NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

October – December 2004

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Executive Summary

ALMA

This quarter has been a busy and productive period for the ALMA project. The two most significant issues were antenna procurement and overall cost. Consequently, the re-baselining activities and prototype antenna testing have been given top priority.

Progress continued towards placing a contract for the production antennas. Analysis of data collected on the VertexRSI prototype antenna continued, and additional tests on both prototypes were initiated by the joint NRAO / ESO team to resolve outstanding technical issues. The offers from the vendors have been extended through March 2005.

The re-baselining exercise progressed rapidly. An integrated project schedule has been produced and detailed statements-of-work are being generated for each subsystem.

The ALMA Board held its November meeting at the newly completed ALMA Camp, with the antennas and finances as key agenda items. The Executives and the JAO held crucial discussions about their working relationships and improving the Management IPT functionality. The opening of the temporary ALMA offices in Santiago occurred in time for the ALMA Board meeting. In addition to housing the JAO, space is available for each Executive's ALMA Santiago staff.

The ALMA Management Advisory Committee met in Italy in October. The committee was briefed on project status and heard detailed presentations on PMCS, antenna procurement, and the JAO / Executive interface.

Several key technology milestones were achieved this quarter, including the first cool-down of the RAL pre-production cryostat. This quarter's achievements also included: testing the Band 6 cartridge; commencement of Band 3 cartridge assembly; and demonstration of a temporary IF processor, LO reference receiver, Central Reference Generator / Distributor and a 2nd LO synthesizer with suitable performance for prototype systems integration and even early science.

Impressive progress continues with the correlator development. Most of the first quadrant is complete; the first quadrant will be installed in Chile by the end of 2006.

An updated and expanded Calibration Plan was produced this quarter. Clarification was provided of the top-level Science Requirements Document so that it can be submitted to the Board for approval.

Executive Summary

EVLA

Interferometric fringes between two EVLA antennas were achieved for the first time on December 2, a particularly important milestone. Antenna 16 was brought into the Antenna Assembly Building for re-fitting as the third EVLA antenna.

The Canadian Partners have selected a contractor to design and fabricate the new correlator chip. A Critical Design Review (CDR) of the correlator chip design, functional testing, and implementation plan will be held January 24 – 26.

Mark McKinnon was appointed EVLA Deputy Project Manager in December. His managerial role will primarily be tracking and understanding project budget and schedule.

A study of the ALMA Science Data Model (ASDM) was performed to assess its suitability for the EVLA and VLBA.

A successful CDR for the Monitor and Control sub-system hardware was held October 20. No significant impediments to quantity production were identified.

The project WBS was updated this quarter and the 2005 GPRA predictions were provided to the NSF.

The annual meeting of the EVLA Advisory Committee took place December 14 – 15 in Socorro.

Green Bank Telescope

Astronomy was scheduled on the Green Bank Telescope (GBT) for ~ 60 percent of total telescope time in this quarter. With the return to cool, clear autumn weather, high-frequency observing and dynamic scheduling returned.

Excellent progress was made this quarter on several development projects designed to enhance the scientific performance and capabilities of the GBT. The Precision Telescope Control System (PTCS) project for providing 3mm observing capability made good progress on pointing models and instrumentation, such as the feed arm quadrant detector and elevation axle inclinometers. The Ka-Band receiver (26 – 40 GHz) was re-installed on the telescope in early October. Commissioning proceeded during the autumn and early winter, and the receiver will be released for regular observing in February 2005. The 3mm (68 – 92 GHz) receiver project was resumed in October, and progress continued on the Caltech / NRAO Continuum Backend. The Penn Array bolometer camera, which will provide GBT observers with a fast, sensitive, continuum imaging system for the 3mm band, is expected to arrive at the GBT for its first engineering tests in spring 2005.

Executive Summary

Green Bank hosted several important and productive meetings this quarter, including workshops to review and discuss: (a) the IDL data reduction project (October 15); (b) pulsar instrumentation priorities, operational needs, and proposal handling issues (November 12-13); and (c) the azimuth track project (December 7-8).

The major engineering progress review for the azimuth track project held at Green Bank on December 7-8 summarized the investigations, analyses, and trials conducted since the initial panel review in October 2002. Comprehensive project reports were provided to the panel prior to the review, and presentations during the meeting by GBT and Simpson, Gumpertz, and Heger engineering staff detailed the investigations and analyses performed to date, and outlined the modifications plan. The panel was generally supportive of the proposed track modifications and suggested several areas for follow-up investigation, which are being pursued by project staff.

Very Large Array & Very Long Baseline Array

The 9th VLA azimuth bearing was changed, marking the 5th bearing change in the last 3-1/4 years. Completion of the annual rail-maintenance season saw the replacement of approximately 3500 railroad ties during the calendar year, and the VLA rail system supported antenna move number 1900 over the lifetime of the VLA. The 9-track tape system for recording VLA visibility data was retired, as part of the gradual move from ancient VLA software systems toward a more modern system for the EVLA.

The VLBA 3mm receiver was moved from Hancock to Brewster, to take advantage of the newly refurbished subreflector at Brewster. Measurements show a 20 percent aperture efficiency at 3mm for Brewster, among the better values for the eight VLBA antennas equipped at 3mm. Mark 5 recording systems now have been deployed at eight VLBA stations in preparation for the Huygens encounter with Titan in January 2005; some of these systems will be redeployed after January. The pilot program to demonstrate angular navigation of interplanetary spacecraft, using the VLBA, was concluded successfully.

Central Development Laboratory

The combination of a low-noise and a high-power amplifier for 1.2-2.0 GHz has provided a high dynamic range receiver configuration for the new EVLA L-Band system. A draft agreement with JPL to gain access to Cryo3 transistors is under review.

Enough 211-275 GHz mixer-preamps have been shown to meet specifications so that the first four ALMA Band 6 cartridges can be built. Development of efficient production procedures is receiving intense effort.

The first ALMA Front End cryostat was successfully operated at the NTC. Design work on the chassis and other subsystem components is very active.

Executive Summary

The performance on the new L-Band feed for the EVLA is now understood from the theoretical perspective.

Nearly half of the first quadrant of the ALMA correlator has been checked out.

ALMA First Local Oscillators were delivered for Bands 3, 6, and 7. The LO for Band 9 meets specification over 80 percent of the required frequency range and development continues.

Regular observations of the Sun at 20-70 MHz continue with the Green Bank Solar Radio Burst Spectrometer, and work is proceeding on extending the frequency range.

Computing and Information Services

The primary goal for the NRAO Windows system administrators this quarter was the completion of the migration from the older NT 4.0 domain to Active Directory (AD). This task has been completed in Charlottesville, Green Bank, and Tucson with little impact on user productivity; this task will be complete in Socorro by the end of first quarter 2005.

Good progress was made during this quarter in testing installation of Red Hat Enterprise Linux (RHEL) on multiple hardware platforms, evaluating problems in a mass migration from Red Hat 9 to RHEL, and in finalizing a contract with Red Hat for a "campus" educational license.

The existing network of the Observatory's web proxy servers has been retrofitted to enable authentication when they are accessed from outside the NRAO. This, combined with webmail and the VPN, addresses the needs of the vast majority of our users when they are travelling or otherwise outside the Observatory's facilities.

The deployment of a commercial malware ("spyware") blocker was completed this quarter for all Windows systems.

The Beowulf Linux cluster for pulsar data processing has been delivered, installed, and made operational in Charlottesville.

The major communications effort this past quarter has been the cabling of the Edgemont Road addition for networking and telephony. The first phase of this effort, to wire the newly constructed areas, is complete.

Executive Summary

Education and Public Outreach

Two new EPO programs—Science Museum Outreach and the Legacy Imagery Project—moved forward this quarter. The first stage of the Science Museum Outreach effort will soon provide for the rapid delivery of all NRAO press releases to more than 50 science centers and planetariums across the country. The Legacy Imagery Project is generating improved radio astronomy image visualization techniques. A recent result of this program is a composite radio—optical image of Fornax A produced from VLA data acquired by Fomalont et al and recently published as NRAO's contribution to the 2005 American Astronomical Society calendar. The Observatory's media efforts this quarter resulted in several press releases that described exciting science being done at the NRAO. Revenue continued to increase at the Green Bank Science Center and the VLA Visitor Center, while attendance held steady. New exhibits were installed in the Green Bank Science Center while draft architectural renderings were generated for a proposed new VLA Visitor Center in New Mexico. The well-received and attended 2004 Jansky Lecture was delivered by IAU President Ron Ekers in Socorro, Green Bank, and Charlottesville.

Environment, Safety and Security

ES&S is focusing on the ALMA Antenna Test Facility, ATF, site to minimize risk to employees during the testing at the site. In Socorro, ES&S participated in the development and design specifications for the gaseous fire suppression system to be installed in the new EVLA Correlator Shielded Room. ES&S prepared and submitted a "Known Needs Request" to the NSF for the acquisition of an ambulance. ES&S negotiated with representatives from New Mexico Tech to formalize procedures for the acceptance of hazardous wastes generated in the AOC Electronics Lab. In Green Bank, a stinging and venomous insect safety program was implemented. Also in Green Bank, hazardous materials management was implemented for the proper disposal of waste generated from the 140 foot antenna. In Charlottesville, ES&S became more involved in the acceptance of the Edgemont Road facility construction efforts and also worked with the Facilities Planning Team on the investigation of the Thanksgiving Day roof fire. ES&S also met with the Facilities Planning Team to address the potential for mold growth in conjunction with UVA Industrial Hygiene group.

Science Highlights

Very Large Array

VLA Shows Young Galaxy with Black Hole, Almost No Stellar Bulge - VLA observations of 1148+5351, the most distant quasar yet found, at z=6.4, show that the mass of molecular gas plus the mass of the presumed supermassive black hole at the core of the AGN account for nearly the total mass of the system. This leaves little mass available for a central galactic bulge, and much less mass than standard black hole-bulge relationships predict for such a bulge. This single example from the early Universe of a young galaxy with a supermassive black hole but no significant bulge may serve as an important clue to the long-standing question of whether the black hole or the bulge formed first, or coevally as some current popular models suggest.

Investigators: F. Walter (MPIfR), C. Carilli (NRAO), F. Bertoldi and K. Menten (MPI Bonn), P. Cox (Paris), K.Y. Lo (NRAO), X. Fan (Steward Observatory), and M. Strauss (Princeton).

Very Long Baseline Array

Cores of Extragalactic Radio Sources Shown to Contain Microarcsecond Structures - Morphologies of compact extragalactic radio sources imaged with the VLBA have been compared to their scintillation properties. The short time-scale scintillation of compact sources is thought to be caused by the interstellar medium in our own galaxy, and reveals the presence of radio-emitting structures that are only a few micro-arcseconds in size. Statistical studies show that the VLBA images of scintillating radio sources are significantly more core-dominated than images of a comparison sample of non-scintillating sources. This demonstrates conclusively that the micro-arcsecond component is directly associated with the core of the radio source, and hence with the actual nucleus of the host galaxy. At the typical large distances of the radio sources, this radio component is no more than a few thousand astronomical units in size, probably only a few hundred times the gravitational radii of the central massive black holes.

Investigators: R. Ojha (ATNF), A. Fey (USNO), D. Jauncey and J. Lovell (ATNF), and K. Johnston (USNO).

Green Bank

GBT Neutral Hydrogen Emission of the Spitzer Extragalactic First-Look Survey Field - The GBT has been used to image the 21 cm Galactic HI emission over a 3° x 3° square centered on the Spitzer Extragalactic First-Look Survey field. The effective angular resolution was 9.8′ and the velocity resolution was 0.62 km s^{-1}. The Galactic HI in this region was found to have a very interesting structure. There is a high-velocity cloud, several intermediate-velocity clouds, and narrow-line low velocity filaments. The HI emission shows a strong and detailed correlation with dust. Except for the high-velocity cloud, all features in the N_{HI} map have counterparts in an $E(B - V)$ map derived from infrared data. Relatively high $E(B - V)/N_{HI}$ ratios in some directions suggest the presence of molecular gas. The best diagnostic of such regions was found to be peak HI line brightness temperature, not the total N_{HI}:

directions where $T_b > 12$ K have $E(B-V)/N_{HI}$ significantly above the average value. The data corrected for stray radiation have been released via the web.

Investigators: F. J. Lockman and J. J. Condon (NRAO).

ALMA

Overall this has been a very busy and productive period for the ALMA project. Currently the two biggest issues facing the project are antenna procurement and overall cost. Consequently the rebaselining activities and prototype antenna testing have been given priority above all else.

In terms of antenna procurement, progress has continued towards placing a contract for production antennas. Further analysis of data collected on the VertexRSI prototype antenna suggests that the finite element model may not accurately predict its performance under all conditions. Additional tests on both prototypes are being conducted as a matter of urgency by the joint NRAO/ESO team to resolve all outstanding technical issues. The offers from the vendors have been extended through March 2005.

The rebaselining exercise is progressing rapidly following a huge effort by all the Integrated Product Teams (IPTs) and the Project Management Control System (PMCS) team, with cost and schedule data being ingested into the new PMCS. For the first time an integrated project schedule has been produced, which is now in the process of being checked in detail. The full implementation of the PMCS in mid-CY2005 will allow full project budget and schedule maintenance, milestone and status tracking to Level 3 (currently tracked at Level 2). As part of the rebaselining exercise, detailed statements-of-work are being produced for each subsystem, both to ensure clarity on all sides in terms of deliverables, and to check for missing scope. In addition, a detailed project risk register is being produced.

In Chile, projected construction costs for the Array Operations Site (AOS) Technical Building were higher than originally planned. A significant exercise has been carried out to limit the cost increases through a series of descopes. Construction is on hold pending approval to award the contract from the National Science Foundation.

Simon Radford, the North American Site IPT lead, resigned from NRAO to join the Cornell/Caltech 25m Telescope project. Eduardo Donoso was appointed to replace him. Although not due to start formally until January 2005, the recently hired North American (NA) ALMA Project Manager, Adrian Russell, has started to become involved in the project, attending the IPT face-to-face meeting in Charlottesville and the ALMA Board in Chile, as wells as various telecons.

The ALMA Management Advisory Committee (AMAC) met in Florence, Italy in October for two days. The committee heard presentations on project status and more detailed presentations on PMCS, antenna procurement and Joint ALMA Office (JAO)/Executive interface issues. The AMAC submitted a written report to the ALMA Board.

The ALMA Board held its November meeting in San Pedro and actually met at the newly completed ALMA Camp, making it the highest ALMA Board meeting ever! High on the agenda was the antenna situation and surrounding finances.

ALMA

In the margins of the Board meeting the Executives and the JAO held crucial discussions about their working relationships and how the Management IPT can function properly. The agreements reached are already bearing fruit.Across the rest of the project progress continues to be excellent.
The opening of the (temporary) ALMA offices in Santiago in rented space was accomplished in time for the October ALMA Board meeting. In addition to housing the JAO, Class A office space is available for each Executive's ALMA Santiago staff.

The NA Site IPT leadership was successfully handed over from Simon Radford to Eduardo Donoso. Sr. Donoso is an experienced Chilean construction manager who has been able to respond quickly to the demands of the position. For example, under his leadership, the Array Operations Site (AOS) Technical Building foundation construction bid process was successfully completed and is awaiting NSF approval. In addition, the completion of extensive work at the ALMA camp has been completed and the camp is now available with 15 beds .

A very effective and focused joint effort to restart antenna testing including holography, photogrammetry, and preparation for optical pointing tests and out-of-focus beams maps has been initiated. The results of the joint testing program will provide valuable input into the successful antenna selection.

Another change in project leadership during the period was the successful hand-over of the Front End (FE) IPT lead responsibilities from Charles Cunningham to John Webber. The first cool-down of the RAL pre-production cryostat in North America was accomplished, successfully cooling the cryostat to <4 degrees K.. In addition, progress was made on the assembly and testing of the Band 3 cartridge (84-116 GHz). Testing of Band 6 cartridge Successfully demonstrated the entire front end signal path from the vacuum window to the output. Also, the preliminary design of the FE power system has been completed. A major planning exercise is underway to optimize the FE integration process. The FE Test Facility Plan has been completed and the equipment is now under construction.

The Back End (BE) IPT has taken delivery of two more (four now in total) digitizer prototypes from Bordeaux. Accomplishment realized within the BE IPT include the demonstration of a temporary IF processor, LO reference receiver, Central Reference Generator/Distributor, and 2nd LO synthesizer with suitable performance for prototype systems integration and even early science. The total power digitizer design has been finalized for the revised specification. And, a significant cost reduction has been realized by reducing the digital transmission system circuit board count from 5 to 1 with a transponder chip.

Very impressive progress continues to be made within the Correlator IPT with most of the first correlator quadrant now complete. Specifically, six of the eight racks in Quadrant 1 have bins and motherboards installed, two station racks and two correlator racks are populated with circuit boards, all 40,000 custom correlator chips are in hand, and the tunable filter bank (an ESO deliverable) has passed its Preliminary Design Review. Everything remains on track to have the first quadrant installed in Chile by the end of 2006.

ALMA

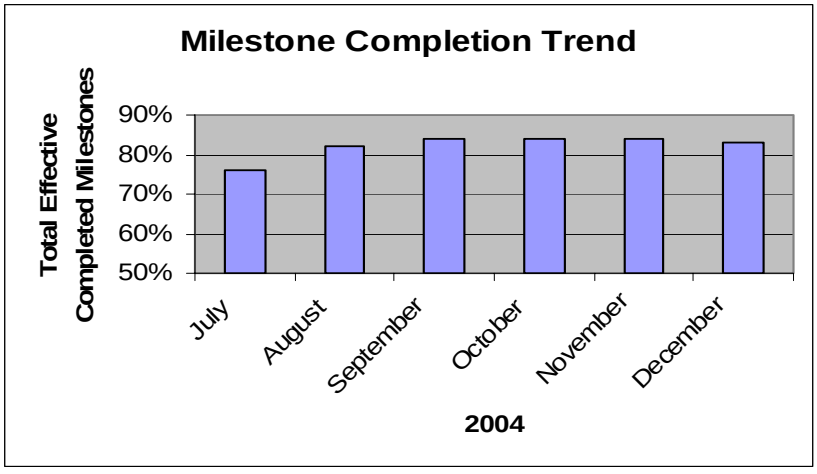
The Computing IPT (CIPT) has successfully completed several important Software-to-Hardware Interface Control Documents (ICDs). A control software release to increase reliability for Prototype Systems Integration (P-SI) was accomplished. The ALMA Science Data Model is bound to source code automatically generated by UML diagrams. User testing of flagging heuristics for the ALMA pipeline has begun and user testing of the next Offline (AIPS++) tests are concluded. All external user tests were passed. Also, the ALMA Science Data Model development is completed. And, agreement is in hand on the impact from the Japanese enhancements to ALMA on the existing CIPT.

Dick Sramek has successfully assumed the Prototype System Integraion (PSI) activities previously led by Larry D'Addario. A comprehensive PSI plan is nearing completion under Dr. Sramek's leadership. Significant progress has been made in a bottom-up analysis of system reliability. Systems Engineering and Integration (SEI) has also supported the development of the statements-of-work for the rebaselining activities. Of the 43 external ICDs, 19 are now approved with 20 submitted for approval and one in draft form.

The Science IPT has provided support for the ALMA Science Advisory Committee (ASAC) as it responded to five charges from the Board, helping the project to start to define priorities as it faces the inevitable operations funding issues. The Science IPT also has made progress in the production of an updated and expanded Calibration Plan. And, progress has been made in the clarification of the wording in the top-level Science Requirements Document bringing it close to the point that it can be submitted to the Board for approval.

The following tables provide summary milestone progress, financial, and staffing information for the ALMA Project as of the end of the reporting period. The reporting for this period demonstrates the project's Level 2 status. A complete listing of the Level 2 Milestones is shown in the Appendix A. With the anticipated full implementation of the PMCS program (under JAO oversight and control), future reporting can be at Level 3, if so desired. Table 1 shows the planned versus completed Level 2 milestones. In addition to the actual milestone completions, the fractional completion of incomplete milestones is tabulated in the *Work in Progress* column. When added to the completed milestones, this provides a more accurate picture of the total amount of progress that has been made to date. This is shown in the column labeled *Total Effective Milestone Completions*.

Table 1 Level 2 Milestone Status North American ALMA Tasks Cumulative Since February 2003 Baseline December 2004					
IPT	**Planned Milestone Completions**	**Actual Milestone Completions**	**Work In Progress On Incomplete Milestones**	**Total Effective Milestone Completions**	**Percent Total Effective Milestone Completions**
Site	13	6	2.5	8.5	65%
Antenna	11	9	.9	9.9	90%
Front End	24	11	5.8	16.8	70%
Back End	6	3	2.4	4.4	73%
Correlator	10	11	0	11	110%
Computing	13	13	0	12	100%
Systems Engineering	12	7	2.2	9.2	77%
Science	9	8	0	8	89%
Total	**98**	**68**	**13.5**	**81.5**	**83%**



Milestone Completion Trend

Table 2 ALMA Project Expenditures and Commitments 1000's of Actual year dollars Activity Through December 31, 2004					
	FY 2005		Project to Date		
WBS	Budget Plan FY 2005	October-November FY 2005	Total Project Budget	Project To Date Budget	Project To Date Actual
1. Management	2,446	632	22,005	6,420	6,162
2. Site	7,960	135	29,040	8,065	1,483
3. Antenna	29,863	175	132,024	9,901	1,975
4. Front End	6,491	1119	40,361	18,419	16,092
5. Back End	6,506	1091	40,571	11,056	9,264
6. Correlator	813	237	9,801	6,917	7,405
7. Computing	2,132	668	16,857	5,959	5,608
8. Systems	1,255	329	12,404	4,555	3,718
9. Science	617	121	4,987	1,342	1,345
Not yet allocated	0	141	0	0	-109
Total	**58,082**	**4,648**	**308,050**	**72,634**	**52,944**

Table 3 ALMA Staffing	
WBS Task Name	Full-time Equivalent Employees
Administration	4.8
Site Development	1.7
Antennas	5.6
Front End	31.0
Back End	21.8
Correlator	6.9
Computing	21.4
System Integration	10.0
Science	3.9
Total:	**107.1**

ALMA

North American ALMA Science Center

Organizational and planning activities included: continued work on an NAASC operations plan with staffing levels and budget estimates for the years 2005 – 12, review of drafts of the ALMA Operations Plan being prepared by the Joint ALMA Office, and preparations for future events where ALMA is to be highlighted.

The largest of these events will be a Town Meeting to be held during the San Diego meeting of the American Astronomical Society this coming January. Plans for this event were completed.

Work continued on improving the access to information on ALMA via the NRAO website. A web page has been established for the NAASC with links to the ANASAC and other web pages with ALMA content. The intent is to work out through the various pages, improving the design and making it easier to reach current information.

NAASC staff members have been engaged in testing ALMA software: the Observe Tool which will be used to submit proposals and data analysis software (AIPS++). In addition, work has begun on spectral line and calibration source databases. Working groups in all three areas have been established.

Regularly scheduled meetings included bi-monthly meetings of the ANASAC and bi-weekly meetings of the NAASC staff. P. Vanden Bout gave a talk at the NRAO New Initiatives Workshop held in Socorro, on December 13, 2004, and outlined the plans for the NAASC.

Goals for the next quarter: Our top goal remains the same—translate the budget in the ALMA Operations Plan (draft I1) into a cost for the NSF that includes all elements of the NAASC not funded as a regional ALMA center in that Plan, and compute the cost to Canada as well. This will be followed by a careful inspection of the elements of the Plan to assess that requirements are met but not exceeded. We will continue work on the website and software testing. We intend to conduct a study in 2005 to determine the requirements for a program of data analysis support grants for U. S. ALMA users. We will prepare for the move into new quarters now anticipated in the next quarter.

Expanded Very Large Array

Expanded Very Large Array (EVLA) Highlights

Interferometric fringes between two EVLA antennas were achieved for the first time on 2 December, a particularly important milestone. Antenna 16 was brought into the Antenna Assembly Building for re-fitting as the third EVLA antenna.

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The annual meeting of the EVLA Advisory Committee took place 14 – 15 December in Socorro.

Expanded Very Large Array Milestones

Milestones	Original Date	Revised Date	Date Completed
1.5 GHz feed horn installed on Antenna 14	10/05/04		10/05/04
Start 1st production antenna overhaul (Ant 16)	09/30/04	10/06/04	10/06/04
Install MCB rack in Antenna 14	10/12/04		10/07/04
Cold storage building ready for inventory	11/15/04		10/12/04
ACU/FR MIB interface installed on Antenna 14	10/04/04		10/14/04
Power supply board (P301 & P302) assembled & tested	07/30/04	10/15/04	10/15/04
Monitor &Control CDR	09/15/04	10/20/04	10/20/04
Bench integration test racks populated	05/07/04	10/05/04	10/25/04

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
1st draft of correlator shielded room specifications	10/14/04		10/29/04
EVLA M&C software ready for multi antenna testing	10/29/04		10/29/04
2nd L353 LO transmitter module w/MIB assembled	10/19/04		11/01/04
3 GHz receiver first cool down	11/05/04		11/05/04
8 GHz receiver installed on Antenna 14	10/07/04		11/10/04
WBS updates	11/12/04		11/12/04
Construct new space for Modcomps	11/16/04		11/16/04
Software requirements for real-time system	08/29/03	10/11/04	11/22/04
L352 RTP module w/ new firmware ready for test rack	11/10/04		11/24/04
Project Book updates	11/24/04		11/24/04
FE card cage prototype assembled	10/07/04		11/29/04
1st DTS module w/ transponder	08/31/04	11/01/04	11/29/04
First fringes on Antenna 14	09/09/04	10/18/04	12/02/04
L352 RTF MIB software available	12/08/04		12/08/04
22 GHz receiver installed on Antenna 14	10/07/04		12/14/04
Project Advisory Committee meeting	12/14/04		12/14/04
Install 1.5 GHz receiver on Antenna 14	12/14/04		12/14/04
2nd F320 module assembled and tested	07/21/04	10/15/04	12/17/04
F320 FE transition module w/MIB & ICD ready for software	12/09/04	10/15/04	12/17/04
Level 2 schedule updates	12/06/04		12/30/04
Fabricate NRAO Q-Band MMIC post amplifier	07/16/04	01/06/05	
4 IF's on Antenna 14 working	09/13/04	01/06/05	
M301 converter interface module ready for software	10/07/04	01/10/05	
75/328 MHz converter module ready for test antenna	10/24/03	01/11/05	
Start transition Operation planning	01/13/05		
MIB control band select switches on Antenna 14	12/15/04	01/18/05	
Install 3 GHz receiver on Antenna 14	12/16/04	01/18/05	
45 GHz receiver installed on Antenna 14	10/28/04	01/19/05	
Multi frequency observing - L & X	07/21/04	01/25/05	
Formatter MIB slot ID ready for Antenna 14	01/26/05		
Move 2nd test Antenna 14 to array	09/27/04	01/31/05	

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
Complete Part 1 hardware bench integration	03/03/03	02/01/05	
Routine test observing	05/13/04	02/01/05	
Module package ready for RFQ	02/02/05		
Antenna 14 move into array	02/04/05		
Antenna 16 move to Master Pad	02/04/05		
Correlator shielded room specifications complete	12/15/04	02/07/05	
Check for interference and bandpass shapes: 8, 22 & 45 GHz	03/15/04	02/08/05	
Receiver stability tests: 8, 22 and 45 GHz	12/19/03	02/08/05	
P, L, X, K & Q-Band receivers usable - Antenna 14	09/13/04	02/08/05	
Deformatter slot ID ready for Antenna 14	02/09/05		
New time synchronization	02/15/05		
Verify linearity of RF designs – receiver to correlator	05/27/04	02/15/05	
L352 RTP module slot ID available	02/16/05		
Feed horns CDR	11/18/04	02/17/05	
L301 and L302 integrated module ready for Antenna 16	02/22/05		
MIB control band select switches on Antenna 16	02/23/05		
L, C, K and Q-Band receiver remote operation on Antenna 14	02/24/05		
First fringes on Antenna 16	03/02/05		
4 IF's on Antenna 16 working	03/09/05		
Total power and sensitivity improvements	03/10/05		
Start transition mode observing	03/15/05		
MIB control band select switches on Antenna 13	10/21/04	03/15/05	
M302 Utility module prelim design complete	03/25/05		
Start production F320 FE transition module	03/28/05		
4 IF's on Antenna 13 working	03/31/05		
Two F317 modules w/ MIB tested and ready for software	09/08/04	04/14/05	

Expanded Very Large Array

Management

Mark McKinnon was appointed EVLA Deputy Project Manager in December. Now that the project is moving into its production phase Mark's particular emphasis will be on budget and schedule aspects of the project with the goal of keeping the project on-schedule and on-budget.

