0.7 cm
BH097	Hoffman, I. (New Mexico) Goss, W.M. Brogan, C. Claussen, M.	Full stokes observations of the 1720 MHz OH masers in W28. 18 cm
BH104	Homan, D.	The 180d Misaligned jet in PKS 1510-089. 20 cm Single antenna VLBI

BM180	Marvel, K. (AAS) Mannings, V. (IPAC)	Water maser kinematics near Herbig Ae/Be Stars 1.3 cm
BP104	Peck, A. (CfA), et al. (See VLBA)	Jet and hotspot velocities in compact symmetric objects. 3.6 cm
BS102	Sahai, R. (JPL) Claussen, M. Morris, M. (UCLA)	VLBA Proper motion study of the water masers in the "Water Fountain" proto planetary nebula, IRAS 16342-3814
GB045	Bartel, N. (York U.) Bietenholz, M. (York U.) Rupen, M.	SN 1986J - evolution of its shell and search for a pulsar nebula. 6 cm
GL026	Lonsdale, C. (Haystack) Lonsdale, C. (IPAC) Smith, H. (Calif., San Diego) Diamond, P. (Manchester)	High sensitivity imaging of supernovae and masers in Arp 220. 18 cm
GM048	Marcaide, J. (Valencia) Guirado, J. (Valencia) Alberdi, A. (IAA, Andalucia) Lara, L. (IAA, Andalucia) Ros, E. (MPIR, Bonn) Diamond, P. (Manchester) Shapiro, I. (CfA) Preston, R. (JPL) Schilizzi, R. (NFRA) Mantovani, F. (Bologna) Perez-Torres, M. (Bologna) Trigilio, C. (Bologna) Van Dyk, S. (IPAC) Weiler, K. (NRL) Sramek, R. Whitney, A. (Haystack)	Monitoring the expansion of SN 1993J at 6 and 18 cm.

GV016	Vermeulen, R. (NFRA) Ros, E. (MPIR, Bonn) Kadler, M. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn) van Langevelde, H. (NFRA) Kellermann, K. Cohen, M. (Caltech)	OH and HI in Seyfert galaxy NGC 1052. 18 cm

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
BA063	Alcolea, J. (OAN) Bujarrabal, V. (OAN) Colomer, F. (OAN) Desmurs, J. (OAN) Soria, R. (OAN)	3mm observations of HCN masers in CIT 6. 0.3, 0.7 cm
BA064	Asada, K. (NAO) Inoue, M. (NAO) Kameno, S. (NAO) Nagai, H. (NAO) Uchida, Y. (NAO)	Faraday rotation measure survey of AGN jets. 2, 4, 6,13 cm
BA066	Asada, K. (NAO) Inoue, M. (NAO)	Faraday rotation measure observation of 3C 273 jet. 2, 4, 6 cm
BB142	Brunthaler, A. (CfA) Falcke, H. (MPIR, Bonn) Greenhill, L. (CfA) Henkel, C. (MPIR, Bonn) Reid, M. (CfA)	Second epoch observations for extra galactic proper motions in the local group with the VLBA. 1.3 cm
BB154	Boboltz, D. (USNO) Wittkowski, M. (ESO)	Joint VLBA/VLTI observations of the Mira variables S Ori and V Mon. 0.7 cm
BC081	Cotton, W. Fanti, C. (Bologna) Fanti, R. (Bologna) Dallacasa, D. (Bologna) Foley, A. (NFRA) Schilizzi, R. (NFRA) Spencer, R. (Manchester)	Faraday rotation in the core of 3C138. 6 cm