A Critical Design Review for the Monitor and Control subsystem hardware was held in October and the third meeting of the EVLA External Advisory Committee was held in December. The presentations and committee reports for these meetings are available on the web pages for the meetings which are accessible via the EVLA Home Page. In preparation for the Advisory Committee meeting the EVLA Project Book was updated and is also available on the web.

The EVLA External Advisory Committee meeting was attended by eight of the thirteen scientists appointed to the committee from outside of the NRAO. Two important areas of discussion at this meeting were the project management plan and software status. With respect to the project management plan, a significant issue is a predicted overrun in Contributed Effort (labor contributed to the project from the VLA operations budget). If the project construction budget has to cover this overrun it may be necessary to descope some of the receiver bands. The Committee advised that the relative scientific merits of the different bands be studied in detail so that they can be prioritized. In the area of software the Committee was pleased with the progress made in AIPS++ testing, the progress in programming the numerous Module Interface Boards for the Monitor and Control system and with the improved state of planning for the correlator software. Two significant software concerns discussed with the Committee were the need for more detail in the top-level EVLA software architecture design and the inadequacy of the personnel resources available for the e2e work. The project is now working to provide increased design detail and to prioritize the e2e tasks to determine which can be accomplished with available resources.

The project WBS was updated during the quarter and the GPRA predictions for 2005 were provided to the NSF. In November the Mexican CONACyT issued an RFQ for the EVLA work which it will fund. NRAO will respond to this RFQ and it is expected that this will result in the Mexican funds being made available to the project.

Systems Integration

One IF's set of electronics was installed in Antenna 14 and first interferometric fringes were obtained between the VLA and the EVLA Test Antennas on December 2, 2004. This provided the first fringes between two EVLA antennas. At the end of the quarter Antenna 14 was being equipped with the full complement of electronics and should be ready for operation with all four IF channels in early January.

Expanded Very Large Array

The integration racks in the AOC lab were also reconfigured to support all four IF systems as well as redundant LO systems. This will allow simultaneous testing of the full suite of electronics as well as side by side testing of two LO or single IF systems to analyze phase and gain stability of the system.

Antenna 16 was brought into the Antenna Assembly Building for refitting as the third EVLA antenna. This antenna will be equipped with the first of the production design equipment.

Civil Construction

Design preparation and clearing of the shell space for the new WIDAR Correlator room continued. The Computer Lab has been relocated. The Operations area has been remodeled. The remodel includes provisions for the VLA Modcomp computers, which will be relocated in February 2005. Electrical work will be completed in January 2005 prior to the Modcomp move .

The sprinkler system and related electrical work in the EVLA Storage Building was completed in November 2004. The building was handed over to the Business Division who will maintain the stored items as part of the warehousing inventory.

The first draft of a bid specification for the fire suppression system in the WIDAR Correlator room has been completed. With help from a consultant, the final bid document is being prepared. The purchase order was issued to the consultant in December 2004.

Antenna

Antenna 14 mechanical outfitting was completed during the quarter. Antenna 16 was brought into the barn for refitting as the third EVLA antenna and, after replacement of its azimuth bearing, installation of its new HVAC system, fiber optics, and electrical cabling commenced. Feed cone #3 was completed and installed on Antenna 16.

The second copies of the L and C-Band horns were fabricated and installed in Antenna 14. X-Band feed horn prototype components were ordered. Production quantities of feed cone panels were received, but some panels had quality issues that are being corrected through negotiations with the vendor.

Front End (FE)

The FE-Rack and the X-Band front-end, as well as the interim L and K-Band receivers, were mounted in Antenna 14. The L-Band receiver is the first to use the new high-dynamic range scheme which was adopted for the 1-2 GHz band. It uses a cooled low-noise amplifier gain block followed by a cooled high-power gain block. The wideband balanced amplifiers are based on a new design from the NRAO Central Development Lab. The receiver underwent a comprehensive series of lab tests which indicate superior sensitivity, compression, and ellipticity over the existing VLA receivers.

Expanded Very Large Array

A series of efficiency and spillover tests were carried out on the L-Band feed installed on the first EVLA antenna. Its G/T performance was found to comply with the EVLA requirement specifications. The second C-Band feed and the first C-Band receiver (without its circular polarizer) were installed on Antenna 13 for a similar set of efficiency tests. While some additional measurements will be needed, the C-Band feed does appears to function adequately over its 4-8 GHz design bandwidth. The prototype down-converter modules for the Ka-Band receiver were machined and sent to Caltech for micro-assembly of their MMIC components. The prototype Card Cage is undergoing testing in the lab and has successfully controlled the cool-down of its first cryogenic dewar. Most of the hardware and software for the new automated antenna range are now in place. The decision on whether to locate it at the VLA site or on the New Mexico Tech campus is imminent.

Local Oscillator (LO)

Designs for the reference receiver (L304) and driver (L354) modules were completed and these modules are now in production. Continued problems with the pulse modulation circuit have delayed design completion of the transmitter (L353). Testing of the round trip phase measurement module (L352) was started to determine if it meets all requirements before production begins. The antenna reference generator (L305), central reference generator (L350), and offset generator (L351) still need some redesign work. The 12-20 GHz (L301) and 10.8-14.8 GHz (L302) synthesizers are still waiting on the AGC integrated assembly, to be provided by a commercial company, before the design can be completed. The current designs of the L301 and L302 are performing well.

Fiber Optics

The new 8-bit digitizer board and the half-transponder formatter board were completed and installed in the newly designed Digital Transmission System (DTS) Modules. Four DTS modules were built and tested and will be installed on Antenna 14 early next quarter for final testing. The design of the LO round trip phase module (L352) was completed and two modules were built and round trip phase testing will re-commence next quarter.

All fiber cables in the vertex room to the LO and Front End racks and the monitor and control fibers were installed on Antenna 14 and testing was completed in support of first light and first fringes. Antenna 16 now has fiber infrastructure from its base to the vertex room. This watch spring and cable assembly were installed and azimuth limits set; the riser assembly with insulated fiber was installed from pedestal room to vertex room; the base box was installed and pigtail assembly spliced into place; and the pedestal room and yoke were installed.

Fiber optic cabling continues in the control building for the switches, LO and Deformatter central racks. A new design was approved and is being made for the fiber feed through on the LO central racks in the control building.

Expanded Very Large Array

Intermediate Frequency System

The integrated design of the base band converter (T304) is near completion and is only lacking the total power digitizer. The UX converter has undergone some manufacturability design changes by the vendor and the redesigned units are due in the first quarter of 2005. The LSC converter (T302) is ready for production and the 4/P converter (T301) requires the redesign of one circuit board.

Correlator

Following a rigorous evaluation and selection process involving an evaluation committee consisting of representatives of all stakeholders in the project, a correlator chip contractor was selected. A Critical Design Review of the correlator chip design, functional testing, and implementation plan will be held in Penticton from January 24-26, and once this is complete the contractor will start work on the chip. It is expected that the first prototypes of the chip will be available sometime late in the summer of 2005.

It has now been decided to implement the FIR chip in a 90 nm FPGA. Testing and analysis with a real chip indicates that power dissipation is acceptable, and that timing specs can be met. Implementation of the FIR filter chip in an FPGA offers significant advantages in terms of flexibility, reduced testing effort, and reduced risk.

Initial testing of the correlator test rack at 10 kW indicated that with a simple vertical airflow it should be able to meet EVLA cooling requirements. Further testing is planned, however, initial testing indicates that a very simple configuration is sufficient. Sub-racks have also been evaluated, and it is now believed there is at least one vendor that can provide a mechanically robust sub-rack that can hold the weight of the boards and provide mechanisms to deal with relatively high insertion and extraction forces.

The Station Board and Baseline Board schematics are nearing completion, and it is expected that place-and-route of these large circuit boards will commence early in 2005. Many of the complex FPGA designs and tests are nearing completion, and it is anticipated that everything is converging to early prototype tests in the late summer of 2005.

A detailed software architecture for the correlator has been developed, as has a detailed description of the software interface to the correlator. Many low-level device drivers have been developed, and priority is placed on development and implementation of software for first prototype tests.

Monitor and Control (M/C)

The Monitor and Control Hardware CDR was held on October 20, 2004. Its primary purpose was to determine if the module interface board (MIB) hardware design was ready for quantity production. No significant impediments to quantity production were found, and an order for 300 MIBs has been

placed. In addition, the software interface to MIB-controlled devices was found to be clean, capable, and adequate to the task of controlling the antenna subsystems.

MIB/module software development continued. Slot-ID hardware and software to support uniform addressing of antenna-based modules on an IP-based network has been developed and is being installed. Hardware and software development for the M301 module, to support computer controlled band selection, is nearly complete. Work began on the software for the F320 front-end transition module that will allow VLA-style card cages used for the control of receivers to be monitored and controlled by a MIB and MIB-based software.

Phase I of the software transition plan is progressing well. EVLA monitor and control software sufficient to the task of multiple antenna testing is in place and in use. The synchronization of scans between the old VLA control system and the developing EVLA control system has been demonstrated. A framework is in place for the development of flagging information for EVLA antennas, and a web-based human interface that allows the specification of sub-arrays and the designation of control scripts for each sub-array has been tested. Design of the software to be used for the control of MIB and non-MIB based subsystems in the mature, final EVLA system is also proceeding.

Data Management

The EVLA monitor data archive is now completely operational and in use by the engineering staff. It archives monitor data from the upgraded EVLA antennas, from devices on the bench at the AOC, and even from old VLA antennas.

A study of the ALMA Science Data Model (ASDM) was performed to assess its suitability for the EVLA and VLBA. A document containing suggested modifications to the ASDM was presented to the appropriate ALMA team. Agreement on a common science data model is essential if the EVLA is going to benefit from ALMA developments in data capture and archiving.

Progress in the e2e area has been affected by lack of staff resources. The plan for 2005 is to gradually reassign EVLA Computing staff from observatory-wide responsibilities to more EVLA-focused duties. Significant effort went into developing the NRAO-wide proposal tool and user database. Although focused on the GBT, it will eventually benefit the EVLA as well.

Green Bank Telescope

Green Bank Telescope (GBT) Highlights

The GBT Azimuth Track Progress review was held on December 7-8, 2004 in Green Bank. The expert engineering panel that attended the first review in October 2002 returned and was once again chaired by Prof. Karl Frank of the University of Texas. Comprehensive project reports were provided to the panel prior to the review, and presentations were given at the review meeting by GBT and Simpson, Gumpertz, and Heger engineering staff. This major review meeting described the investigations and analyses to date, and outlined the plan for modifications. The panel was well satisfied with the work presented and was generally supportive of the proposed track modifications. The panel suggested several areas of follow-up investigations, and the project staff is presently pursuing these

GBT Milestones

GBT Antenna & Operations

Milestones	Original Date	Revised Date	Date Completed
Complete Phase III of track analysis	10/31/04		12/06/04
Complete development of new rail concepts	12/31/03	02/15/05	
Hold panel review meeting	01/31/04	12/07/04	12/07/04

GBT Electronics

Milestones	Original Date	Revised Date	Date Completed
Spectrometer Upgrades			
Cross-correlation/poln. Test fixture designed	01/01/04	01/15/05	
Cross-correlation/poln. Test fixture constructed	03/01/04	03/01/05	
Begin polarization mode checkouts	06/01/04	03/01/05	
LTA redesign (engineering only)	04/01/04	10/01/04	12/15/04
LTA Construction	02/15/05		
LTA Test and Debug	04/15/05		
Sampler distributor redesign (engineering)	08/01/04	On Hold	
RFI Improvements			
Finish GBT receiver room HVAC suppression	12/01/03	On Hold	

GBT Mechanical Engineering & Central Shop

Milestones	Original Date	Revised Date	Date Completed
Penn Array Electronics Crate	11/05/04		12/15/04
Penn Array HDPE Lenses	11/05/04		10/15/04
GBT RFI Antenna Mount Design	10/29/04	04/15/05	
Test Building Receiver Handler	10/15/04	04/30/05	
3mm Quartz Windows	10/31/05		
Penn Array Electronics Crate GBT Mount	03/31/05		
Ka-Band MMIC Amp packages (10)	02/25/05		

GBT Software & Computing

Milestones	Original Date	Revised Date	Date Completed
Deprecate IARDS	03/31/04	02/15/05	
Complete Linux Migration	06/30/05		
Eliminate Backlog of Software Maintenance Requests	12/31/05		

GBT Projects

Milestones	Original Date	Revised Date	Date Completed
PTCS			
Identify 1" level contributors to pointing error	09/30/04	deferred	
Ready for prototype W-Band operation under benign conditions	10/01/04	02/01/05	
Ease of Use			
Production Release of HLAPIs & Online Filler	03/31/04	Task reorganized	
Complete "Phase 4" of Observing API (near-earth objects, source catalogs)	06/30/05		
Remote Observing Specifications Written	12/31/04	05/15/05	
Data Handling			
Generate requirements for imaging	12/31/03	09/01/05	
Beta of IDL package for standard observing modes available for internal tests	12/31/04		12/15/04

Green Bank Telescope

Milestones	Original Date	Revised Date	Date Completed
Beta of IDL package for standard observing modes available to external reviewers	02/15/05		
Production release of IDL package to GBT users	05/15/05		
First draft of GBT Science Data Model	03/31/05		
Spectral Baselines			
Conduct experiments to characterize Q-Band baselines	08/01/04	10/15/04	11/01/04
IF Temperature stabiliy experiments	08/01/04		09/01/04
Ka-Band (1cm Rx)			
Commissioning completed / release for astronomy	02/15/05		
Penn Array Receiver			
Fabricate and deliver crate and mounting hardware	11/05/04	11/05/04	12/15/04
Detectors Delivered to Penn	05/17/04	02/28/05	
Full Lab integration at Penn	09/06/04	03/31/05	
GBT Commissioning	02/21/05	03/31/05	
3mm Receiver			
Restart Project	11/15/03	10/01/04	01/01/04
Revise Project Plan	12/01/03	11/15/04	11/15/04
Caltech Continuum Backend			
Complete CCB design	03/31/04	02/28/05	
Master Board laid out	04/30/04	02/28/05	
FPGA program synthesized and simulated	03/31/04	03/31/05	
Finish Packaging drawings	05/31/04	04/31/05	
Construction and lab testing complete	08/27/04	09/15/05	
Commission on GBT	09/06/04	10/15/05	

Green Bank Telescope (GBT)/Green Bank Overview

GBT astronomical operations were smooth and routine in the fourth Quarter. Astronomy was scheduled on the GBT for 1315 hours in the quarter, or about 60 percent of total telescope time. The remaining time went to tests and commissioning activities, regular maintenance, and the holiday shutdowns. With the return to cool, clear weather in the autumn, high-frequency observing and dynamic scheduling returned.

Green Bank Telescope

This quarter was very busy with workshops for the IDL data reduction project, pulsar observing, and a panel review for the azimuth track project. An all-day workshop for the IDL data reduction project was held on October 15. Five external astronomers with practical IDL experience were invited to attend as project consultants. The project staff presented the objectives and work accomplished to date. The external participants gave several demonstrations of IDL software they or their groups had developed. The day proved to be very useful for information interchange and was very helpful to the project.

A pulsar workshop was organized by Scott Ransom of the NRAO scientific staff and was held in Green Bank on November 12-13. The workshop was well attended by active pulsar astronomers and was designed to advise the NRAO on pulsar instrumentation priorities, operational needs, and proposal handling issues for the GBT. It was a very fruitful two-day session. In addition to the discussion at the workshop, the participants have provided NRAO with a written summary of comments and advice.

A major engineering progress review of the azimuth track project was held in Green Bank on December 7-8. The purpose of the review was to summarize the engineering investigations, analyses, and trials conducted since the initial panel review in October 2002, and to describe the plan for a permanent modification to remedy track deficiencies. A very substantial amount of material was assembled and distributed prior to the meeting. The panel again proved to be truly expert in their engineering knowledge and experience, and were extremely helpful and insightful. The panel was well satisfied with the efforts to date and endorsed the overall plan for modifications. Suggestions for follow-up work were also provided.

Excellent progress was made on a number of development projects to enhance the scientific performance and capabilities of the GBT. The Precision Telescope Control System (PTCS) project for providing 3 mm observing capability on the GBT proceeded well. Good progress was made on pointing models and instrumentation (feed arm quadrant detector, elevation axle inclinometers, and new laser rangefinders). The next quarter will see a concerted push for surface measurements and adjustments.

The Ka-Band (26-40 GHz) Receiver was reinstalled on the telescope in early October. Astronomical commissioning proceeded during the autumn and early winter, and the receiver will be released for regular observing in February 2005. This receiver will see use for high-redshift molecular line observations, sensitive continuum observations to correct CMB fields for foreground emission, and for Galactic spectroscopy. The 3 mm (68-92 GHz) Receiver project was resumed in October following a hiatus required by the demands of other projects. This will be the GBT's first spectroscopic 3 mm receiver and is similar in design to the Ka-Band receiver. Progress continued on the Caltech/NRAO Continuum Backend that will allow very sensitive continuum observations with the Ka-Band and 3 mm receivers. Progress was also very good on the Penn Array bolometer camera, which will provide GBT observers with a fast and sensitive continuum imaging system for the 3 mm band and should arrive at the GBT for first engineering tests in the spring of 2005. The IDL data reduction package also proceeded well over the past quarter, together with a number of other software initiatives.

Green Bank Telescope

GBT Azimuth Track

Phase 3 of the finite element analysis was completed during this quarter by Simpson, Gumphertz, and Heger. The results of this phase are directed toward the new design. Some additional in-house work will be finished in the next quarter to finalize a wear plate thickness and width, a bolting configuration, and to close some design issues such as weld shrinkage stresses and thermal growth.

The modified track joint continues to perform well. Two trial plates made of AISI 4340 material installed in the 3rd quarter also continue to perform well.

The external panel review was held December 7 and 8. Several recommendations came out of this review, and a few design questions were posed that we should address before executing. Several tasks will carry over into the next quarter. These include identifying a method to control machining of the top surface of the base plates, width and thickness of the wear plates, manufacturing controls for the wear plates, and the method to fasten the wear plates to the base plates.

In FY2004, NRAO received a sum of $4.5 million (after rescission) for repair of the GBT azimuth track. The exact plans for use of these funds will follow from the on-going design efforts and the recommendations of the external review panel. We anticipate that designs will be completed in the spring of 2005 and that repair contracts will be executed in 2006/7.

Telescope Operations Activities

The azimuth bearing lubricant change continues to perform well. Cold weather effects on viscosity are being monitored. Oil samples will be taken in the first quarter of 2005 to document wear improvements.

The Telescope Mechanics and Operators performed a number of feed and receiver changes to support the GBT observing schedule.

In the summer of 2004, NRAO was approached by MIT Lincoln Lab concerning a possible contact project that would use the 140 Foot to track radar echoes from low earth orbit satellites as part of a study of the ionosphere. During this quarter, we have conducted some investigations into the feasibility of this project. For example, using available effort on non-GBT maintenance days, the staff de-mothballed the 140 Foot Telescope, and performed movement trials to verify the mechanical state of the antenna and drive system. These tasks were successfully finished during the week after Christmas. The drive system was determined to be basically sound. Work will continue in 2005 to inspect other components. If approved, this project may be undertaken in 2005.

Support of control software development also continues for the 45 Foot Telescope project

Green Bank Telescope

Green Bank Electronics

Green Bank Electronics provides support for all electronic systems at Green Bank, including telescope controls, backends, RF equipment, audio-visual equipment, network installation and maintenance, radio system work, and even machine shop electronic repair. Some specific activities of the three Groups are reported below.

Digital Group

Most of the digital group's time was spent on PTCS activities, 45 foot servo support, Spectrometer support and development, and the Caltech Continuum Backend project.

About 4 FTE's were supplied to the PTCS project. This consisted of sensor construction, installation, maintenance, and calibration work, along with active surface maintenance.

The 45 foot servo system work for this quarter consisted of construction of the new servo system for the telescope, as well implementation of the antenna control software used for the OVLBI project. This antenna is being readied for use with the Solar Radio Burst Spectrometer for studying the Sun over the next two years.

During this quarter, Spectrometer development concentrated on three areas: LTA card replacement, cross-correlation and spigot testing. The LTA replacement project finished the design of the PC Boards. The boards are being built, and should be ready for testing around the first week of February. Spigot mode testing concentrated on development of 200 MHz modes, and addition of a FIFO in the spigot cards to help eliminate tick errors. Cross-correlation testing concentrated on the development of a test fixture, and a filter module similar to that in the GBT IF system. The spectrometer is fairly reliable although it occasionally produces obvious bad data.. Trouble-shooting and repair accounted for only a small amount of the time spent on the Spectrometer. About two FTE's are provided to the Spectrometer.

The Digital Group is supplying engineering to assist the Caltech Continuum Backend project, designing all the hardware including the packaging. About 1.5 FTEs are assigned to this task. Other items that the Digital Group is involved in are GBT servo system support, repairing and maintaining printers, network cabling, and communications hardware on the GBT.

Microwave Group

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

Green Bank Telescope

The Q-Band receiver was reinstalled on the GBT. Fairly major changes were made in the receiver over the past summer: the mixers were moved from the 15K cold stage to room temperature, additional RF gain was added before the mixers and broadband attenuators were introduced to improve the mixer RF port termination. These improvements greatly reduced variations in bandpass shape as the LO frequency changes. However, some performance was lost at the edges of the receiver band, which will be addressed later.

The X-Band receiver was modified with the addition of a polarization switch, along with new filters to accommodate requests for observing outside the original frequency range of 8-10.1 GHz. Observing is now possible to 11.6 GHz with the caveat of a polarizer resonance at 10.55 GHz, and reduced polarization purity above 10 GHz. The PF2 receiver was installed and used for astronomy, while the PF1 receiver had a filter bank repaired.

The 26-40 GHz receiver was installed on the GBT and extensive commissioning observations were made. Additional development is underway to obtain enough power to drive four mixers in the LO Distribution module. In other new developments, work resumed on the 3mm 68-92 GHz receiver construction project. A detailed schedule was developed, and significant progress was made on design of the receiver monitor and control circuitry.

The IF system received also some attention this quarter. New IF amplifiers are being designed and tested. Various module instabilities and failures were repaired, and efforts continue to improve gain stability with better temperature control and other steps.

The outdoor antenna range upgrade was nearing completed. This will provide better positioning, instrumentation, and software for doing antenna measurements on the outdoor range. Test patterns were made and the performance is being evaluated.

In support of various projects, we continue to develop amplifiers around commercial MMIC chips, including a 8-18 GHz LO amplifier and a 0.5-8 GHz medium power IF amplifier. Several microstrip bandpass filters were also designed, developed, and produced. More Microwave Group activity is noted under the baseline investigation project and the Ka-Band receiver project.

RFI Management

A K-Band spectrum summary (17.7 - 20.2 GHz), along with a chart and graph depicting geostationary look angles from the GBT, were developed to aid observers in this band. Assistance was also provided in tracking down a source of L-Band interference that appears to be the Glonass satellite.

A complaint regarding a broadband, short duration RFI source seen by the Solar Radio Burst Spectrometer was investigated. The RFI was initially suspected to be a nearby thermostat but it has since been determined that it is due to brief dropouts in the sweeping process of the system.

Green Bank Telescope

RFI scans were developed and summarized as part of the PF1 450 receiver checkout observations. Temporary suspension of the 432.305 MHz amateur radio beacon on Bald Knob was coordinated in support of PF1 450 observations.

The National Radio Quiet Zone (NRQZ) office completed eight requests for preliminary evaluation on 27 proposed transmitter sites. Forty-four regular applications for 91 sites were also completed. ERPd restrictions were requested on five sites and one objection was filed. Two site inspections were performed. Three sites were discovered that have not been coordinated inside the NRQZ. Two of these sites have now been successfully coordinated and the third is currently being brought into compliance. The propagation software used in NRQZ administration has been upgraded to the latest release. An evaluation method has been developed for satellite internet coordination in the vicinity of the Observatory which is based on FCC rules governing the antenna performance standards.

Community RFI suppression continued with the location and mitigation of power line and cable TV interference. Note that there are no cable TV signals seen in the PF1 450 MHz RFI survey from November 17. A new full-time technician for Milestone Cable is now on-board and has been made aware of NRAO's RFI concerns. The Powerkut ballasts for the GB library fluorescent fixtures have been received and are planned to be installed by the Plant Maintenance Group.

Improvements to the RFI monitoring station include a new winch for the tower and Uni-Trac rotor control software. The OASIS II spectrum monitoring software by Summitek, which is a computer interface for driving spectrum analyzers and receivers, is being evaluated and looks very promising to allow remote use of the monitoring station. A decommissioned Watkins Johnson WJ-8679, 20-500 MHz, Pseudo Doppler DF system has also been acquired.

Significant outreach efforts included a visit by Mike Gallagher and Karl Nebbia of National Telecommunications and Information Administration (NTIA). The group also hosted a visit by the Executive Officer and Commanding Officer of Sugar Grove, along with Bud Berryman, Senior RF engineer. Support was also provided for Shared Spectrum Company to conduct 48 hour monitoring for a joint DARPA/NSF project. Measurements were made from 30 MHz to 3 GHz and will provide an overall measurement of spectrum occupancy.

On-site RFI Management included repair, improvements, and routine maintenance on the shielded doors and windows in the Jansky Lab. The RFI enclosure design was finalized for the Josler security cameras. The RF enclosure design for the science center C3 compact fluorescent fixture filtering project is being evaluated.

NRQZ limits were determined for each band from the location of the 140 Foot Telescope to provide the necessary protection criteria for the GBT to MIT Lincoln Labs for the planned operation of the 140 Foot Telescope.

Green Bank Telescope

An RFI survey at the NRAO Technology Center in Charlottesville was performed as a baseline for assessing the impact of the ALMA Correlator on SIS mixer testing. A preliminary evaluation of the shielded chamber in Building 4 was also performed.

Mechanical Engineering and Central Instrument Shop

In the fourth quarter this year the Mechanical Division shared in the preparation and presentation of the GBT Azimuth Track Panel Review convened in November. In addition, design work continued for improvements and upgrades to the PTCS system and support is expected to be ongoing . The Division will continue to provide engineering and design support to the Solar Telescope upgrades and the 140 Foot Telescope outfitting. Design for the Penn Array receiver electronics crate was completed and design of the GBT mounting structure has begun and will be completed early in the first quarter 2005.

The Central Instrument Shop completed the fabrication of the Penn Array electronics crate. The GBT mounting structure for the crate will be completed in the first quarter 2005. Work next quarter continues on the GBT Ka-Band and 3mm receivers. An effort is currently underway to develop a capability for the fabrication of the quartz windows required by the 3mm receiver. Fixturing, equipment, and processes are being developed and the working windows should be completed near the end of the first quarter 2005. The shop also provided support this quarter for several ALMA assemblies including a number of LO Assembly parts. Continued support was provided for an experiment being conducted by Rich Bradley (CDL) in Green Bank.

Software Development

The Software Development Division (SDD) produced two regular releases of its key product, M&C, with v4.7 being released in mid-November, and v4.8 being released in early January 2005. A new console-based status application, *gbtstatus*, was released with M&C v4.7 after being developed in response to the needs of remote pulsar observers. This application is configurable by the user, who can select which fields they wish to monitor. It refreshes once a second and can be accessed remotely, performing well even under low bandwidth conditions. The low-level interface to the control system (Grail) was also significantly upgraded in November as it was ported to Linux, and in December all applications were updated to use the new version of the utility. This change has resulted in a marked improvement in systems performance, which translates directly to a decrease in lost telescope time.

Green Bank Telescope

The key accomplishment in the final quarter of 2004 was the addition of a full-telescope software simulator. In the past, simulators had been available for portions of the control system but were not available to model the behavior of interactions between different parts of the system. The impact of this has been that the SDD requires a significant amount of on-telescope testing time each month. The new full simulator became available for use within the group in December, and within days its benefits were clear. The SDD was able to troubleshoot solutions to operational support problems and find resolutions prior to final tests on the telescope, reducing the required on-telescope test time from several hours to just minutes. With the addition of simulators in 2005, the SDD will require much less on-telescope test time, meaning more time will be available for hardware tests, commissioning, and astronomy.

Many updates were also made in support of commissioning for the Ka-Band receiver. The greatest changes were related to the addition of the Common MM Downconverter, which challenged the way receivers had been conceptualized in the control system to date. A change was made to the LO1 so that the input switches are correctly set when this receiver is in use. Some parameter types were changed as requested by the Electronics Division. Because configuration for all new observing capabilities is to be done using the Configuration API, updates were made to the IF Rack to prevent misconfiguration of observing modes.

Several smaller additions and improvements were also made. Managers and coordinators were changed from auto-restart to manual restart, to guarantee that if a component of the control system dies, it will be immediately noticed by the user and restored by the operator, minimizing telescope downtime. Additional modes were added to the Configuration API, including support for "expert" metakeywords to directly set parameters within the LO and IF systems, and support for the new, temporary JPL backend for the Huygens Probe. Problems were observed with receivers not clearing messages while turned off, thus potentially confusing users, and these were repaired. The minimum read after a write timeout in the Spectrometer was changed to help alleviate serial line problems with the Spectrometer while electronics considers a more permanent solution. Converter rack errors, which had increased in frequency over the previous quarter, were resolved by making changes to the Transporter code in the control system. Inactive devices were removed from the active control system configuration to suppress erroneous message generation. The Antenna Characterization manager was changed to refer to a default pointing and focus model, and exception handling was added to make the manager less sensitive to reboots in other parts of the system. Many changes were made throughout the control system to support the use of the software in the full-telescope simulator as well as the live telescope. These changes also help to strengthen the security of the system so that tests do not inadvertently interfere with live observing.

Work on the Ease of Use project was sporadic, so that efforts could be more focused on the Data Handling project and maintenance. Members of the SDD also participated in activities outside of Green Bank this quarter, such as IDL training and the ADASS conference.

Green Bank Telescope

Computing Infrastructure

Hardware

A number of new Poweredge machines have been deployed this quarter to upgrade and improve the following services: incoming mail, mail delivery, web proxy, internal web services (wiki.gb etc), NRAO wide webmail service, Samba, secure ftp.

In addition to these servers a "NetApp" has also been deployed to take over the bulk of the fileserving functions previously handled by Prospero. This brings Green Bank into line with the other main NRAO sites, giving GB users the same access to snapshot backups as the rest of the Observatory's users.

The division has also assisted in the setting up of two webservers for the web based business services project which will serve the whole observatory. Other improvements include two new high-end workstations for the reduction of pulsar spigot data and other large data sets and the upgrading of the public windows workstations.

Software

The RedHat operating system currently in use on the bulk of our Unix machines is near the end of its life and in conjunction with the other NRAO sites, we are exploring possible successors to RedHat 9.0. Our current expectation is that we will be moving to RedHat Enterprise Linux, and a few workstations have been set up with this OS to explore the differences.

The migration of Windows machines to the AD domain is essentially complete at Green Bank with only a handful of specialized machines left in the "old" NRAO domain.

Network

This quarter has again seen much work on the network. Documentation has been improved and some new hardware has been configured and installed. Due to observer demand a new 8-port hub has been installed in the observers' periphery to provide additional laptop connectivity. A new Cisco switch has been configured and installed in the Residence Hall. This will eventually allow all rooms in the Residence Hall to have a live internet connection. The switch that was in the Residence Hall has been installed in the old Jansky Lab to provide additional connections. The main Alcatel switch in the Jansky addition has been upgraded to provide more fiber connections in that part of the building.

Work is continuing to improve the shielding of network equipment and upgrade old "thinwire" connections to fiber where possible. The Cable Building switch is now shielded and the Residence Hall switch is due to be fitted in a shielded enclosure shortly.

Green Bank Telescope

The latter part of this quarter saw a number of problems with the network and significant effort was required to analyze and understand the problems. This led to an upgrade of the software used in the three main Alcatel switches. We will also be instituting a program of regular reboots of the switches.

As a result of the work by Joe Brandt and Wolfgang Baudler we now have effective network monitoring in place, both host-based and network-based. This will allow any future problems to be analyzed much more rapidly and effectively. The monitoring software has already proved its worth in tracking down and curing the causes of some slowdowns in our external connectivity.

Projects

Precision Telescope Control System

*Pointing/Focus***:** The failure mode with the temperature sensors was identified to be water ingress into the epoxy-potted thermistors. We have begun a program of replacing the existing thermistors with new, glass-encapsulated sensors. One replacement sensor failed due to a bad solder joint inside the thermistor. The remaining sensors in the new batch were thermally and mechanically stress tested, and two more were rejected prior to installation. Since then we have had no further failures on the telescope (the expected failure rate is less than one per year).

The updated pointing model described in the previous report, including gravitational and thermal coefficients and residual lookup-tables, was released in November, and has been working extremely well since then. Significant upgrades have been made to the processing and display module (GFM) to allow processing of data taken with all switching schemes, and including the new Ka-Band receiver. The treatment of short focus scans has been improved, and an option added to allow less stringent and user-defined heuristics for the assessment of the validity of peak and focus scans. These updates will be tested and released in January.

*Instrumentation***:** The instrumentation work continues to proceed well. The existing Quadrant Decector has been reinstalled on the antenna, and is working well. Under good conditions (low air turbulence) it provides measurements of the position of the tip of the feed-arm with respect to the elevation axle with an accuracy corresponding to ~0.2" of beam motion on the sky, after a linear de-trend. Initially we will use this internally to the PTCS Project to assist in characterization of the antenna tracking performance, both during the acquisition of out-of-focus beam maps, and in anticipation of the arrival of the Penn Array.

A pair of precision inclinometers has now been mounted on each elevation axle. These have been used to investigate azimuth track tilts, by rotating the antenna and making static measurements around the track at locations avoiding wheel/joint interactions. The measured data have been modelled including the zero-points and temperature coefficients of the inclinometers, the track tilt terms, and terms proportional to the square of the alidade-relative wind speed. The measurement uncertainty is less than

1", and bootstrap estimates of the uncertainties of the tilt coefficients are ~0.2". These data are revealing a wealth of information about the track, and this work will continue in the next quarter.

Work continues on developing the next generation quadrant detector and laser rangefinders. The new rangefinder is frequency diverse (100-300 MHz), allowing absolute range measurements. It uses fiber-optically coupled optics, which provide many advantages, including MEMS chopping, a fiber reference loop, and the ability to run many remote heads from a single electro-optics package. The diverged optics mitigates pointing problems and small-scale turbulence; the fiber-coupled optics could be mounted on the existing pointing heads if need be. The new system has already demonstrated ~20μm performance on a 20m path.

Surface Efficiency/Holography: We have remeasured the focus-tracking curve at 20 and ~30 GHz by simple, automated execution of "peak" scans with the subreflector systematically displaced in each axis in turn. This process has been substantially simplified by use of the new "turtle" observing control system. The main effect for the focus-tracking is a small offset in X and Z which appears constant with elevation. We have attempted to measure variations in astigmatism as a function of elevation using the same technique, but these data have been harder to interpret, and processing is still underway.

The Q-Band receiver has been reinstalled on the telescope, after significant rework. Hot and cold load measurements were made at the receiver front-end at five discrete frequencies across the band to determine the system temperature and calibration noise diode temperatures (CALs). The CALs are necessary to evaluated telescope performance such as aperture efficiency. The measured CAL values are within 5 percent of similar lab measurements in most cases. Nonlinear power levels were detected in IF channels 3 and 4 that may compromise aperture efficiency measurements and are currently being investigated. We expect to remeasure the antenna gain-elevation curve, and make absolute efficiency measurements in January.

Staffing: Bojan Nikolic, our new post-doc, will start work on 10 January. His addition to the scientific team will be greatly appreciated, as the scientific staff currently associated with the PTCS project all have significant other duties. Bojan will both continue the OOF holography work, and assist in the astronomical characterization of the antenna tracking performance.

Ease of Use Project

The Ease of Use project is underway to make it simpler for observers to configure the GBT and perform observations. It includes the ability to define observations in advance of observing, the ability to execute those observations, improved monitor and status information while observations are executed, and an improved real-time display. In Q4, the developments were released for evaluation by local scientists. As a result, throughout the quarter, minimal software effort was allocated to this project and instead software efforts focused on continuing maintenance and enhancement activities and the Data Handling project.

Results from the evaluation period indicate that some redesign is required to make the GBT Observing Tools (OT) suitable for use in both interactive and non-interactive observing sessions. However, the tools currently enable pulsar observers to perform tasks that until now would not have been possible remotely, so in Q1 2005 work will be finalized to enable this group of observers to use the new tools in an interactive, remote mode. Pulsar observers will be considered the first beta test group for the new applications, while the design is adjusted and plans for the next phase of capabilities are clarified.

A key goal of improving SDD processes over the past two years has been to automate the regression testing process to make optimal use of staff time and telescope time. Regression tests, which are astronomical tests of the system done to ensure that new functionality does not compromise pre-existing capabilities, are usually labor intensive and require 12-16 hours of telescope time every six weeks. The regression tests have been reconstituted as Scheduling Blocks, and for the first time ever, the operators were in charge of the tests at the end of December. Once the operators are comfortable running the regression tests, and a firm process is in place for managing interactively driven Scheduling Blocks as well as dynamically executed ones, then the regression tests can be run piecemeal using time between observations instead of scheduling large sessions for regression testing. In 2006, the goal is to have all regression tests run dynamically scheduled, non-interactive observations. This will provide a critical proof-of-concept for both GBT and ALMA operations. The pilot program at the end of Q4 2004 is an important step towards this goal.

Data Handling Improvements Project

This project covers all aspects of observer-facing software encountered after an observation is successfully made, from data quality assessment and quick look capabilities through imaging. Work in the previous quarter focused on ramping up the development of IDL modules for reducing the data from the GBT's fundamental observing modes, and crystallizing short-term and long-term plans for single dish data reduction. The plans were presented at the GBT e2e Software Review on August 30. At that time, the panel approved the approach of using IDL development as a means of generating a draft GBT Science Data Model (SDM), as well as the long-term vision of Python-wrapped C and C++ components compatible with an Observatory-wide framework. Complete documents from the review are available on the GB Wiki at *http://wiki.gb.nrao.edu/bin/view/Software/.*

During Q4, significant momentum was generated towards these goals, as jointly developed at the August 30 Software Review. In October, the development team attended IDL training to expand their knowledge of the product. Design approaches which had been worked out in Q3 were tested against the new knowledge gained, after which the team prepared for the IDL Design Workshop on October 15 in Green Bank. Tom Bania (BU), Tim Robishaw (UC Berkeley), Ed Murphy (UVa), Tapasi Ghosh and Chris Salter (Arecibo) were the external consultants at this workshop.

Progress throughout Q4, after the workshop, included the following:

- After the workshop, the design and application architecture for the GBT IDL package was clarified;
- The foundational data input/output layer was developed and fully tested;
- A skeleton for the toolbox, which handles most astronomical functionality, was developed;
- A skeleton for an astronomically enhanced IDL plotter was developed;
- Data reduction recipes were developed for most GBT Standard Observing Modes, and cross-referenced to data reduction cases (see *http://wiki.gb.nrao.edu/bin/view/Data/IDLDocumentation*);
- Documentation for the project was written and centralized at *http://wiki.gb.nrao.edu/bin/view/Data*
- */IDLMain*;
- A draft user's guide was developed, which is being updated as the package evolves (see *http://wiki.gb.nrao.edu/bin/view/Data/GbtidlUsersGuide*);
- Drafts for a GBT Science Data Model were compiled, and a gap analysis was performed against SDrecord, SDFITS and Bania's data model;
- An email discussion forum for the development team and the external consultants was established;
- A unified project plan for SDFITS development, IDL development required for a production release, and flow-through into long-term data reduction work was completed and will be used to manage the production phase of the project in 2005;
- Most significantly, the package was made available to the Project Scientist for early beta testing in December.

Continued, intensive work is required in early 2005 to bring the IDL package into routine production use by visiting observers. This process is being done jointly by the development team, the Project Scientist, and the external consultants who attended the October workshop.

Baseline Investigations

The baseline investigation project has been closed out. A final report, in the form of an addendum to EDIR 312, documents the final state of system.

Penn Array Receiver

Trial detectors for the Penn Array Receiver were fabricated and tested at GSFC. While the noise performance was 25 percent over the maximum spec and the detector transition temperatures were high for reasons not currently understood, these detectors are suitable for the GBT engineering run scheduled for April/May 2005. Bismuth absorber coatings will be applied and tested in January. In spite of a global SQUID MUX shortage caused by a malfunctioning assembly line at NIST, Penn obtained the cold multiplexing components necessary to do multiplexing tests from the dewar and will proceed with these tests, also in January. More cold MUXes will be needed for the final 8x8 array. In response to difficulties

encountered with the cryogenic properties of the metglass originally intended to function as a magnetic shield for the optics tower, a new, solid-metal cryoperm shield was designed, manufactured by a third-party vendor, and delivered to Penn. Green Bank manufactured the RFI box that will house the warm electronics for the Penn Array in the GBT receiver room and delivered it to Penn.

Caltech Continuum Backend

Design work proceeded on the Caltech Continuum Backend. The daughter card schematic was finished, and about 90 percent of the layout was subsequently completed. As a result of the experience with the daughter card we identified a need for one of our senior engineers to learn the layout package, streamlining future development efforts, so he spent some time doing this. Design work on the masterboard schematic was started within the layout package. At Caltech the design for the FPGA state-machine program was completed, documented, and circulated. The real-time computer was assembled and the USB driver was written and tested on it. Towards the end of the quarter, after many weeks of negotiations with Xilinx, Caltech finally received the educationally-discounted development program needed to write and synthesize the FPGA program for the backend. Also towards the end of the quarter the project team conducted a careful review of tasks still to be completed, which resulted in an updated schedule and set of milestones for the completion of the hardware.

Ka-Band Receiver

The Ka-Band receiver was installed and commissioned on the GBT. The system temperature near the band center is ~40 K and baseline ripples on blank sky are minimal. Several open issues remain, but none that will prevent useful astronomy: in particular only two of the four spectral channels currently exist, and there is a spurious harmonic of the LO1 at 29.7 GHz. The receiver was announced on the 05A proposal cycle and observers will be scheduled in late winter and early spring 2005. Analysis software for use by the observers will be implemented in IDL during January and February of 2005.

Very Large Array and Very Long Baseline Array

Very Large Array (VLA) Highlights

The azimuth bearing on VLA antenna 16 was changed in October 2004. This marks the ninth bearing change that has been carried out on VLA antennas, including five since the summer of 2001. We anticipate changing three more azimuth bearings over the next two years.

The season for outdoor work on the VLA rail system came to an end during the fourth quarter. Despite the phase-out of temporary summer workers on the VLA rail crew, a total of 4400 rail ties were replaced during the calendar year. The rail system supported its 1900th antenna move, over the last 30 years, during the fourth quarter.

The 9-track tape system for VLA visibility data was turned off during the fourth quarter. This system has been used since the beginning of the VLA history, for all raw visibility data. The data now are sent directly to an on-line disk archive, with backup on DAT tapes.

Very Large Array and Very Long Baseline Array

Very Long Baseline Array (VLBA) Highlights

The 3mm (86 GHz) receiver was moved from the VLBA station at Hancock to the station at Brewster, after an improved subreflector had been installed at Brewster during the 3rd quarter. The measured aperture efficiency at Brewster is 20 percent, among the best of the eight VLBA antennas with 3mm systems. This compares to an efficiency below 5 percent when the receiver was at Hancock, apparently due to the errors in the setting of the primary antenna panels at that station.

Mark 5 recording systems now have been installed successfully at eight VLBA stations and the GBT, so that the VLBA is fully ready to support tracking of the Huygens Probe on its descent to Titan on January 14, 2005. After the Huygens Probe experiment, we intend to redeploy several of the Mark 5 units to the VLBA correlator or the VLA. We have delayed the full-time switch of several VLBA stations to Mark 5 recorders because there has been insufficient funding to buy enough disk media to support full-time operations.

The final report of the pilot project for spacecraft navigation with the VLBA was submitted at the beginning of December, and followed by a one-day future planning meeting at JPL. NASA/JPL personnel agreed that the program has shown that the VLBA can make a valuable contribution to angular tracking of interplanetary spacecraft. A management plan is under development for a transition to operational activities over the next two years.

Management and Scientific Milestones

Milestones	Original Date	Revised Date	Date Completed
VLA/VLBA General Proposal Deadline	10/01/04		10/01/04
Initial Version of Proposal Submission Tool	09/01/04	10/04/04	10/04/04
Global 3mm VLBI Session	10/13/04		10/13/04
Mark 5 Recorders Installed at Eight VLBA Stations	11/30/04		10/22/04
Pie Town 3mm Test After Re-setting Panels	05/31/04	10/31/04	12/01/04
New Mexico Symposium & Jansky Lecture	11/15/04	11/10/04	11/10/04
AIPS++ Stable Release 9	11/15/04		11/15/04
VLBI High Sensitivity Array—First Observations	11/01/04	12/15/04	11/22/04
Complete VLBA Pilot Program for S/C Navigation	01/30/04	11/15/04	12/02/04
AIPS Frozen Release of 31DEC04, Begin 31DEC05	12/31/04		12/15/04
Complete COSMOS Large Project on VLA	01/09/05		

Very Large Array and Very Long Baseline Array

Milestones	Original Date	Revised Date	Date Completed
VLBA Huygens Probe Tracking Experiment	01/14/05		
AIPS++ Stable Release 10	01/15/05		
VLA/VLBA General Proposal Deadline	02/01/05		
Mark 5 Redeployment after Huygens Experiment	02/15/05		
Move VLA control computers to new location	02/17/05		
Assess Proposal Evaluation Method for Hi-redshift	02/28/05		
Management Plan for Future S/C Navigation	02/28/05		
AIPS++ Stable Release 11	03/15/05		
VLA Public Tours	04/02/05		
Global 3mm VLBI Session	04/21/05		
AIPS++ Stable Release 12	05/15/05		
VLA/EVLA Transition Operations Plan, Version 1	05/27/05		
VLA/VLBA Proposal Deadline; VLA Large Proposals	06/01/05		
Three VLBA Stations to Mark 5 Full Time	12/15/04	06/30/05	
Trial proposal tool released for VLA and VLBA	05/01/05	09/01/05	
VLA/VLBA Proposal Deadline	10/01/05		
Full proposal tool release for VLA and VLBA	09/01/05	01/05/06	

Computer Infrastructure Milestones

Milestones	Original Date	Revised Date	Date Completed
Outfit 2nd EVLA antenna network	09/15/04	10/15/04	10/20/04
Expand archive to 17TB	10/30/04		10/30/04
Outfit 3rd EVLA antenna network	01/30/05		
Examine LDAP support *	08/31/04	01/31/05	
Examine Redhat Enterprise support **	12/31/04	01/31/05	
Examine OS/X support ***	09/30/04	02/28/05	
Migration to Windows 2K domain ****	07/31/04	03/31/05	
Replace approximately 80 older systems	07/31/05		
Expand archive to full capacity of 30TB from 17TB	08/31/05		

* In progress. Project was redefined and rescheduled by CCE

** Awaiting Redhat Licensing

*** In progress

****In progress, we're about 40 percent done

Very Large Array and Very Long Baseline Array

Operations Software Support Milestones

Milestones	Original Date	Revised Date	Date Completed
On-line VLA recording to DAT	02/01/04	10/30/04	12/01/04
Satellite tracking software mods	02/01/04	11/01/04	11/01/04
Track program modifications for Mark 5	10/30/03	02/01/05	
Correlator controller bug fixes	03/31/03	02/15/05	
Correlator controller transition plan	02/28/04	03/31/05	
Translate and copy stored VLA monitor data from 9-track to DAT	03/01/04	06/30/05	
Transcribe VLA observe/system files	11/30/02	01/01/06	

Electronics Milestones

Milestones	Original Date	Revised Date	Date Completed
Projects			
Ready for Production observation with Mark-5 units at KP, PT, LA, NL, MK, BR, OV, FD	10/22/04		10/22/04
Mark-5 AOC playback system #1 Operational	12/15/04		12/15/04
Support the Huygens Probe Observation	01/31/05		
Maser Maintenance			
Remove Maser #13 from OV and install #3	02/28/05		
Build an improved Maser transportation power supply	03/15/05		
Deliver Maser #1 to Sigma-Tau for repair evaluation	03/18/05		
Receivers (FE)			
Replace S-Band receiver at Ft. Davis and perform a RFI survey with the new receiver	11/19/04		12/10/04
Improvements			
Upgrade the TAC and Servo Boards at KP	03/18/05		
Upgrade the TAC and Servo Boards at SC	05/15/05		
Upgrade the TAC and Servo Boards at LA	10/15/05		

Engineering Services Milestones

Milestones	Original Date	Revised Date	Date Completed
Complete BnA array reconfiguration	01/21/05		
Complete B array reconfiguration	02/18/05		
Mechanical Group			
VLBA second drive wheel construction	06/30/04	09/30/04	11/11/04
Owens Valley maintenance visit	10/04/04	02/30/05	
Electrical Group			
Completion of tachometer board	09/30/04		12/20/04
Fiber to Cafeteria	12/31/04	05/31/05	
Site & Wye Group			
Complete track repairs between BN6-AN5	12/31/02	03/31/05*	
ES Engineering Group			
X-K Dichroic design	09/15/04		

*Delay due to equipment failures and other higher priority tasks. Track is usable.

Interferometry Software Division

AIPS

Key Developments

1. Methods were developed to allow for binary distribution of AIPS. This includes enhancing the script which runs each night to prepare for text updates and installations to force the update of the standard public versions of AIPS at the earliest possible moment and then to synchronize them with an area on the main ftp server. The AIPS installation script was revised to offer the option to replace the text installation and compilation with a remote synchronization with the special ftp disk area in Socorro. Similarly the update scripts which allow users to run the latest development version of AIPS was revised to replace the compilations with remote synchronization operations. This capability allows NRAO's users to run code compiled with better, but moderately expensive, compilers without having to buy the compilers. The systems supported are MacIntosh OS/X, Solaris Ultra, and Linux.

2. The main calibration task was provided with new, "robust" methods for gain solution. In these methods, data which deviate too far from the solution of the previous iteration are not used in the current iteration. This scheme converges rapidly to complex gains which are not affected by a few bad samples. The gain solution routines now return information that allows the bad data to be reported statistically and even to be flagged. The spectral bandpass calibration routine was

also provided with the full range of gain solution methods; previously it used only the most basic. This task also offers a new normalization mode of interest for VLBI.

3. All calibration application tasks were revised to control spectral smoothing more carefully. The new choice allows the user to smooth after application of the bandpass calibration; previously, only smoothing before the bandpass calibration was available.

4. Miscellaneous changes included changing contour/grey-scale display tasks to allow plotting of the beam with or without blanking of the normal plot. The precession routines used for old B1950 coordinates were found to be inaccurate and were replaced. Two new calibrator models (8.4 GHz, 3C286 and 3C48) were analyzed and released.

5. The roll-over to a new development release (31DEC05) with freezing of 31DEC04 was completed. A new issue of the AIPSLetter (Volume XIV, Number 2) describing developments in AIPS was published.

6. During 2004, 196 sites downloaded the 31DEC03 (frozen) version of AIPS and 808 downloaded the 31DEC04 (development) version. A total of 797 different sites (separate IP addresses) made some use of the AIPS cvs facility, either during installation of 31DEC04 or running the "midnight job" to update their copy of 31DEC04. Overall, 1276 different IP addresses appear in these three lists.

Goals for the First Quarter 2005

- Continue user support and bug fixes, as the major portion of AIPS effort.
- Develop more calibrator models for use in manual and eventually pipeline data reductions.
- Provide support for pipeline data reduction, especially new automatic editing algorithms.
- Begin investigations of new/improved imaging algorithms, including those dealing with spectral index and multiple pointings.
- Add to the task which computes the fluxes of the primary flux calibration sources new (2004) flux values and interpolation in time between the tabulated values.

AIPS++ (SSG)/ALMA CIPT Offline Subsystem

The key activities for this cycle were development for the SS9 release, the ALMA TST1.1 external user test, delivery of the Offline subsystem for the ALMA R2 release, and initial planning/scheduling and development for the integrated EVLA/ALMA offline reduction requirements.

- SS9 *http://projectoffice.aips2.nrao.edu/ss9.html*

- SS10 Activity: *http://almasw.hq.eso.org/almasw/bin/view/OFFLINE/CurrentActivity*

- ALMA TST1.1 - All needed information on testing goals, data sets, code installation, etc along with tester reports: *http://aips2.nrao.edu/projectoffice/*. The test was passed; final report due by February 1.

- EVLA planning

  Resources within the SSG were allocated to handle EVLA-specific development (Bhatnagar, Urvashi). Current and previous development was tagged with the appropriate EVLA Scientific software requirement. Initial planning with Butler, van Moorsel, Owen and Myers was done on the outstanding issues. *https://wiki.nrao.edu/bin/view/ISD/Planning2004*

- Offline Subsystem deliverables for ALMA R2:

  http://almasw.hq.eso.org/almasw/bin/view/OFFLINE/R2

  The ALMA All-hands meeting was also attended. Discussions were led on the ASDM and DataCapture. Slides and resultant actions/decisions are available at: *http://almasw.hq.eso.org/almasw/bin/view/HLA/AllHandsMeetingFall0*4

Highlights:

- ALMA TST1.1 passed (scientific analysis focus on mosaic data).
- DataCapture delivered for ALMA R2.
- Prototype Filler (converts ALMA Science Data Model to AIPS++ MS) developed for ALMA
- Use of ATM library for atmospheric calibration within system.
- Calibration interpolation facilities expanded within the library.
- Improved data selection for flagging.
- Simplified code distribution through relocatable rpms.
- A namespace for the CASA library was implemented to avoid name conflicts when interacting with external code.
- Initial development of a prototype replacement for the glish-based msplot tool.
- Implementation of the NAUG-approved MS-selection rules (to be completed next cycle).
- Regression testing of end-to-end scientific processing on series of datasets was established (currently 8 datasets from the VLA, PdBI or BIMA): *https://wiki.nrao.edu/bin/view/ISD/RegressionTests*

Very Large Array and Very Long Baseline Array

Goals for the First Quarter 2005

1. Preparation for the third ALMA external science test (ALMA TST2.0); scientific analysis focus on single dish/synthesis data combination.
2. Preparation for the first EVLA science test (EVLA TST1.0); scientific analysis focus on wide field imaging case.
3. Final implementation of ALMA Science Data Model (this incorporates support for EVLA and will be a shared SDM).
4. Implementation of the DataCapture Process V2.0 (all ASDM data supported).
5. Implememtation of the Filler process V1.0 (from the ALMA archive and from disk).
6. Modification of the ASDM based on HLA refinements; adoption of UML framework for continued development.
7. Three-year integrated planning for ALMA and EVLA (development, resources).
8. SS11 Development cycle
9. Simulation facilities for ALMA.

Archive

The NRAO Data Archive has been operational since October 15, 2003 and allows everyone on-line access to all VLA data and some VLBA data (*http://archive.nrao.edu/archive*). To date, over 640 users from 240 institutions have downloaded over 1.4 Tbyte of telescope data. The download data rate is about 100 Gbytes per month. Data files over one year old are in the public domain and accounted for one-half of the download volume. The data files reside on a hard disk array and provide the archive users with fast access and downloads via FTP and HTTP.

Currently the archive contains all VLA data going back to 1976, raw VLBA data going back to June 2002, and some calibrated VLBA data going back to December 2002. Efforts to expand the VLBA archive back to 1992 are underway. There is a small amount of GBT data available now from 2002 and 2003.

We are in the process of constructing and loading an archive mirror-site at the National Center for Supercomputing Applications (NCSA). Thus far 2.2 Tbytes of VLA archival data have been transported to NCSA. Our goal is to completely mirror the Socorro-AOC archive on a hard disk array at the NCSA by the end of the first quarter of 2005. We also intend to support user downloads from the NCSA mirror. This will take advantage of the NCSA high internet bandwidth, and substantially increase the download data rates available to our users.

Proposal Tool

During the fourth quarter of 2004 the group of proposal tool testers was expanded to include Green Bank staff. Although this new tool eventually will serve all NRAO telescopes, our first target is to

develop a replacement for the current GBT proposal tool. We expect adding support for other instruments at a later time to be relatively straightforward.

There were a number of new releases, each of which was tested by a team of GBT astronomers who provided valuable feedback. Since it took longer than expected to agree on the instrument-dependent resource page in the proposal tool, we had to drop our plan to have the software ready for the February 1, 2005 deadline.

In a parallel effort, an NRAO-wide user database is being developed. It will be fully integrated with the new proposal tool, and at a later stage with other NRAO software as well, e.g. a new archive tool. Testing of this user database at the AOC started December, 2004.

Virtual Observatory

NRAO participates in the U.S. National Virtual Observatory (NVO) as a partner in developing the U.S.-NVO and International Virtual Observatory Alliance (IVOA) infrastructure and standards, and as a data provider, interfacing radio astronomy data and other resources to the VO. Most current work is concerned with participation in general VO infrastructure development, and development of a data management and dataflow capability at NRAO to support publishing of data to the VO as the new telescopes come online.

Key Developments

D. Tody chaired the VO Data Access Layer (DAL) working group at the IVOA fall workshop and the VO small-projects meeting, Pune, India from September 23 – October 3. This meeting focused on data models and data representation for image and spectral access, and on interface functionality including support for the astronomical data query language (ADQL) and Grid protocols for asynchronous services and authentication.

NRAO sponsored the fall NVO team meeting held at the AOC in Socorro November 17-18.

The SSA data model was advanced to V0.9 at the end of November. An updated draft of the SSA interface document is in preparation. The JHU spectral service can now return data conformant to the SSA V0.9 data model.