BC119	Cheung, C. (Brandeis) Homan, D. (Brandeis) Roberts, D. (Brandeis) Sambruna, R. (George Mason) Urry, C. (STScI) Wardle, J. (Brandeis)	Full stokes imaging of a sample of detected and non-detected. 2, 4 cm
BC123	Chatterjee, S. (Cornell) Backer, D. (Calif., Berkeley) Benson, J. Brisken, W. Cordes, J. (Cornell) Ellis, R. (Calif., Berkeley) Fomalont, E. Golden, A. (Ireland) Goss, W.M. Kramer, M. (Jodrell Bank) Lazio, T. (NRL) Lyne, A. (Jodrell Bank) McKinnon, M. Thorsett, S. (Calif., Santa Cruz) Wong, D. (Cornell)	First epoch pulsar astrometry with the VLBA. 20 cm
BC127	Cawthorne, T. (Lancashire) Gabuzda, D. (Ireland) Jorstad, S. (Boston) Marscher, A. (Boston) Stirling, A. (Lancashire)	A precessing jet in BL lacertae. 0.7, 0. 4, 2 cm
BD073	Doeleman, S. (Haystack) Attridge, J. (Haystack) Lonsdale, C. (Haystack)	Magnetic fields in environments of SiO masers. 0.3, 0.7 cm
BD082	Desmurs, J. (OAN) Alcolea, J. (OAN) Bujarrabal, V. (OAN) Colomer, F. (OAN) Sanchez-Contreras, C. (OAN)	Water masers in the proto planetary nebula OH 231.8+4.2. 1.3 cm

BG116	Bradshaw, C. (George Mason) Fomalont, E. Geldzahler, B. (George Mason)	Astrometric observations of the compact radio source G127.11+0.54. 4 cm
BG126	Gomez, Y. (UNAM) Anglada, G. (CSIC) Marvel, K. (AAS) Miranda, L. (CSIC) Patel, N. (CfA) Torrelles, J. (IEEC)	Tracking the proper motions of the H20 masers in the planetary nebula K3-35. 1.3 cm
BG129	Greenhill, L. (CfA) Chandler, C. Reid, M. (CfA) Moran, J. (CfA) Diamond, P. (Manchester)	SiO proper motions in Orion KL. 0.7 cm
BG131	Gabuzda, D. (Ireland) Croke, S. (Ireland) Vetukhnovskaya, Y. (ASC)	Nature of variable sheath structures surrounding the jets of compact AGN. 0.4, 1.3, 2, 6 cm
BH081	Healy, K. (Arizona) Claussen, M. Hester, J. (Arizona)	Protostars and water masers in M16, the Eagle Nebula. 1.3 cm
BH083	Hirota, T. (Kagoshima) Hachisuka, K. (Graduated Univ.) Imai, H. (NAO) Omodaka, T. (Kagoshima) Sasao, T. (NAO)	Measurements of proper motion of the Orion-Monoceros molecular cloud complex. 1.3 cm
BH097	Hoffman, I. (New Mexico) Goss, W. M. Brogan, C. Claussen, M.	Full stokes observations of the 1720 MHz OH masers in W28. 18 cm
BH105	Hough, D. (Trinity U.) Aars, C. (Texas Christian Univ.)	Variability in the nuclei of lobe-dominated quasars, Part II. 0.4, 2 cm

BH106	Hough, D. (Trinity U.) Porcas, R. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Multi-frequency polarization imaging of the nuclei in the lobe-dominated quasars 0723+679, 1150+497, and 1317+520. 0.3, 2, 6 cm
BI024	Imai, H. (NAO) Diamond, P. (Jodrell Bank)	Collimated molecular jet in W 43A traced by water maser emission. 1.3 cm
BJ036	Jorstad, S. (Boston) Marscher, A. (Boston) Yurchenko, A. (Boston)	BL Lac objects with high proper motion. 1.3, 2 cm
BJ041	Junor, B. (Los Alamos)	Core of Virgo A at 3mm. 0 .3, 0.7 cm
BJ042	Johnston, K. (USNO) Fey, A. (USNO) Boboltz, D. (USNO) Ma, C. (NASA/GSFC) Gordon, D. (NASA/GSFC) Gaume, R. (USNO) Kingham, K. (USNO) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) Shaffer, D. (Radiometrics) Fomalont, E. Walker, R.C.	VLBA Geodesy/Astrometry Observations for 2002. 3.6 cm
BK089	Kanekar, N. (NCRA) Briggs, F. (Kapteyn) Chengalur, J. (NCRA) Lane, W. (NRL)	Compact structure of QSOs behind damped Lyman systems. 90 cm