In coordination with EU-OPTICON and ESO, a birds-of-a-feather (BOF) session was held at the fall ADASS conference (Oct 25) to discuss requirements and plans for future astronomical software environments. This included side meetings with STScI, ESO (SAMPO), Euro-VO, NOAO, and others to discuss plans for a Python-based CLI, scalable framework, and for integration of general data processing and analysis software with VO.

Very Large Array and Very Long Baseline Array

The first face-to-face meeting of the OPTICON working group on future astronomical software environments was held at ESO December 2-3. A whitepaper prepared by D. Tody for this meeting presented the scope of the project and proposed a scalable component-framework architecture for the software, including a strategy for how to integrate with VO/Grid. This architecture was endorsed by the OPTICON group as a starting point for a more detailed design. Broader review is planned before proceeding with more detailed design. This project is important to link the science software efforts at NRAO with what is happening in the broader astronomical community, and to link general astronomical data processing and analysis with VO.

A whitepaper on the component-container architecture including the task and parameter model was prepared to help guide track 1 SSG/ACS framework development. This work is being coordinated with higher level standardization and design efforts we are carrying out via OPTICON and VO.

J. Ulvestad prepared a proposal for a VLA archive imaging pilot project which was submitted to the NSF (December 9). This would produce images for continuum data for the VLA B configuration at 5 and 8.4 GHz, using data from a single semester (late 1999 to early 2000, consisting of about 300 separate observing programs). The resultant images would be published to the VO. If successful, a more ambitious effort to data mine the VLA archive would be possible. At this point, this is just a proposal and additional resources are needed to proceed with the project.

Near-Term Plans

Finish the V0.9 (development) SSA interface specification. Advance SIA to V1.1 by the time of the spring IVOA workshop in Kyoto. The framework and future astronomical software topic will be discussed at the IVOA executive committee meeting at SDSC in January (the NVO Advisory Committee meets later that same week). Finalize (with OPTICON and VO) the high-level architecture for the data analysis framework so that more detailed design and prototyping can go forward around February. Detail the parameter mechanism and container so that initial prototyping can go forward.

E2E Coordination

E2E is an observatory-wide effort to develop a modern end-to-end dataflow system for all NRAO telescopes. This is primarily a coordination activity, with most development taking place within the telescope construction projects. The goal is for all science user interfaces, e.g., for proposal submission, archive data access, and post-processing, to be common or at least similar for all telescopes. Development should be coordinated where possible to provide a more coherent data system while minimizing costs.

Very Large Array and Very Long Baseline Array

Key Developments

A first cut at a strategy for coordinating development of ALMA and EVLA has been produced. A joint EVLA/E2E working group has been formed which will detail the E2E aspects of EVLA starting in January 2005.

A preliminary assessment of EVLA requirements for post-processing (mainly algorithmic) has been performed. SSG is now co-developing software for both ALMA and EVLA.

The E2E perspective on EVLA was presented to the EVLA Advisory Committee in mid-December.

An analysis of the ALMA science data model (SDM) has been performed (J. Benson, E. Fomalont) to determine its applicability to EVLA and VLBA. This was discussed at the ALMA all-hands meeting (December 7-10) and it was agreed to co-develop an interferometric SDM.

A group at GBT is working on a single-dish SDM. Currently this is only loosely coordinated with ALMA single-dish SDM development; we will need to bring them back together in several months after both groups have made further progress.

E2E (D. Tody) participated in a review of the ALMA archive and the NGAS storage subsystem held at ESO December 10. ESO has agreed to open-source the NGAS storage subsystem, which means that should we choose to do so we can use this as common software for both NRAO and ALMA.

The NRAO user database (drafted by B. Butler) has been adopted by ALMA and ESO as a starting point for their user database and authentication mechanism.

Near-Term Plans

Produce a final report on the E2E review of the EVLA held last fall. Go forward beginning in January with development of a coordinated plan for EVLA E2E development. Work with ALMA to fold the results of this study back into the ALMA high level architecture and development plan. A second review of the GBT software is planned for spring 2005.

Central Development Laboratory

Central Development Laboratory Highlights

The combination of a low-noise and a high-power amplifier for 1.2-2.0 GHz has provided a high dynamic range receiver configuration for the new EVLA L-band system. A draft agreement with JPL to gain access to Cryo-3 transistors is under review.

Enough 211-275 GHz mixer-preamps have been shown to meet specifications so that the first four ALMA Band 6 cartridges can be built. Development of efficient production procedures is receiving intense effort.

The first ALMA front end cryostat was successfully operated at the NTC. Design work on the chassis and other subsystem components is very active.

The performance on the new L-band feed for the EVLA is now understood from the theoretical perspective.

Nearly half of the first quadrant of the ALMA correlator has been checked out.

ALMA first local oscillators were delivered for Bands 3, 6, and 7. The LO for Band 9 meets specification over 80 percent of the required frequency range and development continues.

Regular observations of the sun at 20-70 MHz continue with the Green Bank Solar Radio Burst Spectrometer, and work is proceeding on extending the frequency range.

Major Developments

Milestone	Original Date	Revised Date	Date Completed
Amplifier Design & Development:			
Evaluation of TRW Cryo-3 devices from the point of noise, signal and dc properties at cryogenic temperatures	04-01-04	ongoing	
Design/redesign of cryogenic amplifiers using Cryo-3 TRW devices for EVLA, VLBA, GBT and ALMA covering frequency range from 1 to 120 GHz	04-01-04	4-01-05	
Superconducting Millimeter-Wave Mixer Development:			
Test Band 6 cartridge with production LO and bias supply	07-30-04	02-28-05	

Central Development Laboratory

Milestone	Original Date	Revised Date	Date Completed
Electromagnetic Support:			
Design of EVLA Ku-Band feed	09-30-04	03-31-05	
EVLA L-Band analysis	11-12-04		12-31-04
EVLA C-Band analysis	03-31-05		
EVLA S-Band analysis	03-31-05		
Testing EVLA X-Band prototype feed horn	12-31-04	03-31-05	
ALMA Correlator:			
Complete VLBA data recording project	12-31-02	12-31-04	12-31-04
Support system testing at the AOC as far as the correlator is concerned	03-31-04	ongoing	
Continue to receive and test production circuit cards	09-30-04	ongoing	
Populate and start testing at least 1/2 of the production racks for the first quadrant of the ALMA correlator	12-31-04		12-15-04
Start testing cable interfaces in the first correlator quadrant	12-31-04		11-17-04
Finish motherboard PCB layout of a modified SCC test fixture	12-31-04	05-01-05	
Populate and test at least 2 more first quadrant racks of the ALMA correlator	03-31-05		
Revise station card FPGA personalities to support the new TFB card	03-31-05		
Start testing of the first production TFB card in the first quadrant	03-31-05		
Complete final adder PCB layout	03-31-05		
Install final clock distribution cards in the first quadrant of the ALMA correlator	03-31-05		
ALMA Frequency Multipliers:			
Complete Band 6 frequency tripler evaluation set with actual driver amplifiers	12-15-03	10-15-04	10-15-04
Band 6:			
First batch of 13 units delivered to NRAO (Subsequently, 13 units every 15 days until all of the 139 units are delivered)	07-31-04		11-05-04
Band 7:			
First batch of 13 units delivered to NRAO (Subsequently, 13 units every 15 days until all of the 139 units are delivered)	07-31-04	ongoing	137 delivered by 12/10/04 (2 pending)

Central Development Laboratory

Milestone	Original Date	Revised Date	Date Completed
Band 9:			
Prototyping complete. 3 units available for evaluation	09-15-04	03-01-05	
GB/SRBS Phase II:			
70-300 MHz, dual polarization, log-periodic on 45-foot telescope, new analog spectrometer	03-31-05		
300-1050 MHz, dual polarization, 45-foot telescope with log-periodic feed, new analog spectrometer	02-28-05		
GB/SRBS Phase III:			
10-80 MHz, dual polarization, four crossed dipoles, new digital spectrometer	09-30-05		
80-300 MHz, dual polarization, log-periodic on 45-foot telescope, new digital spectrometer	09-30-05		
300-2500 MHz, dual polarization, 45-foot telescope with log-periodic feed, new digital spectrometer	09-30-05		

Amplifier Design and Development

Work continued on the development of amplifiers using devices from JPL/TRW Cryo-3 wafers. The electrical/mechanical design of a balanced 2-4 GHz amplifier was completed last quarter, and a prototype is being fabricated. The design of a 4-8 GHz amplifier using NGST Cryo-3 devices is in progress.

Five 1-2 GHz amplifiers, delivered to the Array Operation Center (AOC) last quarter for the EVLA Project, have been evaluated; results show excellent sensitivity, high dynamic range and good return loss.

Amplifier Production

A total of 21 amplifiers were either produced or reworked during the quarter. This included late prototype stage production of four L-Band amplifiers for the EVLA. These amplifiers allow for a new receiver design philosophy, with low-noise amplification and high dynamic range cryogenic amplifiers packaged separately, to provide flexibility in dealing with a worsening RFI environment. Other new production included four 3-13 GHz and two 8-18 GHz LNAs. Six Ka-Band amplifiers were completed and four W-Band LNAs were reworked to achieve closer phase matching for the new GBT 90 GHz receiver.

Other Projects

The Chemistry Lab continued to meet all requested plating needs of the CDL, ALMA, Green Bank, and Socorro. The electroforming process has remained problematic but a final attempt at reclaiming the failed copper bath is in progress. Hopefully, this will eliminate the need to dispose of and replace the largest process bath in the lab. During the quarter, a non-documented "feature" of the electroless nickel process was recognized and corrected, allowing for improved gold-nickel plating of small aluminum components.

Superconducting Millimeter-Wave Mixer Development

ALMA Receiver Development

Project re-costing consumed a major part of the effort in the latter half of the quarter.

Band 6 mixer-preamps: During this quarter, we have tested 19 mixer-preamps, mostly by way of evaluating SIS wafers received from UVA. We now have four mixer-preamps ready for installation in cartridges—that is, in addition to the mixer-preamps in cartridge #1 and the prototype cartridge.

An outside machine shop has delivered 20 mixer blocks after some rework. The first of these has been tested as a mixer and excellent RF performance was obtained.

Band 6 wafer evaluation: The early Band 6 budget included a wafer evaluation task, but that was deleted by management during one of the early cost-reduction exercises. Wafer evaluation must therefore be done using the mixer-preamp test system. For evaluation, each of the nine deliverable wafers requires at least eight mixers to be tested, a total of at least 72 mixer tests. This must be done before the end of the wafer fabrication contract in June 2005. The resulting burden on the test set greatly reduces the number of usable mixer-preamps we can produce.

To alleviate this bottleneck, we are preparing a proposal to re-commission the old CDL mixer test system which has a J-T refrigerator. Some of the equipment from the older system has been built into ALMA test sets and will have to be replaced.

4-12 GHz preamplifier production: The formal agreement between NRAO and JPL for access to HFETs from the Cryo-3 wafer has still not been finalized, although a draft agreement is under review. This means that only small sample quantities of devices can be delivered to NRAO for preamp construction. This is very inefficient because there is no control in the selection of devices, which makes it difficult to obtain the matched preamp pairs required for the Band 6 cartridges. There is always encouraging feedback from the parties at JPL who control the devices, but finalization of the agreement remains stalled.

Upon performing the re-costing, the unit cost for commercial assembly and room temperature testing of preamps at ACC increased from $442.00 to $975.00 (for quantity 250). This cost increase was a result of the stringent assembly and test procedures required. The costs for commercial and in-house assembly are now within 5 percent.

ACC is several weeks late in delivering their first batch of 24 amplifiers; to date they have delivered 9 units, and are having some difficulty bonding to the transistors. We plan to send one of our skilled technicians to ACC to help them with the remaining 13 units.

The cryogenic amplifier production test system is almost complete. All the hardware is finished, but the software and data-taking routines still need development and refinement.

Ortho-mode transducers: The Tucson engineer responsible for the ALMA Band 3 and Band 6 OMTs is leaving the NRAO. As a result, this work has been transferred to the NTC. The equipment associated with this task has been transferred to Charlottesville and is being set up. OMT fabrication and testing will commence in the next quarter.

Band 6 cartridge: The manually-operated beam pattern measurement system shows a -15 dB sidelobe. Much of the quarter was spent investigating the source of this sidelobe, and recent measurements suggest it is connected with reflections at the vacuum window. Experiments are continuing with tilted windows in an effort to reduce these effects.

The second cartridge body has been received from Rutherford Appleton Laboratories (RAL). Modifications to the 300 K and 4 K plates are underway.

Vacuum windows for the WR-10 LO waveguide have taken some effort. These tuned windows use two epoxy vacuum barriers 125-microns thick, but difficulties with the epoxy-metal bond have resulted in several vacuum failures. We believe this is due to inconsistent surface preparation. A new version with an anodized aluminum surface is being evaluated and appears to be more reliable.

Software: Software for mixer testing, preamp testing and cartridge testing continues to be enhanced and maintained. Modifications are under way to reduce testing times.

Non-ALMA Millimeter-Wave Development

350-μm Receiver Technology Development: A proposal to develop the technology for a heterodyne receiver in this band has been submitted to the Director. There are two important reasons for undertaking this work: (i) success in this work will put NRAO in a strong position to bid on the ALMA Band 10 receiver production; and (ii) this project will provide bridging funds to keep millimeter-wave receiver development alive at NRAO and UVA between the end of the ALMA development phase and the beginning of its operation phase in about three years when funds are expected to be available to support further receiver development.

385-500 GHz SIS mixer: This is a joint R&D project between NRAO and UVA, and is supported mainly by UVA through an NSF grant. We completed the design of the 385-500 GHz mixer circuit design this quarter. In addition to the mixer design described in the last quarterly report, which uses the microstrip self-inductance of the array as the main tuning element, a new two-junction tuning configuration has also been developed. Mask layout is currently being done at UVA, and mixer block design will begin in the next quarter.

Miscellaneous: We repaired an SIS mixer for the University of Arizona. This was one of our older mixers from the 12 Meter Telescope which is now operated by the University of Arizona.

Investigation of Beamlead HEB Mixers for Heterodyne THz Biohazard Detection:

This is a SGER (Small Grant for Exploratory Research) awarded by the NSF under the ACT (Approaches to Combat Terrorism) program. This was a one-year program (officially ended in September 2004) to build, measure, and compare different types of beamlead HEB mixers in a 600-720 GHz receiver using existing NRAO equipment.

The Nb diffusion-cooled HEB mixer was not superconducting, and the problem was traced to the wax used to hold the HEB in place while processing the backside. A Ge passivation layer has been added to protect the Nb device. This device will be tested shortly. Also, the NbN phonon-cooled HEB mixer will be tested with improved optics.

ALMA Front End Integration and Test

A draft procedure for assembling and testing the ALMA front end assemblies was written and used to complete the front end schedule. We are now able to see the critical path items, which are the chassis and front end support system design and evaluation. Additional effort will be channeled into these areas.

The first production cryostat from RAL was received at the NTC and successfully operated. It has been accepted.

The first production-configuration DC bias supplies were manufactured and delivered to the four cartridge manufacturers. A design for routing the large number of IF cables from the cartridges to the IF switch was completed. The first prototype IF switches were received from a commercial source. The power supply and distribution system design was completed.

With the completion of a draft test plan, it became possible to design the special test equipment needed for verifying performance of the front ends. Major parts of the test system design were completed, and parts were ordered for the signal processing subsystem.

Central Development Laboratory

Electromagnetic Support

EVLA

Using the measured far-field patterns of the L-Band feed, efficiency and spillover were computed for the VLA antenna. The aperture of the feed is 29 inches above the secondary focus plane when installed on the antenna. Far-field amplitude and phase patterns of the feed were measured with the center of rotation of the azimuth table 84 inches behind the aperture of the feed. This places the reference point of the measured patterns at a point 55 inches below the secondary focus. The subreflector surface was defined with respect to this point and used in a physical optics program to calculate the antenna beam patterns and efficiency. The aperture efficiency is 0.43 and 0.41 at 1.4 GHz and 2.0 GHz, respectively. The subreflector was then repositioned to correct for phase errors which gave calculated efficiencies of 0.45 and 0.54 at the two frequencies. The measured efficiency on the antenna is 0.43 at 1.425 GHz and 0.54 at 1.975 GHz.

ALMA

Far-field patterns, as well as patterns incident on the subreflector, were calculated for the Band 6 cartridge at 245 GHz. Feed patterns were computed using a mode-matching program, and a program based on physical optics was used for calculating the scattered fields of the two mirrors in the cartridge. Patterns were also calculated at a distance of 50 cm above the dewar window. The first sidelobe level is calculated to be below -35 dB in all the cases, in disagreement with the observed -15 dB sidelobe.

Spectrometers/Correlators

ALMA Correlator

During the last quarter, construction and testing of the first quadrant of the ALMA correlator continued. One-half of the system (two correlator and two station racks) is now assembled. A full complement of production printed circuit cards has been installed into three of the four completed racks and all motherboard data paths successfully tested in these racks. One station rack is still only partially populated with cards.

System communication using the CAN bus was extensively tested in the partially assembled first quadrant with encouraging but not quite final results. Long error-free data transfers with a configuration similar to the final configuration were demonstrated but better testing software needs to be provided before final acceptance can be concluded.

Some 376 assembled production circuit cards of various types for the ALMA correlator were received and successfully tested during the quarter.

A DTS receiver simulator card to be installed into a DTS receiver slot on the station motherboard was designed and PCB layout completed during the quarter. The PCB layout was sent out for manufacturing. This card will allow testing of the prototype TFB card starting in January 2005.

A new design for the final adder PCB for the ALMA correlator was completed and submitted for PCB layout.

PCB layout of the data port interface card was completed and a purchase order submitted.

PCB layout of the ALMA correlator clock distribution system was begun.

GBT Spectrometer

Minor support for the GBT spectrometer and the pulsar spigot card was provided as needed.

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 currently being developed and evaluated. The status of the cooled frequency multipliers for the various ALMA frequency bands in the baseline plan is described, followed by an outline of other frequency multiplier development efforts.

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

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

Band 6 and Band 7: As reported earlier, Virginia Diodes Inc. (VDI) had been awarded the contract to supply the frequency triplers to meet the full ALMA first LO requirement (all 64 antennae, plus 10 percent spare units). Progress was close to the mutually-agreed schedule that called for the order to be completed by the end of December 2004.

All of the 139 units ordered for Band 6 have been completed, tested and delivered by VDI. These have been accepted based on cryogenic testing of randomly selected units (2 units were evaluated per batch of about 13 units) at the NTC. The plot in Figure 1 shows the measured output power (with 20 mW input drive power) of 18 units at 80 K.

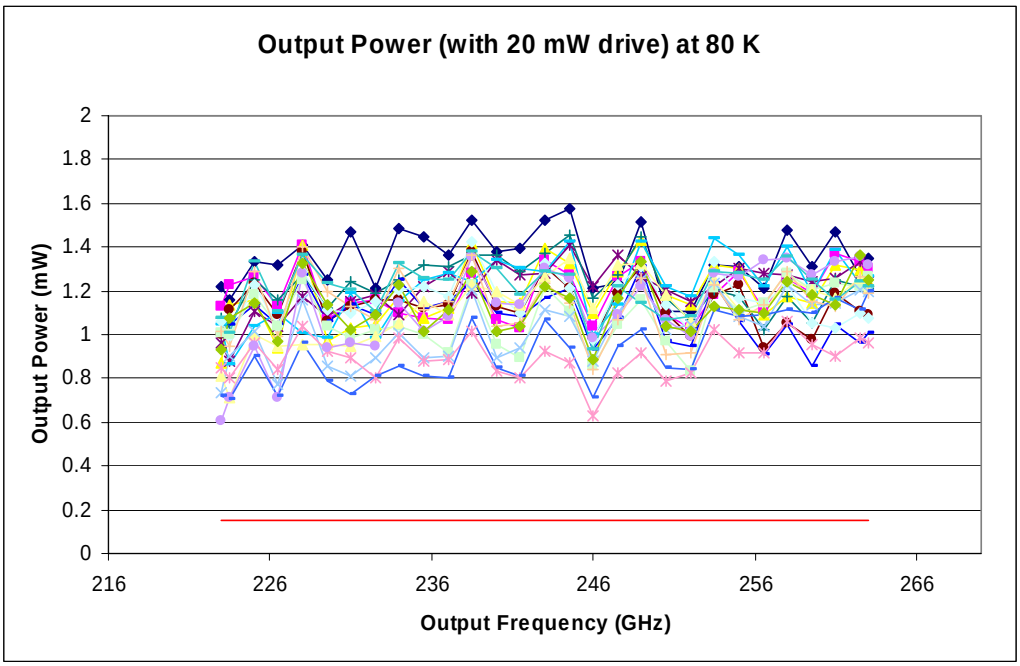

Figure 1. Measured output power of 18 Band 6 frequency tripler units at 80 K. The red line at the bottom is the ALMA specification of 150 μW first LO power for Band 6.

For Band 7, all but two units have been completed, tested and delivered by VDI. Cryogenic evaluation of sample units prior to the acceptance of the above units is in progress at the NTC.

Band 9: As described in earlier reports, the Band 9 frequency quintupler development contract with VDI was modified to support the development of an integrated version of the frequency doubler-tripler cascade and the supply of three such units for use in the Band 9 LO instead. This was done after a cascade of frequency doubler followed by a frequency tripler driven by a Band 7 LO driver was evaluated at the NTC and yielded encouraging results as described in ALMA EDM document number FEND-40-10.00.00-027-A-REP.

Subsequently, three versions of the integrated Band 9 frequency sextuplers were supplied by VDI and evaluated at cryogenic temperatures at the NTC. While each of the units produced the desired output power over portions of the desired frequency band, none of them met the overall specifications since there were dropouts in output power at certain frequencies in the specified LO band. See ALMA EDM document number FEND-40-10.00.00-046-A-MIN for further details regarding the performances of the three design versions and the proposal under consideration for further development work to produce a frequency sextupler that meets the specifications for the ALMA Band 9 LO by March 2005.

Central Development Laboratory

ALMA LO Source

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

The second Band 3 WCA is assembled but on hold pending a decision on whether or not dual-channel control is needed. The second Band 6 LO has been delivered. All parts are on hand to build and test the third Band 6 LO.

Measurements are ongoing at IRAM using the first delivered Band 7 LO. So far, it appears to meet all specifications. The second Band 7 LO has been assembled and partially tested. Completion and delivery are on hold pending approval of documentation. Power amplifiers for units 3-5 have also been built and tested.

A third iteration of the Band 9 power amplifier block was built and tested. This design power combines chips of twice the gate periphery of the last design, so that the total gate periphery per channel is 1.2 mm. This 0.1μm InP technology is capable of 100 mW output power per 1mm of gate periphery. However, this particular MMIC design is only producing half that amount over most of the band, resulting in about 60 mW expected output power per channel. A new MMIC design is being fabricated which is expected to increase this. Using the current MMIC design and after correcting for a flaw in the block design with a dielectric slab inserted in the waveguide, 50 mW was achieved over 75 percent of the band with more than 40 mW everywhere else. New blocks are being machined with this block error fixed so that no dielectric compensation is required. It is expected that the new blocks will produce greater than 50 mW over the entire band.

New iterations of MMIC mixers for the Band 6, 7, and 9 AMCs were received and tested. They meet specifications and eliminate the need for preamps before the mixer or costly commercially-supplied diode hybrid mixers. New designs of the AMC bandpass filters were received and tested. They meet specifications as well.

Detailed micro-assembly procedures have been written for the AMC and power amplifier assemblies. These procedures were used to solicit bids for outside assembly of these critical blocks. Two bids were received and both subcontractors will be awarded work for evaluation.

The Interface Control Document (ICD) for the mechanical interface between the warm cartridge assemblies and the 300 K cartridge base plate was written, officially reviewed, and revised. This is a critical interface involving the blind mate connection of the LO waveguides, the IF output of the cold cartridge, and the mixer control circuitry.

A post-doc from the ASIAA Institute in Taiwan will be coming in the next quarter for a nine-month appointment to work on developing MMIC HBT VCOs for use in the ALMA LOs. This work has the potential to eliminate much of the expense, volume, and heat load burden caused by the use of commercial YIG-tuned oscillators.

Green Bank Solar Radio Burst Spectrometer (GB/SRBS)

In June 2003, the NRAO received an NSF MRI grant to develop a high-performance instrument to receive solar radio emissions with adequate temporal and spectral resolution to probe a wide variety of active solar phenomena from the base of the corona, including energy released from flares, particle acceleration, and escape, coronal shocks, and electron beams. The instrument consists of two radio spectrometers that will together provide frequency coverage from 10-2500 MHz. This instrument provides a basic research tool in solar radiophysics for use by the wider community, remedies the lack of an important component of the U. S. Space Weather effort, and provides a platform for research and development work on broadband antennas, feeds, and receivers needed for the upcoming Frequency Agile Solar Radiotelescope (FASR) project. A significant portion of the development work will be performed at the NRAO Technology Center (NTC) in Charlottesville. Solar activity continues to be monitored over the 20-70 MHz band by GB/SRBS Phase I with excellent reliability.

Work continues on the upgrade to extend the frequency coverage but there have been delays. Antenna and feed fabrication were delayed due to project priorities and completion is now expected in early 2005. A prototype of the dual-polarization low-noise amplifier was designed and evaluated. A suitable front-end box for mounting the receiver on the 45-foot radio telescope has been refurbished. A reliability issue with the ETH spectrometer has forced the rapid development of a new interim spectrometer based on the 20-70 MHz design. This new spectrometer covers 70-1050 MHz (dual-polarization) with a frequency resolution of 300 kHz and time resolution of 1 second. It was developed within two months and is currently ready for use on the 45-foot radio telescope. Real-time data access will be implemented shortly.

The prototype version of a 30-350 MHz RF board for use with the new digital spectrometer has been designed and the circuit board fabricated. Initial evaluation is scheduled for early January 2005.

Computing and Information Services

Computing and Information Services (CIS) Highlights

The primary goal for the NRAO Windows system administrators this quarter was the completion of the migration from the older NT 4.0 domain to Active Directory (AD). This task has been completed in Charlottesville, Green Bank, and Tucson with little impact on user productivity; this task will be complete in Socorro by the end of first quarter 2005.

Good progress was made during this quarter in testing installation of Red Hat Enterprise Linux (RHEL) on multiple hardware platforms, evaluating problems in a mass migration from Red Hat 9 to RHEL, and in finalizing a contract with Red Hat for a "campus" educational license.

The existing network of the Observatory's web proxy servers has been retrofitted to enable authentication when they are accessed from outside the NRAO. This, combined with webmail and the VPN, addresses the needs of the vast majority of our users when they are travelling or otherwise outside the Observatory's facilities.

The deployment of a commercial malware ("spyware") blocker was completed this quarter for all Windows systems.

The Beowulf Linux cluster for pulsar data processing has been delivered, installed, and made operational in Charlottesville.

The major communications effort this past quarter has been the cabling of the Edgemont Road addition for networking and telephony. The first phase of this effort, to wire the newly constructed areas, is complete.

Central Computing Services

Milestone	Original Deadline	Revised Deadline	Date Completed
Use encrypted IMAP/POP3 only from Internet	10/04/04	10/04/04	10/04/04
Resolve remaining AD errors	10/31/04		11/30/04
Update Computing Security Policy	02/05/01	11/30/04	12/08/04
Acquire RedHat Enterprise Linux campus license	11/30/04	01/31/05	
Test authentication of VPN concentrators from AD	11/30/04		11/30/04

Computing and Information Services

Milestone	Original Deadline	Revised Deadline	Date Completed
Use LDAP for Linux authentication	11/30/04		
Personal firewall on all Windows systems	05/31/04	12/31/04	12/31/04
Deploy "spyware" blocker on all Windows systems	12/31/04		12/31/04
CCE: End AD production client migration	12/31/04	03/31/05	

Security

The deployment of a commercial malware ("spyware") blocker was complete this quarter with the publication of the system to all Windows systems. It is hoped this, combined with a focus on user education for safe web browsing habits, will significantly reduce incidence of system infection in the future.

The planned change of NRAO's routers to block all outside access to unencrypted POP3 and IMAP mail protocols on our servers went ahead without incident. The only remaining commonly used unencrypted protocol that requires password authentication and is still accessible from the internet at large is that of non-anonymous ftp. Even this service has been discontinued at two major sites (Charlottesville and Green Bank) due to the availability of alternative solutions such as Secure FTP (sftp, part of the Secure Shell suite) and use of personal web areas to allow others to "pull" large files.

Changes to the NRAO Computing Security Policy in connection with web issues were approved by the NRAO Computing Security Committee (NRAOCSC) in this quarter. However, additional changes to cover new technology such as wireless, VPN (virtual private networking), and instant messaging, are also needed and a new target date has been set for such changes.