BK092	Krichbaum, T. (MPIR, Bonn) Aller, H. (Michigan) Aller, M. (Michigan) Bach, U. (MPIR, Bonn) Polatidis, A. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Terasranta, H. (Metsahovi) Ungerechts, H. (IRAM) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	VLBA Monitoring of 1633+382 during a major millimeter flare. 0.3, 0 .7 cm
BK094	Koopmans, L. (Caltech) de Bruyn, G. (NFRA)	The gravitationally lensed jet of B1600+434. 2 cm
BL098	Lovell, J. (ATNF) Edwards, P. (ISAS) Jauncey, D. (ATNF) Jones, D. (JPL) Reynolds, J. (ATNF) Tzioumis, A. (ATNF) Wieringa, M. (ATNF)	Improving the precision of Ho measured from the gravitational lens 1830-211. 0.4, 2 cm
BL104	Lobanov, A. (MPIR, Bonn) Roland, J. (IAP) Ros, E. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Cross-band monitoring of a flare in the VLBI core of 3C345. 0.7, 1.3, 2, cm
BL111	Lister, M. Aller, H. (Michigan) Aller, M. (Michigan) Cohen, M. (Caltech) Homan, D. Kadler, M. (MPIR, Bonn) Kellermann, K. Kovalev, Y. (Lebedev) Lobanov, A. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Vermeulen, R. (NFRA) Zensus, J. (MPIR, Bonn)	MOJAVE Program. 0.7, 1.3 cm

BM171	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 blazars. 0.7, 1.3 cm
BM178	Marvel, K. (AAS) Alcolea, J. (OAN) Boboltz, D. (USNO) Bujarrabal, V. (OAN) Colomer, F. (OAN) Desmurs, J. (OAN) Diamond, P. (Jodrell Bank) Kemball, A. Soria, R. (OAN)	Relative spatial distribution of SiO masers in AGB stars at 43 and 86 GHz. 0.3, 0.7 cm
BP089	Piner, B. (Whittier) Edwards, P. (ISAS) Jones, D. (JPL)	Monitoring of Ultra-fast blazars. 0.7, 1.3, 2 cm
BP102	Pihlstrom, Y. Conway, J. (Chalmers, Onsala)	Search for excited OH in Cygnus A. 2 cm
BP104	Peck, A. (CfA) Taylor, G.	Jet and hotspot velocities in compact symmetric objects. 3.6 cm
BR074	Romney, J. Dhawan, V. Kellermann, K. Walker, R.C. Zensus, J.A. (MPIR, Bonn)	VLBA 3mm commissioning observations of four bright sources. 0.3, 0.7 cm
BR077	Cohen, M. (Caltech) Kadler, M. (MPIR, Bonn) Kellermann, K. Lister, M. Ros, E. (MPIR, Bonn) Vermeulen, R. (ASTRON) Zensus, J. (MPIR, Bonn)	Kinematics of parsec-scale structure in AGN: a survey of 2 cm.

BR079	Boboltz, D. (USNO) Charlot, P. (Bordeaux) Fey, A. (USNO) Gordon, D. (GSFC) Lanyi, G. Ma, C. (GSFC) Sovers, O. (Remote Sensing) Taylor, G. Ulvestad, J.	Extending the international celestial reference frame to multiple wavelengths. 0.7, 1.3 cm
BR081	Rector, T. Fassnacht, C. (STScI) Myers, S. Taylor, G. Wrobel, J.	AGN Content of Cetus field of the NOAO deep wide-field survey. 6 cm
BR082	Roy, A. (MPIR, Bonn) Colbert, E. (Johns Hopkins) Falcke, H. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Middelberg, E. (MPIR, Bonn) Wilson, A. (Maryland)	Seyfert galaxy NGC 2639 following a radio outburst. 0.7, 1.3, 2 cm
BS088	Shen, Z-Q. (ISAS) Ho, P. (CfA) Lo, K.Y. Zhao, J-H. (CfA)	Probing the intrinsic source structure of Sgr A*. 0.3, 0 .7 cm
BS117	Schmitt, H.	Proper motion and absorption in the jet of the Seyfert galaxy IRAS 01475-0740. 6 cm
BS120	Spangler, S. (Iowa) Cordes, J. (Cornell) Mutel, R. (Iowa)	Investigation of shock-associated turbulence in two supernova remnants. 6, 13, 20 cm
BT064	Taylor, G. Peck, A. (CfA) Ulvestad, J. O'Dea, C. (STScI)	HI and continuum imaging in the giga maser galaxy TXS 2226-184. 6 cm

BT065	Taylor, G. Hough, D. (Trinity Univ.) Venturi, T. (CNR)	Polarimetry of powerful radio cores. 6 cm
BU023	Ulvestad, J. Falcke, H. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Peck, A. (CfA)	Emerging jet component in Mrk 348. 0.4, 1.3, 2 cm
BW051	Benson, J.	Constraining a possible helical flow in 3C120 at 1.7 GHz. 20 cm
BW063	Walker, R.C. Pihlstroem, Y.	Fishing for molecules in the 3C84 accretion disk. 2 cm
BY013	York, T. (Jodrell Bank) Blandford, R. (Caltech) Browne, I. (Jodrell Bank) Fassnacht, C. (STScI) Jackson, N. (Jodrell Bank) Koopmans, L. (Caltech) McKean, J. (Jodrell Bank) Myers, S. Pearson, T. (Caltech) Readhead, T. (Caltech) Wilkinson, P. (Jodrell Bank)	Observations of the most recent CLASS gravitational lens candidates. 20 cm
GB045	Bartel, N. (York U.) Bietenholz, M. (York U.) Rupen, M.	SN 1986J - evolution of its shell and search for a pulsar nebula. 6 cm
GG048	Garrington, S. (Manchester) van Langevelde, H-J. (NFRA) Campbell, R. (NFRA) Gunn, A. (Manchester)	High resolution imaging and astrometry of Theta1 Ori A2. 6 cm
GL026	Lonsdale, C. (Haystack) Smith, H. (Calif., San Diego) Diamond, P. (Manchester)	High sensitivity imaging of supernovae and masers in Arp 220. 18 cm

GM047	Marcaide, J. (Valencia) Guirado, J. (Valencia) Alberdi, A. (IAA, Andalucia) Lara, L. (IAA, Andalucia) Perez-Torres, M. (Bologna) Ros, E. (MPIR, Bonn) Diamond, P. (Manchester) Van Dyk, S. (IPAC) Weiler, K. (NRL)	Monitoring the expansion of SN 1979C at 6 cm and 18 cm.
GM048	Marcaide, J. (Valencia) Guirado, J. (Valencia) Alberdi, A. (IAA, Andalucia) Lara, L. (IAA, Andalucia) Ros, E. (MPIR, Bonn) Diamond, P. (Manchester) Shapiro, I. (CfA) Preston, R. (JPL) Schilizzi, R. (NFRA) Mantovani, F. (Bologna) Perez-Torres, M. (Bologna) Trigilio, C. (Bologna) Van Dyk, S. (IPAC) Weiler, K. (NRL) Sramek, R. Whitney, A. (Haystack)	Monitoring the expansion of SN 1993J at 6 and 18 cm.
GP034	Peck, A. (CfA) Henkel, C. (MPIR, Bonn) Tarchi, A. (MPIR, Bonn) Nagar, N. (Arcetri)	Mega masers in Mrk 1066 and Mrk 34. 1.3 cm
GV016	Vermeulen, R. (NFRA) Ros, E. (MPIR, Bonn) Kadler, M. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn) van Langevelde, H. (NFRA) Kellermann, K. Cohen, M. (Caltech)	OH and HI in Seyfert galaxy NGC 1052. 18 cm