There was one computing/network security incident that occurred during the quarter. A web site outside of NRAO was discovered to contain a file that included two privileged passwords (root and another for Green Bank Monitor & Control) in clear text, albeit not identified as such. The web site (sourceforge.net) was being used by NRAO personnel for code and software configuration management. Within minutes of discovering this exposure, key members of the NRAO Computer Security Committee were notified, and all root passwords on the relevant internal machines were changed. The password for the Monitor & Control account was also changed. There were no unauthorized access attempts from the outside in the consolidated ("loghost") system logs. This "leakage", while accidental and inadvertent, was still potentially very dangerous. Action has been taken to ensure that it does not recur.

Computing and Information Services

Common Computing Environment (CCE)

Good progress was made during the quarter both in testing installation of Red Hat Enterprise Linux (RHEL) on several hardware platforms, evaluating problems in a mass migration from Red Hat 9 to RHEL, and finalizing a contract with Red Hat for a "campus" educational license. It is hoped that the contract can be concluded in the coming quarter.

While much progress was made during the quarter on testing the OpenLDAP server in its context as a NIS (Network Information System) replacement, the deployment of OpenLDAP servers for auth-entication has been deferred substantially, following lengthy discussion and pending resolution of some technical issues. While we still hope to migrate our existing NIS framework to an LDAP one, the timescale for such a migration has been pushed out to at least mid-2005, possibly later. A "make or break" decision on whether to use LDAP for such authentication should be made sometime in the coming two quarters.

On a related front, the existing network of web proxy servers at NRAO has been retrofitted to enable authentication when they are accessed from outside NRAO's networks. This, combined with webmail and the VPN, addresses the needs of the vast majority of our users when they are on travel and wish to access NRAO's network from afar.

As reported last quarter, the main goal for NRAO Windows system administrators this quarter was to complete the migration from the older NT 4.0 domain to Active Directory (AD). This task has been completed in Charlottesville, Green Bank, and Tucson with little disruption to user productivity. Socorro is working very hard at migrating their existing machines, but the number of machines that must be upgraded (~300), and allocating time for each of the migrated users to get them up to speed on the new operating system, has taken longer than expected. At this time, about one third of the machines at the AOC and VLA have been migrated into the new domain. We are hoping this migration will be completed by the end of first quarter 2005.

Significant effort was put into solving issues in the AD domain as a result of the Server 2000 to Server 2003 migration. While some of the issues seemed minor at first, they were causing errors that were causing confusion and perhaps serious problems down the road. Some of these problems involved unreliable replication between domain controllers, and frequent errors in the system logs. The domain controllers at all of the NRAO sites are now replicating correctly and reliably. There was also a problem of mismatched group policy templates (GPO) between the domain controllers as a result of the upgrade which has also been rectified.

The sites are getting ready to start using one of the great benefits of XP-based computers, known as remote assistance. Remote assistance allows XP users to send requests for assistance to other Windows XP system users. The system asking for assistance is known as the "Novice", while the system giving support is known as the "Expert". Once the "Expert" has accepted the invitation and connects to the "Novice" system, they can see the desktop of the "Novice" and even take control of the remote system if

necessary. NRAO plans on using Remote Assistance not only for administrative support, but also in allowing expert users of applications such as AutoCAD to assist coworkers across the NRAO sites.

As always, security is a main concern of the Windows administrative staff. We have been very diligent in testing and applying the latest Windows service packs to all of the Windows machines on the NRAO networks. To further increase the security of the Windows domain, the Windows administrators decided to cease using the Default Administrator account to do administrative tasks and move to individual administrative accounts. Using the Domain Administrator account is equivalent to using the "root" account on a Unix based machine. If many people use the same administrative account it is very difficult to track who is making what changes. All administrators now use separate accounts which makes tracking changes much more accurate.

Since the NRAO now has many users taking advantage of remote access via our VPN concentrators, the issue of security of foreign machines connecting through the VPN has become a pressing issue. To help ensure the security of remote machines out of our administrative control CDs are now available containing the latest service packs for Windows operating systems, and utilities to evaluate the security of systems, like the Microsoft Baseline Security Analyzer.

Finally, good progress was made in the testing of Linux-based system logging "syslog" servers to receive system messages from Windows systems.

Web Infrastructure

Milestones	Original Date	Revised Date	Date Completed
Design of Next Generation Web Services	11/30/04	03/31/05	
Evaluate additional Groupware	04/01/04	06/30/05	
Purchase proxy servers for VLA	06/05/03	03/31/05	
Test RHEL server with NRAO web configuration	12/31/04	11/30/04	11/30/04
Investigate stopgap web calendaring	12/31/04		12/31/04
Instant Messaging Server Pilot Project	12/31/04	03/31/05	
Deploy Next Generation Web Services	07/01/05		

The initial conceptual design overview for a proposed Next Generation of web services for NRAO has been finished, and work is proceeding on writing a more detailed design document. It is hoped to have this design concluded by the end of the quarter.

Due to lack of resources, the evaluation of additional groupware has been deferred.

Computing and Information Services

Testing of the apache web server on a Red Hat Enterprise Linux system has been concluded; the server works as expected. Work is now proceeding on fine tuning the configuration files so as to enable drop-in replacement of the new operating system on the production web servers at each site.

The NRAO's production web-based Calendar Publication and Scheduling service ("WebEvent") will be migrated from its current home on a server in Tucson to a dedicated server in Charlottesville in the coming quarter. The timezone defects alluded to in the previous quarter's report will be avoided by keeping this dedicated machine permanently on Mountain Standard Time.

Charlottesville Computing

Milestones	Original Date	Revised Date	Date Completed
Migrate Tacacs authentication	06/30/04	10/31/04	09/27/04
Upgrade Windows systems to Windows XP	06/30/03	11/30/04	09/13/04

The ongoing construction work at Edgemont Road (Stone Hall) continued to be the dominant influence on work in the CV Computing Division. Excellent progress was made on outfitting the phone and network cables for the new building extension, and planning for the imminent moves of personnel from Old Ivy Commons and within the building is in an advanced stage.

The dial-in modem "tacacs" authentication service, formerly running on a rapidly aging Sun workstation, has been migrated to CV's workhorse internal linux server. With this last migration, NRAO-CV's reliance on proprietary Sun systems for services has come to an end; all services formerly on the Sun platform are now running 100 percent on Linux servers.

Several test installations of Red Hat Enterprise Linux were performed during the quarter, to better grasp the necessary changes involved in a mass migration from Red Hat 9 to this platform. Early results are encouraging.

All Windows systems that are capable of being upgraded to XP have been upgraded. This represents about 60 percent of Windows computers at NRAO/Charlottesville. The remaining systems are too old and lack the necessary memory, disk and/or processor power to run the newer operating system; they will be phased out as replacements are purchased.

The computer inventory spreadsheet continues to be maintained and corrected, providing a valuable tool in assessing the status of our hardware and operating system upgrades.

The "Beowulf" Linux cluster for pulsar data processing mentioned in the previous report has been delivered, installed and made operational. There were few if any technical problems in its deployment, and it is performing as expected.

Computing and Information Services

Observatory-wide Communications

Milestones	Original Date	Revised Date	Date Completed
Move external network connections to Stone Hall	10/31/04		10/31/04
Add video conference unit in AOC West	08/31/04	11/30/04	11/30/04
Upgrade network services to VLBA SC antenna	09/30/04	02/28/05	
Complete network upgrade in Stone Hall	11/30/04		11/30/04

The major effort in communications has been the cabling of the addition of Stone Hall for networking and telephony. The contractor gave us permission to begin pulling the cables in June. The first phase, to wire the newly constructed areas, is complete. Since the completed building will have the main communications room in a different, more central, location, all of the cabling from the existing rooms must be run to the new location. In addition, all external services must be relocated; this includes the network and communication connections for phone service, the intranet connections, and Old Ivy Commons plus dedicated connections to Green Bank, the NRAO Technical Center, and the University of Virginia. These moves were completed on schedule. A completely new Ethernet switch will provide Local Area Network services to the building. Although there were delays caused by inadequate cooling in the communications room, this should all be complete in advance of the occupancy of the building, presently scheduled for February 2005.

As a result of lower costs for our intranet contract with AT&T, we decided to upgrade the service at four VLBA antenna sites. The upgrade to T1 (1.544 Mbps) access was completed at two of the sites (Hancock and Owens Valley). It now seems unlikely that we will be able to make a cost-effective upgrade to the service at Brewster, since the Local Exchange Carrier cannot provide the circuits into the site. Upgrade of the service to a fractional T1 (at 384 kbps) at the St. Croix antenna has been delayed by the local company in the Virgin Islands, but it is now scheduled to be completed by AT&T next quarter.

The network of video teleconferencing units continues to be a fundamental resource for inter-site meetings. A new video unit was installed to support videoconferencing in the recently occupied AOC West facility in New Mexico. Major upgrades to the capabilities are possible in the next year, but these will not be planned in detail until it is clear how much effort will be available. We will also continue to investigate the deployment of equipment and software for use by individuals in their offices.

It is clear that the Ethernet switches in Green Bank are becoming outdated and have reached their limit for expansion. Furthermore, we no longer have staff members who are conversant with the operating system on those switches. We have therefore begun funding a program to replace all of them with new Cisco switches, which will be more capable and more expandable. The initial new switch will provide more capability for the GBT operation. We have also agreed to fund the completion of the communication infrastructure in the Green Bank Residence Hall to provide modern network capabilities in all visitor accommodation.

Education and Public Outreach

Education and Public Outreach (EPO) Highlights

Two new EPO programs—Science Museum Outreach and the Legacy Imagery Project—moved forward this quarter. The first stage of the Science Museum Outreach effort will soon provide for the rapid delivery of all NRAO press releases to more than 50 science centers and planetariums across the country. The Legacy Imagery Project is generating improved radio astronomy image visualization techniques. A recent result of this program is a composite radio—optical image of Fornax A produced from VLA data acquired by Fomalont et al and recently published as NRAO's contribution to the 2005 American Astronomical Society calendar. The Observatory's media efforts this quarter resulted in several press releases that described exciting science being done at the NRAO. Revenue continued to increase at the Green Bank Science Center and the VLA Visitor Center, while attendance held steady. New exhibits were installed in the Green Bank Science Center while draft architectural renderings were generated for a proposed new VLA Visitor Center in New Mexico. The well-received and attended 2004 Jansky Lecture was delivered by IAU President Ron Ekers in Socorro, Green Bank, and Charlottesville.

Science Museum Outreach

During this past quarter, the NRAO EPO staff continued its discussions with the Space Telescope Science Institute (STScI) Office of Public Outreach regarding a mutually beneficial collaboration for radio astronomy outreach to science museums and planetariums. The Observatory's initial goals for this collaboration will be accomplished by the addition of the NRAO and radio astronomy to *ViewSpace,* a free, readily-updated, multi-media electronic exhibit designed for museums and planetariums.

ViewSpace consists of multiple five to fifteen minute program elements that can be programmed to play in a locally customized order and combines imagery, digital movies, animations, interpretive captions, and music to effectively and attractively discuss and publicize modern astronomical research progress. Current *ViewSpace* programming options include: "Celestial Update," which features breaking astronomical research news and emphasizes the contributions of the NASA Great Observatories; "Skylines," which is updated monthly and provides an illustrated introduction to the night sky and special astronomical events; "Mars Exploration Rover Update" and "Cassini-Huygens Update," which publicize the science being done by these programs; and others.

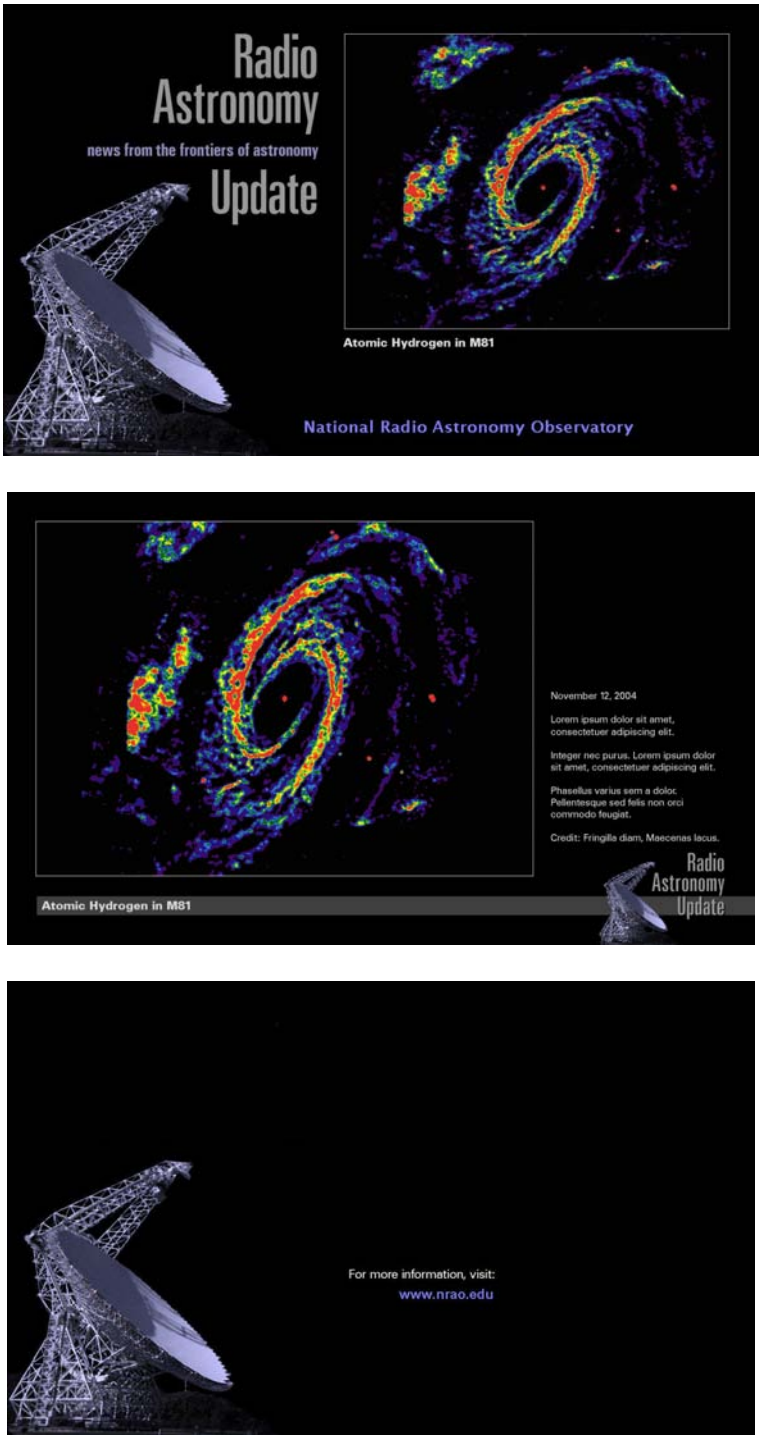

Figure 1. Draft format for the NRAO press release / ViewSpace template.

Education and Public Outreach

This past quarter, an agreement was reached between STScI and the NRAO to create the infrastructure and programming required to quickly distribute NRAO press releases, as they are announced, via *ViewSpace*. A draft NRAO press release template has been developed, is undergoing review, and is planned to be implemented this coming quarter (see Fig. 1). EPO staff are also procuring and installing a *ViewSpace* system at NRAO – Charlottesville for program module test and evaluation.

EPO staff have also begun planning for the design, production, and delivery of two additional programs for science museum outreach via *ViewSpace*: an "evergreen" program module that provides a broad overview of radio astronomy and the NRAO; and an ALMA program module.

Legacy Imagery Project

The Legacy Imagery Project, an NRAO initiative to improve the Observatory's capability to process radio-wavelength astronomical data into compelling visual imagery, also made good progress this quarter and, like our science museum outreach program, benefited from collaboration with our colleagues at Hubble. STScI image specialist Zoltan Levay gave an invited talk in Charlottesville this quarter on the image processing techniques and issues the Hubble Heritage Program team have employed to generate their highly effective optical imagery. As mentioned in last quarter's EPO report, internal NRAO efforts to improve radio imagery visualization for EPO are underway. The composite radio - optical image of Fornax A in Figure 2 was recently produced by NRAO scientist Juan Uson from VLA and STScI-POSS-II imagery as a processing technique demonstration. This image is also featured in the 2005 American Astronomical Society calendar. NRAO is also planning to sponsor a radio image contest that will debut at the June AAS meeting in Minneapolis. This program seeks to motivate our telescope users to generate high-quality radio images suitable for scientific and EPO use.

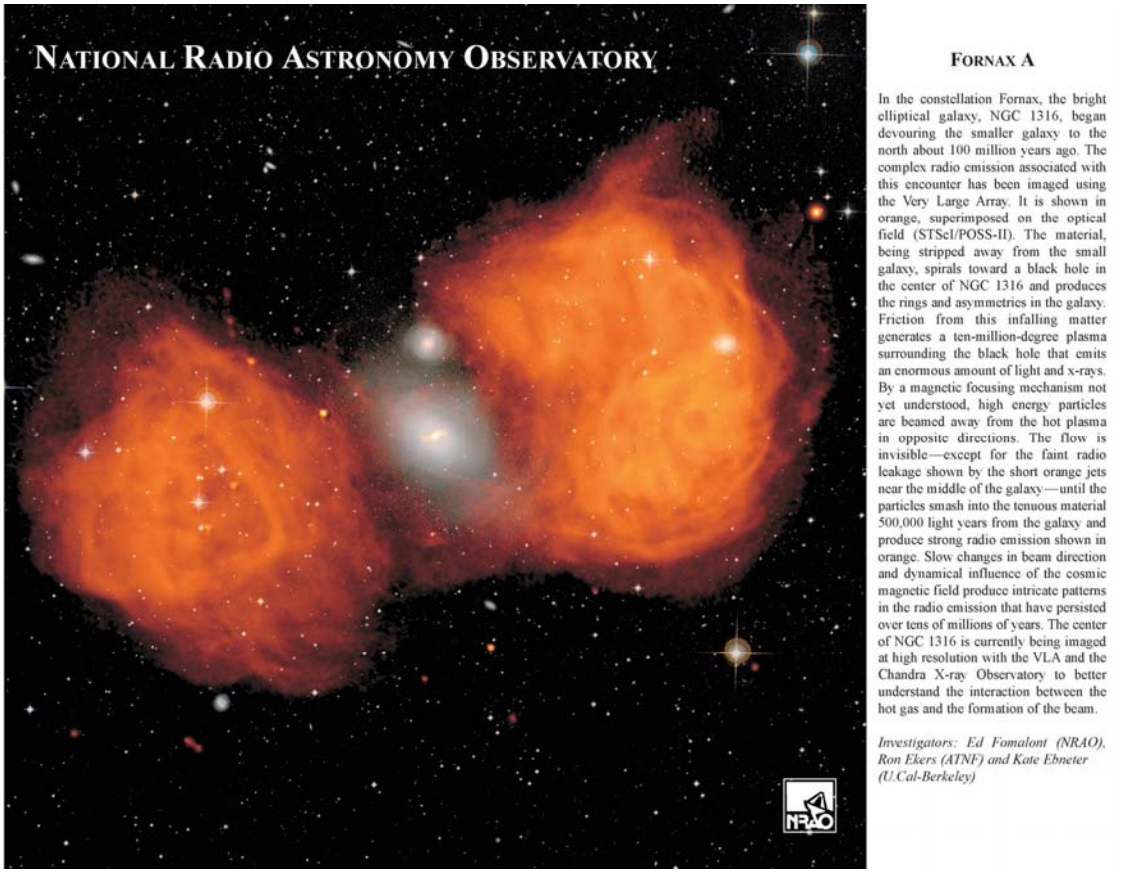

Figure 2. Fornax A in the radio (VLA) and the optical.

Media Relations

NRAO EPO staff collaborated with Observatory scientists and members of the external astronomical community to produce and distribute press releases this quarter on a wide range of exciting science derived from NRAO telescopes and data. These included the VLA Low-frequency Sky Survey (VLSS) a VLA study focusing on the order of galaxy formation, and most recently, a release about using the NRAO telescopes to track the Cassini-Huygens probe as it studies Saturn's largest moon, Titan. In mid-January, the GBT and eight VLBA antennas will directly receive the faint signal from Huygens during its descent through Titan's atmosphere. Using the extremely accurate measurements of the probe's position, speed, and direction of motion expected from these radio telescopes, scientists hope to obtain data vital to a full understanding of the winds in Titan's atmosphere. Press releases will undoubtedly result from this exciting mission and NRAO's unique role.

Education and Public Outreach

Several groups acquired unique video at Green Bank this quarter and have made their footage available to the NRAO. In October, West Virginia Public Television acquired video from a helicopter, spending a Sunday afternoon and a foggy Monday morning obtaining wonderful aerial photography of Green Bank and the GBT. The producer was very pleased with the results of this shoot. NRAO has received DVD copies of some of the raw footage and will soon receive high resolution copies for Observatory usage including public relations and news releases, though West Virginia Public Television retains the rights for anyone wanting to use the footage for commercial purposes.

Figure 3. The GBT in the fog: a scene from the WV Public Television footage.

In October, the Array Operations Center (AOC) and the VLA hosted a workshop for Public Information Officers (PIO's) sponsored by National Science Foundation's Office of Legislative and Public Affairs (OLPA). This was the OLPA's third workshop and the first held outside of Washington. PIO's from NSF's "top 100" research universities (in terms of grants awarded to investigators), as well as PIO's from NRAO, NOAO, Gemini, Woods Hole, Scripps, and other research institutions were invited. The objective was to work on improving the public relation collaborations between the institutions and OLPA. Thirty-four persons attended. NRAO EPO's Dave Finley co-chaired the meeting with Terry Devitt (University of Wisconsin).

The VLA was also host to a Sky and Telescope astronomy tour in October. In late spring of 2005, Sky and Telescope is promoting an astronomically-themed tour of the Atacama Desert, and we are exploring the idea that this tour might visit ALMA facilities.

Working with NRAO Human Resources, EPO helped coordinate interviews and obtain illustrations for an upcoming article on ALMA for the journal *Diversity / Careers in Engineering & Information Technology* that is scheduled to appear early in 2005.

Figure 4. NRAO engineer Angel Otarola, one of several people interviewed for an ALMA / NRAO story.

Informal Education

The 2004 Jansky lectures, an annual fall highlight, featured Dr. Ronald Ekers speaking about the history of radio astronomy in a talk entitled "Paths to Discovery." Dr. Ekers' talk attracted good attendance at Green Bank (65 attendees), Charlottesville (200 attendees), and Socorro (250 attendees). In concert with the Jansky lectures another successful New Mexico Symposium was held in Socorro, while the NRAO and UVA's Astronomy Department collaborated to re-initiate Charlottesville's Jansky Symposium. Both symposia were well attended and included a range of interesting presentations.

Education and Public Outreach

Figure 5. Dr. Fred K.Y. Lo, NRAO Director, presents a plaque to the 2004 Jansky Lecturer, Dr. Ronald D. Ekers.

Though the October–December quarter is a low point for annual visitation, attendance at the Green Bank Science Center and the VLA Visitor Center held relatively steady. Compared to these same months in 2003, attendance for the months October through December decreased 1 percent at Green Bank and increased 2 percent at the VLA.

Table 1

Green Bank Science Center and VLA Visitor Center attendance: October – December 2004

Site	October	November	December	Quarterly Total
Green Bank	5,220	957	785	6,962
VLA	2,160	1,348	1,057	4,565

On a calendar year, both sites did well. From 2003 to 2004, the Green Bank Science Center registered a 25 percent annual attendance increase to 35,505 visitors; the VLA Visitors Center annual attendance increased by 40 percent to 23,300 persons. Revenue at the Green Bank Science Center and the VLA Visitor Center increased in this quarter compared to the same quarter in 2003 by 10 percent and 2 percent, respectively.

Table 2				
Green Bank Science Center and VLA Gift Shop revenue: October – December 2004				
Site	**October**	**November**	**December**	**Quarterly Total**
Green Bank	$19,927	$5,053	$5,293	$30,273
VLA	$15,033	$7,034	$8,304	$30,371

The Green Bank Science Center Café also generated increased revenues.

Table 3.				
Green Bank Science Center Cafe Revenue				
Calendar Year	**October**	**November**	**December**	**Total**
2003	$6,934	$2,341	$1,243	$10,518
2004	$7,017	$3,006	$1,514	$11,538

The VLA's quarterly public tour in October was attended by 294 people. In addition, NRAO staff hosted 13 guided tours this quarter, primarily school groups. At Green Bank school groups accounted for 1,106 of the Science Center's attendees this quarter.

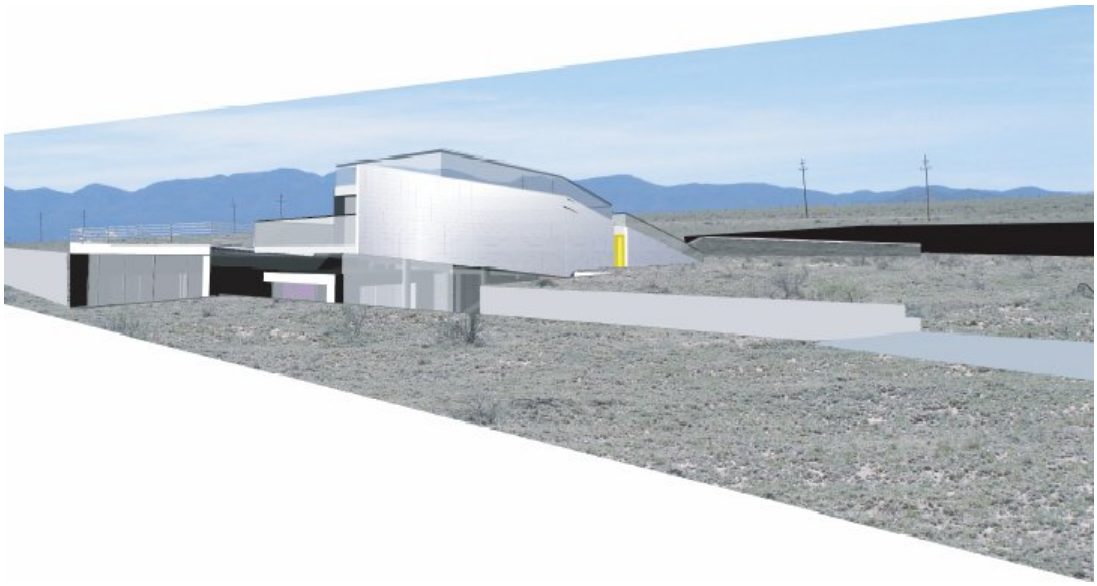

Figure 6. Architectural rendering of a proposed new VLA Visitor Center.

New exhibits describing blackbody radiation and infrared imaging were installed in the Green Bank Science Center exhibit hall this quarter. At the VLA Visitor Center, planning is underway for a new EVLA exhibit.

Education and Public Outreach

The University of New Mexico - School of Architecture produced first draft architectural renderings for a new VLA Visitor Center. The VLA Visitor Center Committee, chaired by Robyn Harrison, produced objectives and a draft business plan to accompany this architectural vision. A meeting with the Director in December brought suggestions for future progress, and the committee is proceeding to have the architectural drawings and business plan revised accordingly.

In the Socorro area, the 11th annual Enchanted Skies Star Party was held with strong NRAO support, but encountered the worst hail storm the area has perhaps ever seen. In addition to severely damaging many vehicles, the hail damaged the 2-element N^2I^2 Interferometer dishes at the Etscorn Observatory. The bad weather also cancelled a planned visit by the Star Party to South Baldy at 10,000 feet, for an observing session at the site of the future Magdalena Ridge Observatory.

Figure 7. Tattered dish of one element of the N^2I^2 interferometer at Etscorn Observatory following the hail storm of 2004.

About 30 participants from the annual Socorro *Hamfest*, a ham-radio event that draws people from New Mexico and surrounding states, attended a VLA tour. This was preceded by an EPO presentation on the ham radio - radio astronomy connection, and the history of radio astronomy and the VLA.

The official ALMA brochure, serving NRAO and ESO, was reproduced with the official logo and project description. A Spanish version was also reproduced and a supply was sent to Chile for use by the NRAO, ESO, and the Joint ALMA Office.

Education and Public Outreach

Formal Education

In November, NRAO Education Officer Robyn Harrison held school outreach programs for Acoma Elementary in Albuquerque (300 students) and Dulce Elementary on the Jicarilla Apache Reservation (7 classes, 120 students). Green Bank played host to the West Virginia Youth Environmental Program with about 120 students attending for an all-day event in October. In November, Green Bank Education Officer Sue Ann Heatherly prepared and hosted a workshop at the regional American Association of Physics Teachers meeting in Staunton, Virginia.

Autumn was a busy time for the 40 Foot Telescope for high school and college groups from Kentucky, North Carolina, Pennsylvania, Virginia, and West Virginia coming to observe and stay overnight. The schools included Highland Adventist School, Fox Chapel High School, University High School, Western Albemarle High School (two visits), James Madison University, Marshall University, Morehead State University, and Villanova University.

In November, Green Bank hosted a meeting of teachers who had participated in *RareCats*, providing an opportunity for feedback to the Observatory and an opportunity for the teacher to learn more about radio astronomy and the NRAO.

Community Relations

In New Mexico, NRAO employees served as judges for the Socorro middle school and Socorro High School science fairs. Green Bank held a December Holiday Open House prior to the scheduled star party to show appreciation for the community.

During this quarter, two dozen NRAO employees volunteered time to participate in more than 40 EPO community-related activities. These activities included replying to on-line astronomy questions, grant program support, exhibit support, special tours and presentations at Green Bank, VLA tours, star parties, and radio interviews. Staff also assisted EPO efforts with support for exhibit hardware, exhibit software, teacher classes / workshops, and web content.

EPO staff also designed Holiday Greeting cards for Charlottesville, Green Bank, AUI, and our offices in Chile.

Environment, Safety and Security

Environment, Safety, and Security (ES&S) Highlights

Environment, Safety, and Security (ES&S) is focusing on the ALMA Antenna Test Facility, ATF, site to minimize risk to employees during the testing at the site. In Socorro, ES&S participated in the development and design specifications for the gaseous fire suppression system to be installed in the new EVLA Correlator Shielded Room. ES&S prepared and submitted a "Known Needs Request" to the NSF for the acquisition of an ambulance. ES&S negotiated with representatives from New Mexico Tech to formalize procedures for the acceptance of hazardous wastes generated in the AOC Electronics Lab. In Green Bank, a stinging and venomous insect safety program was implemented. Also in Green Bank, hazardous materials management was implemented for the proper disposal of waste generated from the 140 foot antenna. In Charlottesville, ES&S became more involved in the acceptance of the Edgemont Road facility construction efforts and also worked with the Facilities Planning Team on the investigation of the Thanksgiving Day roof fire. ES&S also met with the Facilities Planning Team to address the potential for mold growth in conjunction with UVA Industrial Hygiene group.

ALMA

ES&S continued to provide periodic support services to check on security and look for potential safety problems. The ALMA Antenna Test Facility, ATF, is becoming more of a focus for ES&S efforts due to the increased work performed by NRAO and ESO staff. Draft procedures were developed and submitted to the ALMA NA Project Manager for implementation of access controls to assure employee safety. The issues include the coordination of work efforts and the appropriate training of employees in procedures to ensure proper operation of safety equipment.

NRAO-New Mexico

This quarter marked the retirement of one of the safety officers from the Socorro site. This individual was responsible for the inspections of the ATF to ensure site safety, and also was responsible to provide training for new employees.

ES&S participated in the development and design specifications for the new gaseous fire suppression system to be installed in the new EVLA Correlator Shielded Room.

ES&S developed protocols for the new Automated External Defibrillator, AED. The protocols were submitted and approved by the AED medical director. ES&S prepared and submitted a "Known Needs Request" to the NSF for the acquisition of an ambulance. The ambulance is used in the Emergency

Medical Services provided at the VLA and surrounding areas. Also during this quarter, the rural access to emergency devices grant application was submitted for a new EMS AED.

During this quarter, ES&S completed training and provided for the certification of two site trainers for the Terex Aerial Lift. Also, ES&S and members of the Safety Committee completed safety inspections of both the VLA Site and the AOC building.

ES&S negotiated with representatives from New Mexico Tech to formalize procedures for the acceptance of hazardous wastes generated in the AOC Electronics Lab.

NRAO-Green Bank

This quarter, the GBT was visited by several stinging and venomous insects. ES&S prepared a safety program for the control of insects to address the potential for allergic reactions by visitors and employees. The GBT High Angle Rescue Team participated in a full day exercise using the GBT itself for staged rescue events.

ES&S participated in a Risk Management seminar that addressed insurability risk issues and potential for terror actions at both local and international facilities. Additionally, ES&S participated in the Business Managers meetings to discuss and resolve issues relating to vehicle liability and the solutions needed to reduce exposure from any unauthorized drivers of NRAO vehicles.

ES&S assisted the machine shop in the characterization of the waste from the bath and proper techniques for hazardous chemical handling procedures. ES&S also worked with the planning team for the 140 Foot Telescope revitalization effort. This included the disposal of over 1000 gallons of waste oil from the antenna and planning for elevator safety inspections.

NRAO-Charlottesville

In Charlottesville, ES&S coordinated with the laboratory manager on the disposal of the Copper Sulfate Bath from the chemistry lab at the NTC.

ES&S became much more involved in the Facilities Planning Team for acceptance of the Edgemont Road construction project. Efforts included participation in contractor meetings, fire safety inspections, signage inspections for emergency egress, and employee training preparations for NRAO staff. ES&S also provided inspections and support in response to the Thanksgiving Day fire on the roof of the Edgemont Road site. The fire was caused by a light fixture and fire damage was limited to the immediate roof area. Water damage and access damage was a bit more extensive. ES&S also met with the Facilities Planning Team to address the potential for mold issues in conjunction with UVA Industrial Hygiene group. The potential for mold growth was examined as a result of the water damage from the Thanksgiving Day roof fire.

Future Efforts

The development of the crane and hoist operations safety was delayed due to the retirement of the Socorro Safety Officer. It is anticipated that during the next quarter ES&S will focus efforts on the forklift safety program. Additionally, it is planned that ES&S will coordinate with the Observatory Business Services to further define the steps necessary to initiate the Vehicle Safety Program.

The actual disposal of the waste chemicals from the NTC Chemistry Lab was placed on hold due to an attempt by the laboratory manager to revitalize the bath. This process will be watched closely to ensure disposal, if deemed necessary, is done in accordance with proper procedures.

The ES&S Division has lost a member to retirement and decisions were made to replace the position in Green Bank. Consequently, the ES&S staff will be better distributed throughout the Observatory and will also be able to better meet the needs of the growing efforts in Charlottesville. Recruitment is underway and it is anticipated that a replacement will begin working on the ES&S efforts in the next quarter. The current staffing level of ES&S is as follows:

Location	Position	FTEs
Green Bank	ES&S Manager	1
Green Bank	Administrative Support	½
Socorro, VLA	Safety Officer	1
Tucson	Deputy Safety Officer	0
Charlottesville	Deputy Safety Officer	0
ALMA Project, VLA Site	Safety Officer	0
NRAO ES&S Total		**2 ½**

Telescope Usage

The NRAO telescopes were scheduled for research and maintenance during the fourth quarter of 2004 as described in the table below. Note that time lost and actual observing for the arrays are computed as fractions of the total antenna arrays. For example, losing 27 VLA antennas for one hour counts as 1.0 hour of time lost, while losing one out of ten VLBA antennas for one hour counts as 0.1 hours of time lost. Also note that in the case of the GBT, Test and Calibrations occasionally require less time than is scheduled for them, and the excess time is then allocated to refereed backup science programs.

Activity	**VLA** (hrs)	**VLBA** (hrs)	**GBT** (hrs)
Scheduled Observing	1762.38	1172.40	1347
Scheduled Maintenance and Equipment Changes	318.42	217.10	229
Scheduled Tests and Calibration	156.77	247.10	561
Time Lost	149.25	52.47	101
Actual Observing	1613.13	1119.90	1246

GBT Observing Programs

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

No.	Observer(s)	Programs
BB190	Bietenholz, M. (York) Bartel, N. (Cork)	Supernova 2001em: Does it have a GRB Jet? 3.5 cm
BB191	Barvainis, R. (NSF) Ulvestad, J. Birkinshaw, M. (U. of Bristol) Lehar, J. (CombinatoRx)	Are Radio-Quiet Quasars superluminal? 6 cm
BG150	Giovannini, G. (Istituto di Radioastronomia) Feretti, L. (Istituto di Radioastronomia) Giroletti, M. (Bologna) Taylor, G. Edwards, P. (Institute of Space and Astrona)	Jet and Counter-jet emission in Markarian 501. 21 cm
BG155	Greenhill, L. (Harvard-Smithsonian) Madejski, G. (Stanford) Henkel, C. (MPIfR) Peck, A. (CfA) Braatz, J. Wilson, A. (Maryland)	Mapping the accretion disk in the IC2560 AGN and implications for H0. 1.3 cm
BH128	Hough, D. (Trinity) Aars, C. (Trinity)	Deep imaging of faint nuclei in SCR FR-II Quasars and Radio Galaxies with the High Sensitivity Array. 3.5 cm
BJ054	Jackson, N. (NRAL) Browne, I. W. A. (NRAL) York, T. (Jodrell Bank) Mao, S. (Manchester) Porcas, R. (MPIfR) Biggs, A. (JIVE)	Detection of a third image in CLASS B1030+074. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
BK114	Kondratko, P. (CfA) Greenhill, L. (CfA) Moran, J. (CfA) Reid, M. (CfA)	Follow-up imaging of three NGC 4258-like Water Megamasers discovered with the GBT. 1.3 cm
BP116	Piner, B. (Whittier College) Edwards, P. (Institute of Space and Astrona) Jones, D. (JPL) Murphy, D. (JPL)	Space VLBI without the Space: Using the High Sensitivity Array to measure high brightness temperatures. 6 cm
BW076	Winn, J. (CfA Rusin, D. (CfA) Kochanek, C. (Ohio State)	Gravitational lensing by a supermassive black hole. 3.5 cm
GBT01A-004	Turner, B. Brown, R. (Cornell) Dennison, B. (VA Polytechnic Inst.) Minter, A.	A search for the fine structure of the hydrogen atom. 3.5 cm
GBT01A-029	Eales, S. (Cardiff) Carilli, C. Dunne, L. (Cardiff) Ivison, R. (Astronomy Technology Centre)	A first investigation of the Origin of Galaxies with the GBT. 1.3 cm
GBT02A-035	Yun, M. (Massachusetts) Carilli, C. Rupen, M. Wootten, H. A. Bertoldi, F. (MPIfR) Eales, S. (Cardiff) Ivison, R. (Astronomy Technology Centre)	Cosmic evolution of the most luminous submm galaxies. 2, 1.3 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT02A-066	Hughes, D. (INAOE) Aretxaga, I. (INAOE) Gaztanaga, E. (INAOE) Chapin, E. (INAOE) Dunlop, J. (Inst. for Astron. of Edinburgh) Devlin, M.J. (Pennsylvania)	Breaking the redshift deadlock: The spectroscopic redshift of HDF850.1, the brightest sub-millimetre source in the Hubble Deep Field. 1.3 cm
GBT02A-069	Fisher, R.	Galaxy survey of HI emission. 21 cm
GBT02B-004	Hunter, T. (CfA) Zhang, Q. (CfA) Tirupati, S. (CfA)	Molecular tracers of high-mass protostellar accretion disks (NH_3, CH_3C_3N, CH_3OH). 1.3 cm
GBT02B-020	Benford, D. (NASA/Goddard) Hunter, T. (CfA) Staguhn, J (NASA/Goddard)	Search for low excitation molecular gas in High Redshift Quasars (CO). 1.3 cm
GBT02C-025	Greve, T. (Caltech) Ivison, R. (Astronomy Technology Centre) Carilli, C. Papadopoulos, P. (Leiden) Lewis, G. (Sydney)	CO(1-0) in the 'big five' high-z sources. 1.3 cm
GBT02C-043	Finkbeiner, D. (Princeton) Heiles, C. (UC, Berkeley) Schlegel, D. (Princeton) Frank, C. (Maryland)	Microwave emission from spinning dust. 2, 3.5, 1.3 cm
GBT02C-050	Blain, A. (Caltech) Chapman, S. (Caltech) Ivison, R. J. (Astronomy Technology Centre) Smail, I. (Durham) Owen, F.	Survey for CO(1-0) from dusty galaxies at the highest redshifts. 1.3 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT02C-054	Braatz, J. Henkel, C. (MPIfR) Wilson, A. (Maryland) Greenhill, L. (CfA) Moran, J. (CfA)	Measuring nuclear disks in NGC 1386 and IC 2560 (H_2O). 1.3 cm
GBT03A-011	Walter, F. Carilli, C. L. Yun, M. (Massachusetts) Bertoldi, F. (MPIfR)) Menten, K. (MPIfR) Scoville, N. (Caltech)	The molecular gas content of Quasars at z~4.5. 1.3 cm
GBT03A-015	Lane, W. (NRL) Kanekar, N. (Kapteyn Astronomical Institute) Ellison, S. (U. of Victoria) Chengalur, J. (NCRA (TIFR))	A search for 21cm absorption in high redshift damped Lyman-alpha absorbers. 70 cm
GBT03B-019	Li, D. (CfA) Goodman, A. (CfA) Goldsmith, P. (Cornell) Schnee, S. (CfA)	The GBT HI narrow self-absorption survey of star forming regions. 21 cm
GBT03C-031	Jacoby, B. (Caltech) Anderson, S. (Caltech) Kulkarni, S. (Caltech) Kaplan, D. (Caltech) Backer, D. (UC, Berkeley)	Timing the pulsars in M62, NGC 6544, and NGC 6624 and search for ultra-fast pulsars. 21, 38 cm
GBT04A-003	Curran, S. (New South Wales) Whiting, M. (New South Wales) Webb, J. (South Wales) Murphy, M. (New South Wales) Pihlstroem, Y Wiklind, T. (Space Telescope Science Institute) Francis, P. (Australian National)	Highly redshifted HI and OH absorption in red Quasars. 90 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT04A-018	Robishaw, T. (UC, Berkeley) Heiles, C. (UC, Berkeley) Goldsmith, P. (Cornell)	CCS: The molecular magnetometer of choice. 3.5 cm
GBT04A-029	Ransom, S. Camilo, F. (Columbia Astrophysics Laboratory) Stairs, I. (British Columbia) Kaspi, V. (McGill) Kaplan, D. (Caltech)	S-Band pulsar observations of Terzan5 and Liller1. 11 cm
GBT04A-030	Stairs, I. (British Columbia) Thorsett, S. (UC, Santa Cruz) Arzoumanian, Z. (NASA/GSFC) Ferdman, R. (British Columbia)	High-precison timing of binary pulsars at the GBT. 21 cm
GBT04A-045	Roberts, M. (McGill) Hessels, J. W. T. (McGill) Ransom, S. Kaspi, V. (McGill) Tam, C. (McGill) Livingstone, M. (McGill) Backer, D. (UC, Berkeley) Crawford, F. (Haverford College) Kaplan, D.(Caltech)	Timing of three binary pulsars discovered in a survey of mid-latitude EGRET error boxes. 11, 21, 38 cm
GBT04B-011	Rickett, B. (UC, San Diego) McLaughlin, M. (Manchester) Coles, W. (UC, San Diego) Lyne, A. G. (NRAL) Stairs, I. (British Columbia) Camilo, F. (Columbia Astrophysics Laboratory) Freire, (Arecibo)	Scintillation studies of the J0737-3039 binary system. 6, 11 cm
GBT04B-014	Kondratko, P. (CfA) Greenhill, L. (CfA) Moran, J. (CfA) Braatz, J.	Anchoring the extragalactic distance scale. 1.3, 2 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT04B-022	Troland, T. (Kentucky) Benjamin, R.(Wisconsin-Whitewater) Lockman, F. J.	The magnetic field in a compact high velocity cloud. 21 cm
GBT04B-026	Kramer, M. ((RAL) Stairs, I. (British Columbia) Camilo, F. (Columbia Astrophysics Laboratory) McLaughlin, M. (Manchester) Lorimer, D. (Manchester) Lyne, A. (NRAL) Manchester, D. (Australia Telescope) Possenti, A. (Osservatorio di Cagliari) D'Amico, N. (Osservatorio di Cagliari) Burgay, M. (Osservatorio di Bologna) Freire, (Arecibo) Joshi, B. (National Centre for Radio Astrophysics (India)) Ferdman, R. (British Columbia)	Timing the first double pulsar system. 21, 38 cm
GBT04B-028	Ransom, S. Kaspi, V. (McGill) Backer, D. (UC, Berkeley) Ramachandran, R. (UC, Berkeley) Demorest, P. (UC, Berkeley) Arons, J. (UC, Berkeley)	Multi-epoch multi-frequency scintillation velocity measurements of the double-pulsar binary J0737-3039. 21, 38 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT04B-029	Stairs, I. (British Columbia) Camilo, F. (Columbia Astrophysics Laboratory) Kramer, M. (NRAL) Faulkner, A. (Nuffield Radio Astronomy Laboratories) McLaughlin, M. (Manchester) Lorimer, D. (Manchester) Lyne, A. (NRAL) Hobbs, G. (ATNF) Manchester, D. (Australia Telescope) Possenti, A. (Osservatorio di Cagliari) D'Amico, N. (Osservatorio di Cagliari) Burgay, M. (Osservatorio di Bologna) Ferdman, R. (British Columbia) Ramachandran, R. (UC, Berkeley) Backer, D. (UC, Berkeley) Demorest, P. (UC, Berkeley) Nice, D. (Princeton)	Timing new binary and millisecond pulsars from the Parkes multibeam survey. 21 cm
GBT04B-040	Stil, J. (Calgary) Taylor, A. (Calgary) Lockman, F. J.	Re-observations of Galactic plane clouds. 21 cm
GBT04C-008	Pidopryhora, Y. (Ohio) Shields, J. (Ohio) Lockman, F. J.	Mapping the Galactic Halo HI: Evidence of outflow from the Galactic Plane? 21 cm
GBT04C-009	Quireza, C. (Virginia) Bania, T. (Boston) Rood, R. (Virginia) Balser, D.	Using HI absorption to resolve kinematic distance ambiguity of Galactic HII reigons. 21 cm
GBT04C-011	Yun, M. (Massachusetts)	Hydrogen recombination lines in Starburst+AGN Systems. 2 cm
GBT04C-012	Donovan, J. (Columbia) Camilo, F. (Columbia Astrophysics Laboratory)	Deep searches for young pulsars in "shell" supernova remnants. 38 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT04C-013	Jacoby, B. (Caltech) Bailes, M. (Swinburne U. of Technology) Ord, S. (Swinburne U. of Technology) Kulkarni, S. (Caltech) Hotan, H. (Swinburne U. of Technology) van Straten, W. (Astron)	Precision pulsar timing. 21, 38 cm
GBT04C-018	Bolatto, A. (UC, Berkeley) Darling, J. (Carnegie Institution of Washington)	A search for cosmological HI absorption systems toward radio selected flat-spectrum sources. 21 cm
GBT04C-021	Wang, Y. (CfA) Zheng, X. (Nanjing) Zhang, Q. (CfA) Ho, P. (CfA)	Large-scale structures, fragmentation and cluster formation in OMC-2 and OMC-3. 1.3 cm
GBT04C-022	Ma, C. (National Taiwan) Lim, J. (Academia Sinica, IAA)	Search for HI gas in the central molecular-mas-rich elliptical galaxies of rich clusters. 21 cm
GBT04C-023	Knight, H. (Swinburne U. of Technology) Jacoby, B. (Caltech) Bailes, M. (Swinburne U. of Technology) Ord, S. (Swinburne U. of Technology) Kulkarni, S. (Caltech) Hotan, H. (Swinburne U. of Technology)	High time resolution giant pulse searches. 21, 38 cm
GBT04C-025	McLaughlin, M. (Manchester) Lyne, A. (NRAL) Kramer, M. (NRAL) Lorimer, D. (Manchester) Stairs, I. (British Columbia) Manchester, D. (Australia Telescope)	Investigating a new class of transient radio sources. 38 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT04C-027	Araya, E. (New Mexico Tech) Hofner, P. (New Mexico Tech) Goss, W. M. Kurtz, S. (UNAM) Olmi, L. (Istituto di Radioastronomia, Italy) Linz, H. (TLS Tautenburg)	A GBT search for H2CO 6cm emission from massive protostars. 6 cm
GBT04C-030	van Driel, W. (DAEC, Observatoir de Meudon) O'Neil, K. Schneider, S. (Massachusetts)	A search for massive Low Surface Brightness galaxies. 21 cm
GBT04C-032	Dyer, K. Robishaw, T. (UC, Berkeley) Cornwell, T.	Large-scale polarized emission in supernova remnant SN1006. 21 cm
GBT04C-036	Ramachandran, R. (UC, Berkeley) Deshpande, A. (Arecibo) Cordes, J. (NAIC and Cornell) Backer, D. (UC, Berkeley) Freire, (Arecibo) Vlemmings, W. (Cornell) Demorest, P. (UC, Berkeley) Deneva, (Cornell)	Searching for young pulsars in the Cygnus Super Bubble region. 11 cm
GBT04C-039	Bower, G. (UC, Berkeley) Ramachandran, R. (UC, Berkeley) Muno, M. (UC, Los Angeles) Baganoff, F. (MIT)	Searching for radio pulsations from X-ray sources with radio counterparts in the Galactic Center. 3.5 cm
GBT04C-040	Margot, J.(Cornell) Peale, S. (UC, Santa Barbara) Slade, M. (JPL)	The interior of Mercury revealed by its spin dynamics. 3.5 cm
GBT04C-041	Braatz, J. A. Henkel, C. (MPIfR)	Monitoring Extragalactic H_2O masers Discovered with the GBT. 1.3 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT04C-045	Stairs, I. (British Columbia) Ferdman, R. (British Columbia) van Leeuwen, (British Columbia)	A search for pulsar companions to new low-mass white dwarfs. 90 cm
GBT04C-051	Matthews, B. (UC, Berkeley) Robishaw, T. (UC, Berkeley) Heiles, C. (UC, Berkeley	Probing magnetic field strength and geometry of the Orion Filament. 21 cm
GBT04C-052	Kanekar, N. (Kapteyn Astronomical Institute) Chengalur, J. (NCRA (TIFR)) Ghosh, T. (Arecibo)	A search for 21cm absorption in a high metallicity DLA at z = 2.462. 70 cm
GBT04C-055	Hewitt, J. (Northwestern) Yusef-Zadeh, F. (Northwestern) Braatz, J. Palmer, P. (Chicago)	A search for OH(4765 MHz) maser emission associated with supernova remnant masers using the GBT. 6 cm
GBT04C-056	Demorest, P. (UC, Berkeley) Backer, D. (UC, Berkeley) Ferdman, R. (British Columbia) Stairs, I. (British Columbia) Nice, D. (Princeton) Ramachandran, R. (UC, Berkeley)	Precision timing of binary and millisecond pulsars. 21, 38 cm
GBT04C-057	Cameron, P. (Caltech) Pannuti, T. (MIT) Rho, J. (Caltech IPAC) Jacoby, B. (Caltech)	Search for radio pulsations from a new X-ray pulsar in CTB 1. 38 cm
GBT04C-058	Ransom, S. Chakrabarty, (MIT) Juett, (Virginia) Kaplan, D. (Caltech) Rupen, M. Gaensler, B. (CfA)	A search for radio pulsations from the fast X-ray MSP IGR J00291+5934. 6, 11 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT04C-059	Hyman, S. (Sweet Briar College) Lazio, T. J. (NRL) Ray, P. (NRL) Kassim, N. (NRL)	A coherently-emitting radio transient source toward the Galactic Center? 11 cm
GM055	Marcaide, J. M. (U. de Valencia) Marti-Vidal, I. (U. de Valencia) Guirado, J. C. (U. de Valencia) Alberdi, A. (Instituto de Astrofisica de Andalucía) Lara, L. (U. of Granada) Perez-Torres, M. A. (IAA) Ros, E. (MPIfR) Diamond, P. J. (MERLIN/VLBI National Facility) Shapiro, I. I. (CfA) Preston, R. A. (JPL) Schilizzi, R. T. (JIVE) Mantovani, F. (Istituto di Radioastronomia) Trigilio, C. (Istituto di Radioastronomia CNR) Van Dyk, S.D. (Caltech) Weiler, K. W. (NRL) Sramek, R. A. Whitney, A. R. (Haystack)	Monitoring the expansion Of Sn 1993j at 6 and 18 cm. 6 cm
GR024	Ramachandran, R. (UC, Berkeley)) Deshpande, A.A. (Arecibo) Gwinn, C. R. (UC, Santa Barbara) Ghosh, T. (Arecibo)	Measuring apparent angular size of pulsars behind HII regions. 90 cm

VLA Observing Programs

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

No.	Observer(s)	Programs
AA295	Aalto, S. (Chalmers, Onsala) Beswick, R. (Manchester) Huttemeister, S. (Bochum) Pedlar, A. (Manchester)	HI and OH absorption toward the Medusa merger. 20 cm
AA296	Araya, E. (NMIMT) Hagiwara, Y. (NFRA) Hofner, P. Baan, W. (NFRA) Mateen, M. (NMIMT)	Formaldehyde absorption in starburst galaxies. 6 cm
AA297	Araya, E. (NMIMT) Hofner, P. Goss, W.M. Kurtz, S. (Mexico/UNAM) Olmi, L. (Puerto Rico) Linz, H. (Puerto Rico)	H_2CO 6cm masers discovered in Arecibo and GBT surveys. 6 cm
AB1131	Bash, F. (Texas, Austin) Gebhardt, K. (Texas, Austin) Goss, W.M. VandenBout, P.	Deep imaging of the centers of globular clusters. 3.6 cm
AB1134	Bower, G. (UC, Berkeley) Backer, D. (UC, Berkeley) Lithwick, Y. (UC, Berkeley) Herrnstein, R. (Columbia) Goss, W.M. Falcke, H. (MPIR, Bonn) Zhao, J. (CfA)	Scattering size of Sgr A*. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AB1135	Bally, J. (Colorado/JILA) Churchwell, E. (Wisconsin) Felli, M. (Arcetri) Pedelty, J. (NASA/GSFC) Smith, N. (Colorado) Moeckel, N. (Colorado) Walawender, J. (Colorado)	Proper motions of young stars in the Orion Nebula. 0.7, 1.3, 2, 6 cm
AB1137	Behar, E. (Technion) Guedel, M. (Paul Scherrer)	Continuum from the pre-main sequence candidate Lep-B. 3.6, 6 cm
AB1139	Brisken, W. Thorsett, S. (UC, Santa Cruz) Goss, W.M.	Proper motion of the Duck pulsar B1757-24. 20 cm
AB1140	Buckalew, B. (Rice) Kobulnicky, H. (Wisconsin)	Continuum search for young star clusters in NGC 450. 6 cm
AB1141	Boyce, E. (MIT) Bowman, J. (MIT) Bolton, A. (MIT) Hewitt, J. (MIT) Burles, S. (MIT)	Candidate gravitational lenses from the SDSS. 3.6 cm
AB1144	Brunthaler, A. (MPIR, Bonn) Falcke, H. (MPIR, Bonn) Reid, M. (CFA) Greenhill, L. (CfA) Henkel, C. (MPIR, Bonn)	Calibrator search near M33 and IC 10. 0.7, 3.6 cm
AB1146	Brunthaler, A. (MPIR, Bonn) Falcke, H. (MPIR, Bonn) Reid, M. (CfA) Greenhill, L. (CfA) Henkel, C. (MPIR, Bonn	Search for more water masers in M33. 1.3 cm