New Hires

Anderson, Jr., Robert	Division Head	10/7/2002
Bauer, Janet	Senior Secretary	12/12/2002
Chen, Hongxia	Electronics Engineer II	10/14/2002
Davis, Lindsey	Software Engineer I	11/22/2002
de Guise, Karen	Administrative Aide	10/11/2002
Lychock, Janet	Administrative Aide	12/02/2002
Terezon Segura, Brisa	Junior Research Associate	10/29/2002
Tody, Douglas	Software Engineer I	11/22/2002
Zivick, Jeffrey	Systems Engineer I	11/07/2002

Terminations

de Guise, Karen	Administrative Aide	12/27/2002

Promotions

Campbell, James	Supervisor, VLA Operations	10/07/2002
Cryer, Mary	Administrative Aide	12/16/2002
McMullin, Joe	Project Manager	11/01/2002
Durand, Steven	Division Head	12/16/2002
Golap, Kumar	Deputy Project Manager	12/01/2002

Publications

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

PREPRINTS RECEIVED, SEPTEMBER - DECEMBER 2002

APPLETON, P.N.; CHARMANDARIS, V.; GAO, Y.; JARRETT, T.; BRANSFORD, M.A. Azimuthal and Kinematic Segregation of Neutral and Molecular Gas in Arp 118: The Yin-Yang Galaxy NGC 1144.

BARTEL, N.; BIETENHOLZ, M.F.; RUPEN, M.P.; BEASLEY, A.J.; GRAHAM, D.A.; ALTUNIN, V.I.; VENTURI, T.; UMANA, G.; CANNON, W.H.; CONWAY, J.E. SN 1993J VLBI. II. Related Changes of the Deceleration, Flux-Density Decay, and Spectrum.

BIETENHOLZ, M.F.; BARTEL, N.; RUPEN, M.P. SN 1986J VLBI: The Evolution and Deceleration of the Complex Source and a Search for a Pulsar Nebula.

BROGAN, C.L.; GOSS, W.M. VLA Observations of the Eye of the Tornado, The High-Velocity H II Region G357.63-0.06.

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

COTTON, W.D.; SPENCER, R.E.; SAIKIA, D.J.; GARRINGTON, S. Faraday Rotation in the CSS QSOs 3C43 and 3C454.

FONG, D.; MEIXNER, M.; SHAH, R. Discovery of Multiple Molecular Shells in the Outer Envelope of IRC+10216.

GALAMA, T.J.; FRAIL, D.A.; SARI, R.; BERGER, E.; TAYLOR, G.B.; KULKARNI, S.R. Continued Radio Monitoring of the Gamma Ray Burst 991208.

GORDON, M.A. The Stellar 'Wind' of MWC349A.

HERRNSTEIN, R.M.; HO, P.T.P. Hot Molecular Gas in the Galactic Center.

HIBBARD, J.E.; SANSOM, A.E. A Search for HI in Five Ellipticals with Fine Structure.

HOFFMAN, I.M.; GOSS, W.M.; BROGAN, C.L.; CLAUSSEN, M.J.; RICHARDS, A.M.S. The Sizes of OH (1720 MHz) Supernova Remnant Masers: MERLIN and VLBA Observations of IC 443.

HOMAN, D.C.; WARDLE, J.F.C. Probing the Circular Polarization of Relativistic Jets on VLBI Scales.

JOHNSTON, K.J.; GAUME, R.A.; FEY, A.L.; DE VEGT, C.; CLAUSSEN, M.J. The Variable Radio Source T Tauri.

KELLERMANN, K.I.; LISTER, M.L.; HOMAN, D.C.; ROS, E.; ZENSUS, J.A.; COHEN, M.H.; RUSSO, M.; VERMEULEN, R.C. Superluminal Motion and Relativistic Beaming in Blazar Jets.