VLA Observing Programs

No.	Observer(s)	Programs
AB1150	Birzan, L. (Ohio State) McNamara, B. (Ohio State) Carilli, C. Rafferty, D. (Ohio Univ.) Nulsen, P. (CfA) Wise, M. (MIT)	Systems with X-ray cavities. 20, 90 cm
AB1167	Bower, G. (Calif., Berkeley)	X-ray/radio transient 2.5" from Sgr A*. 0.7, 1.3, 3.6, 20 cm
AB1168	Bower, G. (Calif., Berkeley) Backer, D. (Calif., Berkeley) Falcke, H. (ASTRON) Goss, W.M. Herrnstein, R. (Columbia) Lithwick, Y. (Calif., Berkeley) Muno, M. (Calif., Los Angeles)	X-ray/radio transient 2.5" from Sgr A*. 1.3, 3.6, 6, 20 cm
AC616	Colina, L. (IFCA) Alberdi, A. (IAA, Andalucia) Torrelles, J. (IAA, Andalucia) Panagia, N. (STScI) Wilson, A. (Maryland)	Search for new radio supernovae in NGC 7469. 3.6 cm
AC710	Cannon, J. (Minnesota) vanZee, L. (Indiana) Skillman, E. (Minnesota)	HI imaging of low-metallicity galaxy I Zw 18. 20 cm
AC740	Chandler, C. Low, F. (Arizona) Wilner, D. (CfA) Claussen, M.	Debris disk around HD 98800. 0.7, 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AC741	Carilli, C. Bertoldi, F. (MPIR, Bonn) Menten, K. (MPIR, Bonn) Walter, F. (MPIA) Cox, P. (IAP, Paris) Beelen, A. (IAP, Paris) Omont, A. (IAP, Paris) Fan, X. (Princeton) Strauss, M. (Princeton)	Deep imaging of z~6 QSOs. 20 cm
AC742	Clarke, T. (Virginia) Sarazin, C. (Virginia) Blanton, E. (Virginia)	Structure of the cores of Abell 2597 and Abell 4059. 6, 20, 90 cm
AC743	Curiel, S. (Mexico/UNAM) Canto, J. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) D'Alessio, P. (Mexico/UNAM) Torrelles, J. (IAA, Andalucia) Trinidad, M. (Mexico/UNAM) Loinard, L. (Mexico/UNAM) Raga, A. (Mexico/UNAM)	Structural monitoring of the disks in the L1551 IRS5 system. 0.7 cm
AC748	Cesaroni, R. (Arcetri) Hofner, P. Walmsley, M. (Arcetri) Kurtz, S. (Mexico/UNAM) Churchwell, E. (Wisconsin) Olmi, L. (Puerto Rico) Beltran, M. (CfA) Araya, E. (NMIMT)	Ammonia in two hot cores. 1.3 cm
AC749	Colina, L. (IFCA) Alberdi, A. (IAA, Andalucia) Torrelles, J. (IAA, Andalucia) Panagia, N. (STScI) Wilson, A. (Maryland)	Search for RSNe in highly luminous infrared galaxies. 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AC750	Clarke, T. (Virginia) Lane, W. (NRL) Sarazin, C. (Virginia) Kassim, N. (NRL)	FRIs in high and low density environments. 90, 400 cm
AC753	Castangia, P. (Cagliari) Roselt, B. (MPIR, Bonn) Tarchi, A. (MPIR, Bonn) Peck, A. (CfA) Brunthaler, A. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Menten, K. (MPIR, Bonn)	The water kilomaser in the starburst galaxy NGC 253. 1.3 cm
AC757	Cross, N. (Johns Hopkins) White, R. (STScI) Goto, T. (Johns Hopkins) Demarco, R. (Johns Hopkins)	AGN in three galaxy clusters at z~1. 20 cm
AC759	Cohen, A. (NRL) Israel, F. (Leiden) Kassim, N. (NRL)	Spectral flattening in the spiral galaxy NGC 891. 400 cm
AC761	Chatterjee, S. (Cornell) Brisken, W. Goss, W.M. Benson, J. Arzoumanian, Z. (NASA/GSFC) Lazio, T. (NRL) Cordes, J. (Cornell) Vlemmings, W. (Leiden) Thorsett, S. (UC, Santa Cruz) Lyne, A. (Manchester) Kramer, M. (Manchester)	Calibrator search for pulsar astrometry with the VLBA or HSA. 3.6, 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AC762	Chatterjee, S. (Cornell) Brisken, W. Gaensler, B. (CfA) Melatos, A. (Univ. Of Melbourne) Lazio, T. (NRL) Goss, W.M.	The unpulsed emission from the double pulsar J0737-3039. 3.6, 6, 20 cm
AC763	Curiel, S. (Mexico/UNAM)	Structures within disks in young stellar systems. 0.7 cm
AD487	Dahlem, M. (ESO) Brogan, C. (Hawaii) Breitschwerdt, D. (MPE)	Spectral indices in the halo of NGC 891. 90 cm
AD498	DeLaney, T. (Minnesota) Rudnick, L. (Minnesota) Sankrit, R. (Johns Hopkins) Blair, W. (Johns Hopkins) Petre, R. (NASA/GSFC) Harrus, I. (NASA/GSFC)	Proper motions within Kepler's supernova remnant. 6, 20 cm
AD502	Dougherty, S. (DRAO) Pittard, J. (Leeds) Williams, P. (Edinburgh)	Monitoring colliding-wind binary WR146. 0.7, 1.3, 2, 3.6, 6, 20 cm
AD504	Demorest, P. (Calif., Berkeley) Wang, T. (Science and Tech U.) Yu, Q. (Calif., Berkeley) Backer, D. (Calif., Berkeley) Lu, Y. (Calif., Berkeley)	Galaxies with double narrow emission lines. 1.3, 3.6, 6 cm
AF413	Franco-Hernandez, R. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Moran, J. (CfA)	Time variability of NGC 7538 IRS1 and other UC HII regions. 2, 3.6, 6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AF414	Frail, D. Soderberg, A. (Caltech) Kulkarni, S. (Caltech)	Continued monitoring of the bright GRB 030329. 3.6, 6, 20 cm
AF415	Furuya, R. (Arcetri) Cesaroni, R. (Arcetri) Shinnaga, H. (CFA)	Continuum emission toward a cluster of high-mass protostars. 6 cm
AF417	Fuchs, Y. (CEA, Saclay) Rupen, M. Dhawan, V.	Simultaneous IR and radio emission of GRS 1915+105. 3.6, 6 cm
AG670	Greene, J. (CfA) Ho, L. (DTM/Carnegie) Ulvestad, J.	AGNs with intermediate mass black holes. 6 cm
AG671	Gaensler, B. (CfA) Chatterjee, S. (Cornell) Camilo, F. (Columbia) Vander Swaluw, E. (FOM) Stappers, B. (Amsterdam)	Proper motion of young pulsars and their bow shocks. 20 cm
AG672	Gelfand, J. (CfA) Gaensler, B. (CfA) Lazio, T. (NRL) Cohen, A. (NRL) Kassim, N. (NRL)	Sources with very steep spectra in the field of M31. 20, 90 cm
AG673	Gelfand, J. (CfA) Williams, B. (CfA) Sjouwerman, L. Lazio, T. (NRL) Gaensler, B. (CfA) Kong, A. (CfA) Trudolyubov, S. (UC, Riverside)	Structures and spectral indices of M31 SNRs. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AG675	Gurwell, M. (Caltech) Butler, B.	Brightness temperature of Titan before and during Huygens descent. 0.7, 1.3 cm
AG688	Gal-Yam, A. (Caltech)	SN04D2jz-a new high-redshift type Ic supernova from the Canada-France-Hawaii. 3.5 cm
AH824	Harper, G. (Colorado/JILA) Brown, A. (Colorado/JILA) Guinan, E. (Villanova) Brown, J. (Caltech)	Evolution of Betelgeuse's extended atmosphere. 0.7, 1.3, 2, 3.6, 6, 20 cm
AH847	Humphreys, E. (Chalmers, Onsala) Reid, M. (CfA) Greenhill, L. (CfA) Moran, J. (CfA) Argon, A. (CfA)	Monitoring of water maser spectrum and jet continuum of NGC 4258. 1.3, 3.6 cm
AH855	Hardcastle, M. (Bristol, UK) Kraft, R. (CfA) Worrall, D. (Bristol, UK)	Proper motion and variability in the jet of Cen A. 3.6 cm
AH856	Hofstadter, M. (JPL) Butler, B.	Seasonal variations and depth probing of the atmosphere of Uranus. 2, 6, 20 cm
AH858	Hardcastle, M. (Bristol, UK) Harris, D. (CfA) Worrall, D. (Bristol, UK) Birkinshaw, M. (Bristol, UK)	Hotspots of FRII sources. 1.3, 2 cm
AH862	Harris, D. (CfA) Junor, W. (LANL) Cheung, C. (Brandeis)	Monitoring knot HST-1 in the M87 jet. 1.3, 2, 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AI113	Imai, H. (Kagoshima) Diamond, P. (Manchester) Deguchi, S. (NAO, Japan) Nakashima, J. (NAO, Japan) Miyazaki, A. (Ibaraki U.)	SiO and continuum from AGB star W43A. 0.7 cm
AI116	Ivison, R. (Royal Obs) Webb, T. (Leiden) Yee, H. (Toronto) Hoekstra, H. (Groningen/Kapteyn) Gladders, M. (Carnegie Obs.)	Deep imaging of two strong-lensing clusters. 20 cm
AJ313	Johnson, K. (Wisconsin) Plante, S. (Laval)	Structure and spectra of low-metallicity starburst SBS0335-052. 1.3, 2, 3.6, 6 cm
AJ314	Johnson, K. (Wisconsin)	Structure and spectra of starburst galaxy Henize 2-10. 1.3, 2, 3.6, 6 cm
AJ315	Johnston, K. (USNO) Boboltz, D. (USNO) Claussen, M. Fey, A. (USNO) Puatua, W. (USNO) Zacharias, N. (USNO)	Radio star observations for a radio/optical frame tie. 3.6 cm
AK575	Kulkarni, S. (Caltech) Senko, S. (Caltech) Frail, D. Harrison, F. (Caltech) Fox, D. (MIT) Soderberg, A. (Caltech)	Triggered observations of GRB afterglows. 0.7, 1.3, 2, 3.6, 6, 20 cm
AK583	Kenney, J. (Yale) Van Gorkom, J. (Columbia) Vollmer, B. (MPE-Bonn)	HI in highly-inclined ram pressure stripped spirals in the Virgo Cluster. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AK585	Karovska, M. (CfA) Matthews, L.	Monitoring of maser line and continuum flux densities of Mira. 0.7, 1.3, 3.6, 20 cm
AK586	Kurtz, S. (Mexico/UNAM) Hofner, P. Araya, E. (NMIMT)	Continuum imaging of DR 21 (OH). 3.6 cm
AK596	Kulkarni, S. (Caltech) Cenko, S. (Caltech) Fox, D. (MIT) Frail, D. Gal-Yam, A. (Caltech) Harrison, F. (Caltech) Moon, D-S. (Caltech) Soderberg, A. (Caltech)	GRBs prior to Swift checkout.
AL604	Laing, R. (Oxford) Parma, P. (Bologna) Bridle, A. Fanti, R. (Bologna)	Depolarization asymmetry in extragalactic radio sources. 20 cm
AL627	Landt, H. (STScI) Bignall, H. (JIVE) Padovani, P. (STScI) Perlman, E. (Maryland)	A sample of faint BL Lacertae objects. 20 cm
AL634	Lister, M. Kochancyzk, M. (Purdue)	Deep imaging of the MOJAVE blazar sample. 20 cm
AL635	Lovell, A. (Agnes Scott) Butler, B. Schloerb, P. (Massachusetts)	Resolving asteroids. 0.7, 1.3, 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AL636	Lim, J. (Academia Sinica) Carilli, C. White, S. (Maryland)	Imaging the atmospheres of red supergiant stars. 0.7, 1.3, 2, 3.6, 6 cm
AL637	Laing, R. (Oxford) Hardcastle, M. (Bristol, UK) Bridle, A.	Deep polarimetry of the jets in the FRI radio galaxy 3C 296. 3.6 cm
AL639	Linz, H. (Puerto Rico) Hofner, P. Araya, E. (NMIMT) Stecklum, B. (Thuringian) Henning, T. (Jena U.) Kurtz, S. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Marti, J. (U. Jaen)	Structure of the central source in HH80/81. 0.7, 1.3, 3.6 cm
AM803	Marti, J. (U. Jaen) Combi, J. (U. Jaen)	Spectrum and variability of gamma-ray source IGR J18027-1455. 3.6, 6, 20 cm
AM805	Mason, B. (Caltech) Lockman, F.J.	Galactic hydrogen column density towards Abell 478. 20 cm
AM814	McNamara, B. (Ohio State) Carilli, C. Nulsen, P. (CFA) Birzan, L. (Ohio State) Wise, M. (MIT)	X-ray cavities in the z=0.22 cluster MS0735+7421. 3.6, 20, 90 cm
AN122	Nagar, N. (Arcetri) Wilson, A. (Maryland) Falcke, H. (MPIR, Bonn) Veilleux, S. (Maryland) Maiolino, R. (Arcetri) Teng, S. (Maryland)	Imaging ultraluminous infra-red galaxies. 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AN123	Nagar, N. (Arcetri) Storchi-Bergman, T. (UFRGS, Brazil) Eracleous, M. (Penn State Univ.) Strateva, I. (Penn State Univ.)	Imaging SDSS galaxies with double-peaked broad H alpha lines. 6 cm
AO185	Orru, E. (Cagliari) Feretti, L. (Bologna) Giovannini, G. (Bologna) Govoni, F. (Bologna) Lane, W. (NRL) Kassim, N. (NRL) Murgia, M. (Bologna) Perley, R.	Spectral indices of giant radio galaxies. 90, 400 cm
AP478	Pedlar, A. (Manchester) Muxlow, T. (Manchester) Beswick, R. (Manchester) Argo, M. (Manchester) Wills, K. (Sheffield)	Monitoring radio SNe and SNRs in nearby starbursts. 2, 3.6, 6, 20 cm
AP479	Perlman, E. (Maryland) Rector, T. (Alaska) Padovani, P. (STScI) Landt, H. (STScI) Stocke, J. (Colorado/JILA)	Radio quasars with synchrotron peaks in the UV or above. 20 cm
AP483	Paragi, Z. (NFRA) Kouveliotou, C. (NASA/MSFC) Garrett, M. (NFRA) Paczynski, B. (Princeton) Mazzali, P. (INAF) Ramirez-Ruiz, E. (Univ. Cambridge) Hillebrandt, W. (MPA, Garching) Woosley, S (Calif., Santa Cruz)	SN 2004aw at late times. 6, 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AP486	Patel, N. (CfA) Curiel, S. (CfA) Greenhill, L. (CfA) Ho, P. (CfA) Hunter, T. (CfA) Moran, J. (CfA) Sridharan, T. (CfA) Torrelles, J. (IEEC) Zhang, Q. (CfA)	Water masers in Cepheus-A HW2 and HW3. 1.3 cm
AR545	Rupen, M. (NASA/GSFC) Mioduszewski, A. Dhawan, V.	Monitoring of X-ray binaries etc. 0.7, 1.3, 2, 3.6, 6, 20 cm
AR552	Rodriguez, L. (Mexico/UNAM) Reipurth, B. (Hawaii)	Structure of two protostellar outflow sources. 0.7 cm
AR554	Romani, R. (Stanford) Greenhill, L. (CfA) Michelson, P. (Stanford)	Search for a kpc-scale jet in the high-z blazar Q0906+6930. 3.6, 6, 20 cm
AR555	Romani, R. (Stanford) Ulvestad, J. Michelson, P. (Stanford) Healy, S. (Stanford) Sadler, E. (Sydney) Greenhill, L. (CfA)	Southern survey for flat-spectrum blazars. 3.6, 20 cm
AR557	Robberto, M. (STScI) Keto, E. (CfA) Kamp, I. (STScI)	HI absorption against Orion proplyds. 20 cm
AR558	Ribo, M (Barcelona) Mirabel, I. (CNRS, France) Casares, J. (Laguna) Combi, J. (U. Jaen)	A new micro quasar candidate. 20, 6, 3.6, 2 cm

VLA Observing Programs

No.	Observer(s)	Programs
AS796	Soderberg, A. (Caltech) Frail, D. Kulkarni, S. (Caltech) Chevalier, R. (Virginia)	Triggering on further type Ibc SNe. 1.3, 3.6, 6, 20 cm
AS800	Sjouwerman, L. Messineo, M. (Leiden) Habing, H. (Leiden) Honma, M. (NAO, Japan) Imai, H. (NFRA)	Monitoring circumstellar SiO masers near Sgr A*. 0.7 cm
AS801	Schinnerer, E. (MPIA) Carilli, C. Scoville, N. (Caltech) Bertoldi, F. (MPIR, Bonn) Blain, A. (Caltech) Bondi, M. (Bologna) Ciliegi, P. (Bologna) Impey, C. (Arizona) Koekemoer, A. (Mt. Stromlo) LeFevre, O. (Marseille Obs) Urry, C. (Yale) Vettolani, P.	COSMOS deep 1.4 GHz imaging survey. 20 cm
AS806	Schmitt, H. (Virginia) Anderson, J. (NMIMT) Cid-Fernandes, R. (UFSC) Heckman, T. (STScI) Gonzales-Delgado, R. (IAA, Andalucia) Storchi-Bergmann, T. (UFRGS)	Continuum images of Palomar LLAGNs at 6cm and 3.5cm. 3.6, 6 cm
AS810	Schindler, S. (Liverpool JMU) Feretti, L. (Bologna) Ferrari, C. (Cote d'Azur) Gitti, M. (Univ. Innsbruck)	X-ray luminous galaxy cluster RBS797. 6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AS812	Schinnerer, E. (MPIA) Rupen, M. (NASA/GSFC) Kennicutt, R. (Arizona) Mason, B. (Caltech)	Deep imaging of M51 at 20cm. 20 cm
AS813	Shinnaga, H. (CfA) Moran, J. (CfA) Young, K. (CfA) Ho, P. (CfA) Furuya, R. (Arcetri)	Spectropolarimetric imaging of SiO masers toward VY Canis Maj. 0.7 cm
AS814	Snellen, I. (Royal Obs) Best, P. (Royal Obs) Rigby, E. (Edinburgh)	Structure of high-redshift FR I candidates. 20 cm
AS815	Sarma, A. (Illinois) Claussen, M.	Water masers near high-mass proto stellar objects. 1.3 cm
AS819	Sjouwerman, L. Garrett, M. (NFRA) Dickel, J. (Illinois)	Simultaneous EVN/VLA observations of M31*. 6 cm
AS820	Stalder, B. (IfA) Chambers, K. (Hawaii)	Imaging sources near bright natural guide stars. 3.6 cm
AS821	Strasser, S. (Minnesota) Dickey, J. (Minnesota)	OH absorption of background sources in the Galactic Plane. 20 cm
AS823	Sokoloski, J. (Southampton) Mioduszewski, A. Brocksopp, C. (MSSL) Rupen, M. (NASA/GSFC) Kaiser, C. (MPIfEP, Garching)	Imaging the jet in the symbiotic binary Z. 1.3, 3.6, 6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AS825	Shirley, Y. Claussen, M.	Spitzer core L1014. 6, 20 cm
AT298	Tafoya, D. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Gomez, Y. (Mexico/UNAM) Lopez, A. (Mexico/UNAM)	Structural changes in MWC 349 A. 1.3, 2, 6 cm
AT299	Terashima, Y. (ISAS) Ho, L. (DTM/Carnegie) Ulvestad, J.	Search for emission from ultra-low-luminosity AGNs. 3.6 cm
AT300	Tao, A. (Shanghai Obs.) Goss, W.M. Morris, M. (UCLA) Hong, X. (Shanghai Obs) Zhao, J. (CfA)	Proper motions of radio components near Sgr A*. 1.3 cm
AT303	Tsai, C-W. (UCLA) Turner, J. (UCLA) Beck, S. (Tel-Aviv) Ho, P. (CfA)	HII regions in M82 and NGC 253. 0.7, 1.3 cm
AT304	Turner, J. (UCLA) Naiman, J. (UCLA) Beck, S. (Tel-Aviv) Ho, P. (CfA) Tsai, C-W. (UCLA)	The super star cluster nebula in NGC 660. 1.3 cm
AU100	Umana, G. (Bologna) Cerrigone, L. (Catania) Trigilio, C. (Bologna)	Young planetary nebulae. 0.7, 2, 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AU101	Umana, G. (Bologna) Buemi, C. (Bologna) Trigilio, C. (Bologna) Leto, P. (Bologna)	Luminous blue variable IRAS 18576+0341. 6, 20 cm
AV277	Vlemmings, W. (Leiden) Menten, K. (MPIR, Bonn) Reid, M. (CfA)	Astrometry of the water masers and continuum from VX Sgr. 1.3 cm
AW638	Williams, P. (Edinburgh) Dougherty, S. (DRAO)	Monitoring the nonthermal emission by WR 125. 3.6, 6, 20 cm
AW641	Weiler, K. (NRL) Stockdale, C. (NRL) Sramek, R. VanDyk, S. (UCLA) Panagia, N. (STScI) Marcaide, J. (Valencia) Lewin, W. (MIT) Pooley, D. (MIT) Immler, S. (Massachusetts) Ryder, S. (AAO)	Triggered observations of type II SNe. 1.3, 2, 3.6, 6, 20, 90 cm
AX009	Xu, Y. (Shanghai Obs) Reid, M. (CfA) Menten, K. (MPIR, Bonn) Zheng, X. (Nanjing) Moscadelli, L. (Bologna)	Astrometric calibrators for massive star forming regions. 2 cm
AY151	Yusef-Zadeh, F. (Northwestern) Palmer, P. (Chicago) Hewitt, J. (Northwestern)	Search for 6cm OH maser emission from SNR maser regions. 6 cm
AY152	Yusef-Zadeh, F. (Northwestern) Cotton, W. D. Bower, G. (UC, Berkeley)	VLA+PT+VLBA study of Sgr A*. 6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AZ154	Zapata, L. (Mexico/UNAM) Rodriguez, L. (Mexico/UNAM) Kurtz, S. (Mexico/UNAM) O'Dell, C. (Vanderbilt) Ho, P. (CfA)	Structure and spectra of sources in OMC1 South. 0.7, 1.3 cm

VLBA Observing Programs

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

No.	Observer(s)	Programs
BA071	Agudo, I. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Bach, U. (MPIR, Bonn) Bremer, M. (IRAM) Graham, D. (MPIR, Bonn) Grewing, M. (IRAM) Krichbaum, T. ((MPIR, Bonn) Terasranta, H. (Metsahovi) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	NRAO 150: A moving helical jet?. 0.7, 1, 2 cm
BB172	Brunthaler, A. ((MPIR, Bonn) Falcke, H. (MPIR, Bonn) Greenhill, L. (CfA) Henkel, C. (MPIR, Bonn) Reid, M. (CfA)	Proper motions in the local group. 1 cm
BB174	Bower, G. (UC, Berkeley) Bolatto, A. (UC, Berkeley) Plambeck, R. (U, Berkeley)	Trigonometric parallax of radio stars in the Orion Nebula. 2 cm
BB190	Bietenholz, M. (York U.) Bartel, N. (York U.)	SN 2001em. 0.4 cm
BB191	Barvainis, R. (NSF) Ulvestad, J. Birkinshaw, M. (Bristol, UK) Lehar, J. (CFA)	Radio-quiet quasars. 0.7, 6 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BB207	Bower, G. (UC, Berkeley) Backer, D. (UC, Berkeley) Falcke, H. (MPIR, Bonn) Goss, W.M. Herrnstein, R. (Columbia) Lithwick, Y. (UC, Berkeley) Muno, M. (UC, Los Angeles)	An X-ray/radio transient 2.5" from Sgr A*. 0.4, 1 cm
BC120	Chatterjee, S. (Cornell) Backer, D. (UC, Berkeley) Benson, J. Brisken, W. Cordes, J. (Cornell) Ellis, R. (UC, Santa Cruz) Fomalont, E. Golden, A. (Ireland) Goss, W.M. Kramer, M. (Manchester) Lazio, T. (NRL) Lyne, A. (Manchester) McKinnon, M. Thorsett, S. (UC, Santa Cruz) Wong, D. (Cornell)	Pulsar astrometry with the VLBA. 20 cm
BC146	Colomer, F. (OAN, Spain) Alcolea, J. (OAN, Spain) Bujarrabal, V. (OAN, Spain) Desmurs, J. (OAN, Spain) Soria-Ruiz, R. (OAN, Spain)	Relative spatial distribution of SiO masers in AGB Stars. 0.7 cm
BC147	Cotton, W.D. Danchi, W. (NASA/GSFC) Lacasse, M. (CfA) Ragland, S. (CfA) Schloerb, F. (UC, Berkeley) Townes, C. (UC, Berkeley) Traub, W. (CfA)	VLBA/IOTA observations of Miras with photospheric asymmetrics. 0.7 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BD087	Dhawan, V. Fomalont, E. Lestrade, J-F. (Obs. de Paris) Mioduszewski, A. Rupen, M. (NASA/GSFC)	Astronometry of X-ray binaries. 1, 2 cm
BD099	Dallacasa, D. (Bologna) Orienti, M. (Bologna) Tinti, S. (Brera Obs) Stanghellini, C. (Bologna)	Spectral imaging of two classes of CSOs. 0.4, 6, 20 cm
BD101	Dougherty, S. (DRAO) Beasley, A. Pittard, J. (Leeds) Claussen, M. Bolingbroke, N. (NRC) Zauderer, A. (Agnes Scott College)	Observing wind-collision and orbital motion in WR140. 0.7, 1.3, 2, 3.6 cm
BD102	DeBreuck, C. (ESO) Perez-Torres, M. (IAA, Spain) deVries, W. (IGPP) Miley, G. (Leiden) Overzier, R. (Leiden) van Breugel, W. (IGPP)	Imaging of two high redshift galaxies. 6 cm
BG121	Gabuzda, D. (Cork) Cawthorne, T. (Lancashire) Pashchenko, I. (Moscow State) Pushkarev, A. (ASC)	High frequency polarization of a complete sample of BL Lac objects. 0.7, 1, 2 cm
BG131	Gabuzda, D. (Cork) Croke, S. (Cork) Vetukhnovskaya, Y. (ASC)	Nature of variable sheath structures surrounding the jets of compact AGN. 0.4, 1, 2, 6 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BG150	Giovannini, G. (Bologna) Feretti, L. (Bologna) Giroletti, M. (Bologna) Taylor, G. Edwards, P. (ISAS, Japan)	Jet and counterjet in Mrk 501. 20 cm
BG152	Gabuzda, D. (Cork) Rastorgueva, E. (Moscow/SSAI) Smith, P. (Arizona)	Simultaneous radio and optical polarimetry of AGN jets. 0.7, 1, 2 cm
BG153	Goddi, C. (Cagliari) Brand, J. (IRA-CNR, Bologna) Moscadelli, L. (Cagliari) Tarchi, A. (IRA-CNR, Cagliari)	H20 maser kinematics close to high-mass YSOs. 1 cm
BG154	Greenhill, L. (CfA) Michelson, P. (Stanford) Romani, R. (Stanford)	Jet proper motion and millimeter spectral index in the High Z blazar Q0906-6930. 2 cm
BG155	Greenhill, L. (CFA) Madejski, G. (NASA/GSFC) Henkel, C. (MPIR, Bonn) Peck, A. (CFA) Braatz, J. Wilson, A. (Maryland)	Water masers in IC 2560 AGN. 1 cm
BH126	Harris, D. (SAO) Cheung, C. (Brandeis) Junor, W. (LANL)	Ongoing outburst of knot 'HST-1' in the M80 jet. 90 cm
BH128	Hough, D. (Trinity U.) Aars, C. (Trinity U.)	Faint nuclei 3CR FR II radio sources. 0.4 cm
BI030	Imai, H. (Kagoshima) Diamond, P. (Manchester)	Evolution on a water fountain in W43A. 1 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BJ036	Jorstad, S. (Boston) Marscher, A. (Boston) Yurchenko, A. (St. Petersburg)	BL Lac objects with high proper motion. 0.4, 0.7, 1, 2 cm
BJ048	Johnston, K. (USNO) Fey, A. (USNO) Ma, C. (NASA/GSFC) Gordon, D. (NASA/GSFC) Boboltz, D. (USNO) Kingham, K. (USNO) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) MacMillan, D. (Interferometrics) Petrov, L. (NASA/GSFC) Fomalont, E. Walker, R.C.	Geodesy/astrometry observations for 2000. 0.4, 13 cm
BJ054	Jackson, N. (Manchester) Browne, I. (Manchester) York, T. (Manchester) Mao, S. (Manchester) Porcas, R. (MPIR, Bonn) Biggs, A. (Manchester)	Search for a third image in CLASS B1030+070. 0.4, 20 cm
BJ058	Cimo, G. (Tasmania) Fey, A. (USNO) Jauncey, D. (ATNF) Johnston, K. (USNO) Lovell, J. (ATNF) Ojha, R. (ATNF) Quick, J. (HartRAO)	Measure the scattered size of the remarkable scintillator PKS 0405-385 in order to determine the distance to the scattering screen. 20 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BK107	Krichbaum, T. (MPIR, Bonn) Sohn, B. (MPIR, Bonn) Agudo, I. (IAA, Andalucia) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn) Ungerechts, H. (Massachusetts) Terasranta, H. (Helsinki)	Polarimetric monitoring of blazar 1633+382 after major flare. 0.7, 1 cm
BK113	Kemball, A. (Univ. Illinois) Diamond, P. (Manchester)	Monitoring SiO masers at 0.7mm and 3mm in two evolved stars. 0.7 cm
BK114	Kondratko, P. (CfA) Greenhill, L. (CfA) Moran, J. (CfA) Reid, M. (CfA)	Imaging three NGC 4258-like water megamasers. 1 cm
BK115	Kunert, M. (Torun) Marecki, A (Torun)	Looking for prematurely dying, young radio sources. 0.4, 6, 20 cm
BL104	Lobanov, A. (MPIR, Bonn) Roland, J. (IAP, Paris) Ros, E. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Cross-band monitoring of a flare in the VLBI core of 3C345. 0.7, 1, 2 cm
BL105	Lobanov, A. (MPIR, Bonn) Klare, J. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Multi-frequency monitoring of the parsec-scale jet in 3C345. 0.4, 6 cm