LAINE, S.; VAN DER MAREL, R.P.; LAUER, T.R.; POSTMAN, M.; O'DEA, C.P.; OWEN, F.N. Hubble Space Telescope Imaging of Brightest Cluster Galaxies.

LISTER, M.L.; KELLERMANN, K.I.; VERMEULEN, R.C.; COHEN, M.H.; ZENSUS, J.A.; ROS, E. 4C +12.50: A Superluminal Precessing Jet in the Recent Merger System IRAS 13451+1232.

LISZT, H.S. Gas-Phase Recombination, Grain Neutralization and Cosmic-Ray Ionization in Diffuse Gas.

LOCKMAN, F.J. Discovery of a Population of H I Clouds in the Galactic Halo.

MOMJIAN, E.; ROMNEY, J.D.; CARILLI, C.L.; TROLAND, T.H.; TAYLOR, G.B. VLBA Continuum and H I Absorption Observations of the Ultra-luminous Infrared Galaxy IRAS 17208-0014.

MORRISON, G.E.; OWEN, F.N. Radio-Selected Galaxies in Very Rich Clusters at z <= 0.25. II. Radio Properties and Analysis.

MORRISON, G.E.; OWEN, F.N.; LEDLOW, M.J.; KEEL, W.C.; HILL, J.M.; VOGES, W.; HERTER, T. Radio-Selected Galaxies in Very Rich Clusters at z <= 0.25. I. Multi-wavelength Observations and Data Reduction Techniques.

OSTEN, R.A.; AYRES, T.R.; BROWN, A.; LINSKY, J.L.; KRISHNAMURTHI, A. Chandra, EUVE, and VLA Observations of the Active Binary System sigma(2) Coronae Borealis.

RANSOM, R.R.; BARTEL, N.; BIETENHOLZ, M.F.; RATNER, M.I.; LEBACH, D.E.; SHAPIRO, I.I.; LESTRADE, J.-F. VLBI Imaging of the RS CVn Binary Star System HR 5110.

REID, M.J.; MENTEN, K.M.; GENZEL, R.; OTT, T.; SCHODEL, R.; ECKART, A. The Position of Sagittarius A*. II. Accurate Positions and Proper Motions of Stellar SiO Masers near the Galactic Center.

PREPRINTS RECEIVED, SEPTEMBER - DECEMBER 2002

ROSENBERG, J.L.; SCHNEIDER, S.E. The Contribution of HI-Rich Galaxies to the Damped Ly-alpha Absorber Population at z = 0.

SHEPHERD, D.S.; TESTI, L.; STARK, D.P. Clustered Star Formation in W75 N.

STRELNITSKI, V.; ALEXANDER, J.; GEZARI, S.; HOLDER, B.P.; MORAN, J.M.; REID, M.J. H2O Masers and Supersonic Turbulence.

SUBRAHMANYAN, R.; BEASLEY, A.J.; GOSS, W.M.; GOLAP, K.; HUNSTEAD, R.W. PKS B1400-33: An Unusual Radio Relic in a Poor Cluster.

THILKER, D.A.; WALTERBOS, R.A.M.; BRAUN, R.; HOOPES, C.G. H II Regions and Diffuse Ionized Gas in 11 Nearby Spiral Galaxies.

USON, J.M.; MATTHEWS, L.D. H I Imaging Observations of Superthin Galaxies. I. UGC 7321.

WALKER, R.C.; ANANTHARAMAIAH, K.R. A VLBA Search for a Stimulated Recombination Line from the Accretion Regiion in NGC 1275.

WELCH, G.A.; SAGE, L.J. The Cool ISM in S0 Galaxies. I. A Survey of Molecular Gas.

WINN, J.N.; PATNAIK, A.R.; WROBEL, J.M. Interferometric Phase Calibration Sources in the Declination Range 0 to -30.

YUSEF-ZADEH, F.; WARDLE, M.; ROBERTS, D.A. Thermal OH (1967/65 MHz) Absorption and Nonthermal OH (1720 MHz) Emission Towards the W28 Supernova Remnant.