VLBA Observing Programs

No.	Observer(s)	Programs
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. 2 cm.
BL122	Lanyi, G. (JPL) Boboltz, D. (USNO) Charlot, P. (Bordeaux) Fey, A. (USNO) Fomalont, E. Gordon, D. (NASA/GSFC) Ma, C. (NASA/GSFC) Romney, J. Sovers, O. (Remote Sensing) Taylor, G. Ulvestad, J.	High precision K/Q-Band astrometry. 1 cm
BL124	Loinard, L. (Mexico/UNAM) Mioduszewski, A. Rodriguez, L. (Mexico/UNAM) Rodriguez, M. (Mexico/UNAM) Torres, R. (Mexico/UNAM)	Parallax and proper motions of young stellar sources in Taurus. 0.4 cm
BM208	Middelberg, E. (ATNF) Krichbaum, T. (MPIR, Bonn) Roy, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Proper motions in NGC 3079:Infall, outflow or jet? 1, 6 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BM211	Marscher, A. (Boston) Aller, M. (Michigan) Gomez, J. (IAA, Granada) Jorstad, S. (Boston) McHardy, I. (Southampton)	Multi-frequency monitoring of the jets of selected blazars and radio galaxies. 1, 0.7 cm
BM215	Middelberg, E. (ATNF) Bach, U. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Roy, A. (MPIR, Bonn)	Fate of polarized emission in NGC 4261, Hydra A and Cygnus A. 0.7 cm
BN021	Nagar, N. (Arcetri) Falcke, H. (MPIR, Bonn) Maoz, D. (Tel Aviv) Wilson, A. (Maryland)	Accretion in low-luminosity AGN: a radio, UV, and X-ray variability study. 6 cm
BP116	Piner, B. (Whittier College) Edwards, P. (ISAS, Japan) Jones, D. (JPL) Murphy, D. (JPL)	Measurements of high brightness temperatures. 6 cm
BP117	Polatidis, A. (MPIR, Bonn) Conway, J. (Chalmers, Onsala) Marcha, M. (Lisbon) Bondi, M. (Bologna) Owsianik-Rottmann, I. (MPIR, Bonn)	Measurements of expansion velocities in CSOs. 0.4, 6 cm
BR092	Ratner, M. (CFA) Bartel, N. (York U.) Bietenholz, M. (York U.) Lebach, D. (CFA) Lederman, J. (York U.) Lestrade, J. (Paris Obs) Ransom, R. (York U.) Shapiro, I. (CFA)	Astrometric monitoring of HR 8703 for GP-B mission. 0.4 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BR095	Ramsdale, P. (Tasmania) Caswell, J. (CSIRO) Cragg, D. (Monash Univ.) Ellingsen, S. (Tasmania) Godfrey, P. (Monash Univ.)	Multi-transition observations of OH masers in G35341-036. 6, 20 cm
BR096	Garrett, M. (JIVE) Rawlings, S. (Oxford) Sansigre, A. (Oxford) Simpson, C. (Durham)	In-beam VLBI calibrators for the Subaru/XMM-Newton Deep Survey. 20 cm
BR103	Romney, J. Antreasian, P. (JPL) Benson, J. Border, J. (JPL) Dhawan, V. Fomalont, E. Jacobs, C. (JPL) Lanyi, G. (JPL) McElrath, T. (JPL) Mur, T. (JPL) Naudet, C. (JPL) Roth, D. (JPL) Walker, R.C.	Spacecraft navigation observations of Cassini spacecraft during a flyby of Iapetus. 0.4 cm
BS133	Savolainen, T. (Tuorla) Bottcher, M. (Ohio U.) Raiteri, C. (Torino) Takalo, L. (Tuorla) Villata, M. (Torino) Wiik, K. (Tuorla)	Multi-frequency properties of the blazar 3C 66A. 0.4, 0.7 ,6, 13 cm
BS144	Iguchi, S. (NAO, Japan) Murata, Y. (JAXA/ISAS) Takaba, H. (Gifu Univ.) Taniguchi, Y. (Tohoku) Wakamatsu, K. (Gifu Univ.)	Astrometric monitoring of the radio galaxy 3C 66B. 0.4, 13 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BT078	Taylor, G. Gugliucci, N. (Lycoming)	VLBA imaging of two exotic sources from Caltech-Jodrell Bank VLBI Surveys. 0.4,1, 2, 6 cm
BT079	van der Tak, F. (MPIR, Bonn) Hachisuka, K. (MPIR, Bonn) Menten, K. (MPIR, Bonn)	Proper motions of H_2O. 1 cm
BV053	Vlemmings, W. (Cornell) Chatterjee, S. (Cornell) Diamond, P. (Manchester) van Langevelde, H. (JIVE)	Parallax and proper motions of late-type stars OH maser VLBA astrometry with in-beam calibrators. 20 cm
BV055	Vlemmings, W. (Cornell) Diamond, P. (Manchester) Langevelde, H. (JIVE)	Monitoring the magnetic field on the water masers of U Ori. 1 cm
BV056	Vlemmings, W. (Cornell) van Langevelde, H. (JIVE)	Magnetic fields on the proto-stellar and proto-planetary nebulae H_20 masers. 1 cm
BW069	Wiik, K. (Tuorla) Raiteri, C. (Torino) Savolainen, T. (Tuorla) Takalo, L. (Tuorla) Villata, M. (Torino)	Multi-wavelength monitoring of a highly active blazar: BL lac object AO 0235+16 during an outburst. 0.4, 0.7, 1,2, 6, 13 cm
BW076	Winn, J. (CfA) Rusin, D. (CfA) Kochanek, C. (CfA)	Deep search for fourth image, due to a SMBH in lens at z=1. 0.4 cm
BW077	Walker, R.C. Benson, J. Hardee, P. (Alabama)	Constraining a possible helical flow in 3C120 at 10.0.7 GHz, II. 20 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BW079	Winn, J. (CfA) Kochanek, C. (Ohio State) Rusin, D. (Pennsylvania)	Test for free-free absorption of a central lensed image. 13 cm
BY018	Yusef-Zadeh, F. (Northwestern) Cotton, W.D. Bower, G. (Calif., Berkeley)	VLA+PT+VLBA study of Sgr A* . 6 cm
GA019	Agudo, I. (IAA, Andalucia) Bach, U. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Bremer, M. (Bristol, UK) Grewing, M. (IRAM) Terasranta, H. (Helsinki) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Structural monitoring of jet in NRAO 150. 0.7 cm
GA021	Argo, M. (Manchester) Beswick, R. (Manchester) Pedlar, A. (Manchester) Muxlow, T. (Manchester)	Possible radio supernova in the outer part of NGC 3310. 6 cm
GB051	Bach, U. (MPIR, Bonn) Friedrichs, S. (MPIR, Bonn) Impellizzeri, C. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Polarimetric monitoring of IDV blazar 0716+0714. 0.3 cm
GC024	Colomer, F. (Yebes Obs) Soria-Ruiz, R. (Yebes Obs) Bujarrabal, V. (Yebes Obs) Alcolea, J. (Yebes Obs) Desmurs, J. (Yebes Obs)	Distribution of SiO masers in AGB stars. 0.3 cm

VLBA Observing Programs

No.	Observer(s)	Programs
GG056	Gwinn, C. (Calif., Santa Barbara) Ramachandran, R. (Amsterdam) Deshpande, A. (Raman Institute) Walker, M. (Sydney) Stinebring, D. (Oberlin College) Boldyrev, S. (Univ. Chicago)	Spatial arrangement of sub-images in scattered pulsars. 90 cm
GG057	Gurvits, L. (JIVE) Pogrebenko, S. (JIVE) Avruch, I. (JIVE) Bignall, H. (JIVE) Campbell, R. (JIVE) Garrett, M. (JIVE) Lebreton, J. (ESA) vantKlooster, C. (ESA-ESTEC) Folkner, W. (JPL) Preston, R. (JPL) Romney, J. Bird, M. (Univ. Bonn)	VLBI and Doppler tracking of the Huygens Titan Probe. 3.6, 13 cm
GG058	Gwinn, C. (Calif., Santa Barbara) Deshpande, A. (Raman Institute) Ramachandran, R. (Amsterdam) Boldyrev, S. (Univ. Chicago) Desai, K. (Renaissance Tech)	Structure of scattering disks of pulsars. 90 cm
GG059	Gomez, J. (IEEC-Barcelona) Marscher, A. (Boston) Jorstad, S. (Boston) Agudo, I. (IAA, Andalucia) Krichbaum, T. (MPIR, Bonn) Lobanov, A. (MPIR, Bonn) McHardy, I. (Southampton)	Structural monitoring of jet in 3C120. 0.3, 0.7 cm
GG060	Garrett, M. (NFRA) Campbell, B. (Air & Space Museum)	Wide field 320.7 MHz observations of M81 and M82. 90 cm

VLBA Observing Programs

No.	Observer(s)	Programs
GI002	Impellizzeri, C. (MPIR, Bonn) Bach, U. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Kraus, A. (MPIR, Bonn) Friedrichs, S. (MPIR, Bonn) Britzen, S. (Heidelberg Obs) Witzel, A. (MPIR, Bonn)	Intermediate scales in the BL Lac object 0716+0104. 90 cm
GK023	Krichbaum, T. (MPIR, Bonn) Sohn, B. (MPIR, Bonn) Agudo, I. (IAA, Andalucia) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn) Ungerechts, H. (Massachusetts) Terasranta, H. (Helsinki)	Structural monitoring of blazar 1633+382 after major flare. 0.3, 0.7 cm
GK025	Klare, J. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Lobanov, A. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Zensus, J. (MPIR, Bonn) Witzel, A. (MPIR, Bonn)	Structural monitoring of jet in quasar 3C 300.45. 0.3, 0.7 cm
GK027	Kadler, M. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Kraus, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Lobanov, A. (MPIR, Bonn) Bremer, M. (Bristol, UK) Grewing, M. (IRAM)	Structure of NGC1052 at 3mm. 0.3, 0.7 cm

VLBA Observing Programs

No.	Observer(s)	Programs
GK028	Krichbaum, T. (MPIR, Bonn) Britzen, S. (Heidelberg Obs) Strom, R. (NFRA) Gabanyi, K. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Ros, E. (MPIR, Bonn)	Imaging the large scale curvature in the jet of 1803+784. 90 cm
GM055	Marcaide, J. (Valencia) Marti-Vidal, I. (Valencia) Guirado, J. (Valencia) Alberdi, A. (IAA, Andalucia) Lara, L. (IAA, Andalucia) Perez-Torres, M. (Bologna) Ros, E. (MPIR, Bonn) Diamond, P. (Manchester) Shapiro, I. (CFA) Preston, R. (JPL) Schilizzi, R. (NFRA) Mantovani, F. (Bologna) Trigilio, C. (Bologna) VanDyk, S. (UCLA) Weiler, K. (NRL) Sramek, R. Whitney, A. (Haystack)	Structural monitoring of SN 1993J in M81. 6 cm
GM056	Mittal, R. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) Browne, I. (Manchester) Biggs, A. (Manchester)	3mm observations of gravitational lens B0218+357. 0.3, 0.7 cm
GP040	Pagels, A. (MPIR, Bonn) Klare, J. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Structural monitoring of jet in quasar 3C 04. 0.3, 0.7 cm

VLBA Observing Programs

No.	Observer(s)	Programs
GP041	Pagels, A. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J. (MPIR, Bonn)	Structural monitoring of 3C800.4 at 3mm. 0.3, 0.7 cm
GR024	Ramachandran, R. (Amsterdam) Deshpande, A. (Raman Institute) Gwinn, C. (Calif., Santa Barbara) Ghosh, T. (NAIC)	Apparent angular sizes of pulsars behind HII regions. 90 cm
GS023	Smith, N. (Cork) Gabuzda, D. (Cork)	Polarization of three radio-intermediate quasars. 6 cm

Personnel

NEW HIRES

Hart, Derek	Systems Administrator I	12/13/2004
Macquart, Jean-Pierre	Research Associate	10/01/2004

PROMOTIONS

Ben Frej, Hichem	Software Engineer I	11/01/2004
Crady, Warren "Kirk"	Electronics Engineer III	11/01/2004
Kanekar, Nissim	Research Associate	11/15/2004
Luce, Matthew	Electronics Engineer III	10/18/2004
Pan, Shing Kuo	Deputy Division Head, CDL	10/01/2004
Reynolds, Eric	Electronics Engineer III	12/13/2004
Romero, Magdalene	Senior Buyer	11/01/2004
Schreier, Ethan	President	10/22/2004
Srikanth, Sivasankaran "Sri"	Research Engineer	10/01/2004

TRANSFERS

Ridgeway, Robert	Electronics Engineer II	12/01/2004
Taylor, Gregory	Division Head	10/01/2004

Publications

The following preprints were received in the NRAO Charlottesville library during this reporting period authored by the NRAO staff or based on observations on an NRAO telescope.

ARAYA, E.; HOFNER, P.; KURTZ, S.; LINZ, H.; OLMI, L.; SEWILO, M.; WATSON, C.; CHURCHWELL, E. Discovery of an H2CO 6 cm Maser in IRAS 18566+0408.

BOBOLTZ, D.A.; WITTKOWKSI, M. Joint VLBA/VLTI Observations of the Mira Variable S Orionis.

BRAATZ, J.A.; HENKEL, C.; GREENHILL, L.J.; MORAN, J.M.; WILSON, A.S. A Green Bank Telescope Search for Water Masers in Nearby Active Galactic Nuclei.

CARILLI, C.L.; SOLOMON, P.; VANDEN BOUT, P.; WALTER, F.; BEELEN, A.; COX, P.; BERTOLDI, F.; MENTEN, K.M.; ISAAK, K.G.; CHANDLER, C.J.; OMONT, A. A Search for Dense Molecular Gas in High Redshift Infrared-Luminous Galaxies.

CID FERNANDES, R.; GONZALEZ DELGADO, R.M.; STORCHI-BERGMANN, T.; PIRES MARTINS, L.; SCHMITT, H. The Stellar Populations of Low Luminosity Active Galactic Nuclei. III: Spatially Resolved Spectral Properties.

COLES, W.A.; MCLAUGHLIN, M.A.; RICKETT, B.J.; LYNE, A.G.; BHAT, N.D.R. Probing the Eclipse of J0737-3039A with Scintillation.

DARLING, J.; GIOVANELLI, R.; HAYNES, M.P.; BOLATTO, A.D.; BOWER, G.C. Detection of 21 Centimeter H I Absorption at z=0.78 in a Survey of Radio Continuum Sources.

DWARAKANATH, K.S.; GOSS, W.M.; ZHAO, J.H.; LANG, C.C. On the Origin of the Wide HI Absorption Line Toward Sgr A*

FOMALONT, E.; REID, M. Microarcsecond Astrometry using the SKA.

FRAIL, D.A.; SODERBERG, A.M.; KULKARNI, S.R.; BERGER, E.; YOST, S.; FOX, D.W.; HARRISON, F.A. Accurate Calorimetry of GRB 030329.

FREIRE, P.C.C.; HESSELS, J.W.T.; NICE, D.J.; RANSOM, S.M.; LORIMER, D.R.; STAIRS, I.H. The Millisecond Pulsars in NGC 6760.

GARRETT, M.A.; WROBEL, J.M.; MORGANTI, R. Deep VLBI Imaging of Faint Radio Sources in the NOAO Bootes Field.

GIACANI, E.; REYNOSO, E.M.; DUBNER, G.; GOSS, W.M.; GREEN, A.J.; JOHNSTON, S. The Neutral Gas in the Environs of Geminga Gamma-Ray Pulsar.

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GIOVANNINI, G.; TAYLOR, G.B.; FERETTI, L.; COTTON, W.D.; LARA, L.; VENTURI, T. The Bologna Complete Sample of Nearby Radio Sources.

GIROLETTI, M.; TAYLOR, G.B.; GIOVANNINI, G. The Two Sided Parsec Scale Structure of the Low Luminosity Active Galactic Nucleus in NGC 4278.

GUGLIUCCI, N.E.; TAYLOR, G.B.; PECK, A.B.; GIROLETTI, M. Dating COINS: Kinematic Ages for Compact Symmetric Objects.

HARPER, G.M.; BROWN, A.; BENNETT, P.D.; BAADE, R.; WALDER, R.; HUMMEL, C.A. VLA Observations of Zeta Aurigae: Confirmation of the Slow Acceleration Wind Density Structure.

HERRNSTEIN, R.M.; HO, P.T.P. The Nature of the Molecular Environment within 5 pc of the Galactic Center.

HIBBARD, J.E.; BIANCHI, L.; THILKER, D.A.; RICH, R.M.; SCHIMINOVICH, D.; XU, C.K.; NEFF, S.G.; SEIBERT, M.; LANGER, S.; BURGARELLA, D.; BARLOW, T.A.; BYUN, Y.-I.; DONAS, J.; FORSTER, K.; FRIEDMAN, P.G.; HECKMAN, T.M.; JELINSKY, P.N.; LEE, Y.-W.; MADORE, B.F.; MALINA, R.F.; MARTIN, D.C.; MILLIARD, B.; MORRISSEY, P.; SIEGMUND, O.H.W.; SMALL, T.; SZALAY, A.S.; WELSH, B.Y.; WYDER, T.K. UV Morphology and Star Formation in the Tidal Tails of NGC 4038/39.

HOFFMAN, I.M.; GOSS, W.M.; BROGAN, C.L.; CLAUSSEN, M.J. The OH (1720 MHz) Supernova Remnant Masers in W28: MERLIN and VLBA Polarization Observations.

HORIUCHI, S.; FOMALONT, E.B.; SCOTT, W.K.; TAYLOR, A.R.; LOVELL, J.E.J.; MOELLENBROCK, G.A.; DODSON, R.; MURATA, Y.; HIRABAYASHI, H.; EDWARDS, P.G.; GURVITS, L.I.; SHEN, Z.-Q. The VSOP 5 GHz Active Galactic Nucleus Survey. IV. The Angular Size/Brightness Temperature Distribution.

KEEL, W.C.; IRBY, B.K.; MILEY, G.K.; GOLOMBEK, D.; DE GRIJP, M.H.K.; GALLIMORE, J.F. An Atlas of Warm AGN and Starbursts from the IRAS Deep Fields.

KONDRATKO, P.T.; GREENHILL, L.J.; MORAN, J.M. Evidence for a Geometrically Thick Self-Gravitating Accretion Disk in NGC 3079.

LO, K.Y. Mega-masers and Galaxies.

LUCERNO, D.M.; YOUNG, L.M.; VAN GORKOM, J.H. Ram Pressure Stripping in the Low Luminosity Virgo Cluster Elliptical Galaxy NGC 4476.

MILAM, S.N.; SAVAGE, C.; ZIURYS, L.M.; WYCKOFF, S. HCO+ Observations towards Comet Hale-Bopp (C/1995 O1): Ion-Molecule Chemistry and Evidence for a Volatile Secondary Source.

Publications

MOHAN, N.R.; GOSS, W.M.; ANANTHARAMAIAH, K.R. Multi-Density Model of the Ionised Gas in NGC 253 Using Radio Recombination Lines.

MUTEL, R.L.; DENN, G.R. Is the Radio Core of BL Lac Precessing?

NICE, D.J.; STAIRS, I.H.; ARZOUMANIAN, Z. GBT Observations of Very Low Mass Binary Millisecond Pulsars: A Search for Eclipses.

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OWEN, F.N.; KEEL, W.C.; LEDLOW, M.J.; MORRISON, G.E.; WINDHORST, R.A. A Deep Radio Survey of Abell 2125 I. Radio, Optical and Near-IR Observations.

OWEN, F.N.; LEDLOW, M.J.; KEEL, W.C.; WANG, Q.D.; MORRISON, G.E. A Deep Radio Survey of Abell 2125 II. Accelerated Galaxy Evolution during a Cluster-Cluster Merger.

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SNYDER, L.E.; LOVAS, F.J.; HOLLIS, J.M.; FRIEDEL, D.N.; JEWELL, P.R.; REMIJAN, A.; ILYUSHIN, V.; ALEKSEEV, E.A.; DYUBKO, S.F. A Rigorous Attempt to Verify Interstellar Glycine.

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UKITA, N.; SAITO, M.; EZAWA, H.; IKENOUE, B.; ISHIZAKI, H.; IWASHITA, H.; YAMAGUCHI, N.; HAYAKAWA, T.; ATF-J TEAM Design and Performance of the ALMA-J Prototype Antenna.

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ULVESTAD, J.S.; ANTONUCCI, R.R.J.; BARVAINIS, R. VLBA Imaging of Central Engines in Radio Quiet Quasars.

VAN LANGEVELDE, H.J.; PIHLSTROM, Y.; BEASLEY, A. Molecular Absorption in Cen A on VLBI Scales.

WALTER, F.; CARILLI, C.; BERTOLDI, F.; MENTEN, K.; COX, P.; LO, K.Y.; FAN, X.; STRAUSS, M.A. Resolved Molecular Gas in a Quasar Host Galaxy at Redshift z = 6.42.

WILLIAMS, B.F.; SJOUWERMAN, L.O.; KONG, A.K.H.; GELFAND, J.D.; GARCIA, M.R.; MURRAY, S.S. Two New X-ray/Optical/Radio Supernova Remnants in M31.

WU, Y.; ZHANG, Q.; CHEN, H.; YANG, C.; WEI, Y.; HO, P.T.P. CO J=2-1 Maps of Bipolar Outflows in Massive Star Forming Regions.

Budget

The table below represents NRAO Operations (without EVLA) expenses and commitments for the first quarter of FY 2005 as reported at Work Breakdown Structure (WBS) Level 1.

Available funds for NRAO Operations (excluding EVLA) total $13,850,403. This amount includes first FY 2005 funding of $11,652,500 (less $1,335k for EVLA Phase I construction) in new NSF funds, $1,861,325 in prior year commitments, and $1,671,581 in prior year carryover. The second increment of new NSF funds is expected to be released by the end of January.

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NRAO Operations Expenses and Commitments FY 2005 Quarter 1 (October 1 - December 31, 2004)

Work Breakdown Structure Element Level 1	Salaries & Benefits	Materials & Services	Travel	Revenue or Cost Recovery	Total
Observatory Management	$663,328	$1,770,701	$81,685	($64,449)	$2,451,265
Education and Public Outreach	$90,101	$49,209	$4,144	($32,246)	$111,208
Central Development Lab	$316,435	$12,755	$897	$0	$330,087
Green Bank Operations	$2,010,454	$1,196,366	$27,829	($135,017)	$3,099,632
New Mexico Operations	$3,034,553	$1,096,491	$31,331	($18,868)	$4,143,507
ALMA Operations	$89,106	$0	$6,324	$0	$95,430
Computer and Information Services	$228,449	$176,405	$5,449	$0	$410,303
Division of Science and Academic Affairs	$952,507	$210,165	$35,062	$0	$1,197,734
	$7,384,933	$4,512,092	$192,721	($250,580)	$11,839,166

Appendix A
ALMA Level 2 Milestone Status

IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
Site Development	8212	1.02.025.0225	Draft Joint Antenna Foundation Interface	Complete	1-Feb-03	6-Mar-03	
Site Development	8300	1.02.025.0260	Engr. Contract Award - Hwy to OSF road	Complete	13-Feb-03	9-Jun-03	ESO
Site Development	8213	1.02.025.0225	Freeze Joint Antenna Foundation Interface	Complete	15-Feb-03	30-Jun-03	
Site Development	8290	1.02.025.0260	Open for Constr. Traffic - Hwy to OSF road	Complete	15-Feb-03	1-Mar-05	ESO
Site Development	8216	1.02.025.0225	Freeze Central Cluster Configuration	Complete	1-Mar-03	1-Mar-03	
Site Development	8222	1.02.025.0225	AOS Foundations CDR	Complete	1-Mar-03	4-Jun-04	
Site Development	8320	1.02.025.0210	Tender Docs Comp - ALMA Camp Const.	Complete	1-Mar-03	6-May-03	ESO
Site Development	8302	1.02.025.0260	CDR Compl. - Hwy to OSF road	Complete	31-Mar-03	9-Jun-03	ESO
Site Development	8370	1.02.025.0212	Power Supply Study Completed	Complete	31-Mar-03	7-Apr-03	
Site Development	8292	1.02.025.0260	Const. Contract Award - Hwy to OSF road	Complete	1-Apr-03	26-Jul-03	ESO
Site Development	8360	1.02.025.0280	Freeze Fiber Optics and Electrical Specifications	Planned	1-Apr-03	15-Jun-05	
Site Development	8224	1.02.025.0225	AOS Foundations Central Cluster Construction Tender Docs Complete	Planned	15-Apr-03	4-Oct-05	
Site Development	8304	1.02.025.0260	CDR Complete - OSF to AOS Road	Complete	15-Apr-03	3-Jul-03	ESO
Site Development	8324	1.02.025.0210	Contract Award - ALMA Camp Const.	Complete	1-May-03	7-Aug-03	ESO
Site Development	8340	1.02.025.0240	Design Contract Award - OSF Phs 1 (Tech area)	Complete	1-Jun-03	15-Jun-04	ESO
Site Development	8306	1.02.025.0260	Tender Docs Complete - OSF to AOS Road	Complete	16-Jul-03	26-Nov-03	ESO
Site Development	8326	1.02.025.0210	ALMA Camp Initial Occupancy (6 beds)	Complete	15-Aug-03	15-Jun-04	ESO
Site Development	8372	1.02.025.0212	Project Power Supply Plan Approved	Complete	31-Aug-03	17-Sep-03	
Site Development	8342	1.02.025.0240	CDR Complete - OSF Phs 1 (Tech area)	Complete	15-Sep-03	17-May-04	ESO
Site Development	8294	1.02.025.0260	Hwy tp OSF Road EU - Provisional Acceptance	Complete	30-Sep-03	26-Nov-03	

Appendix A
ALMA Level 2 Milestone Status

IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
Site Development	8226	1.02.025.0225	Contract Award - Central Cluster AOS Found.	Planned	1-Oct-03	9-Feb-06	NRAO
Site Development	8344	1.02.025.0220	Tender Docs Complete - AOS Foundation Construction	Complete	31-Dec-03	15-Apr-04	
Site Development	8344	1.02.025.0220	Tender Docs Complete - TB Construction	Planned	31-Dec-03	28-Sep-05	
Site Development	8344	1.02.025.0240	Tender Docs Complete - OSF Tech area	Complete	31-Dec-03	15-Oct-04	
Site Development	8374	1.02.025.0215	Tender Docs Complete - PPS Gas Pipeline	Planned	31-Dec-03	17-Mar-06	ESO
Site Development	8374	1.02.025.0215	Tender Docs Complete - PPS Construction	Planned	31-Dec-03	17-Mar-06	ESO
Site Development	8346	1.02.025.0220	Const. Contract Award - AOS Foundation Construction	Planned	1-Apr-04	15-Mar-05	ESO
Site Development	8346	1.02.025.0220	Const. Contract Award - TB Construction	Planned	1-Apr-04	5-Jan-06	ESO
Site Development	8346	1.02.025.0240	Const. Contract Award - OSF Tech area	Planned	1-Apr-04	22-Dec-05	ESO
Site Development	8308	1.02.025.0260	Const. Contract Award - OSF to AOS Road	Complete	30-May-04	17-May-04	ESO
Site Development	8376	1.02.025.0215	Contract Award - PPS Gas Pipeline	Planned	31-May-04	2-Nov-06	ESO
Site Development	8376	1.02.025.0215	Contract Award - PPS Construction	Planned	31-May-04	2-Nov-06	ESO
Site Development	8362	1.02.025.0280	Fiber Optic Cables and Electrical Cables in Chile, N.A.	Planned	15-Sep-04	1-Jun-06	
Site Development	8234	1.02.025.0225	AOS Foundations Provisional Acceptance	Planned	2-Oct-04	19-Jul-10	
Site Development	8230	1.02.025.0225	AOS Foundations NA Remaining Construction / Tender Docs Complete	Planned	1-Mar-05	19-Feb-07	
Site Development	8228	1.02.025.0225	AOS Foundations NA Central Cluster Provisional Acceptance	Planned	30-Jun-05	27-Nov-06	NRAO
Site Development	8310	1.02.025.0260	Road Avialable for Transporter use - OSF to AOS Road	Planned	30-Jun-05	8-Mar-06	ESO
Site Development	8378	1.02.025.0215	PPS - Initial on-line - Provisional Acceptance	Planned	30-Jun-05	10-Apr-08	ESO

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IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
Site Development	8348	1.02.025.0220	Provisional Acceptance - TB Foundation Construction	Planned	31-Jul-05	7-Jul-05	ESO
Site Development	8348	1.02.025.0220	Provisional Acceptance - TB Construction	Planned	31-Jul-05	24-Apr-07	ESO
Site Development	8348	1.02.025.0240	Provisional Acceptance - OSF Phs 1 (Tech area)	Planned	31-Jul-05	29-Jun-07	ESO
Site Development	8232	1.02.025.0225	AOS Foundations NA Remaining Construction Contract Signed	Planned	1-Sep-05	25-Jun-07	
Site Development	8364	1.02.025.0280	OSF - AOS Fiber Optics Link Installed	Planned	31-Dec-06	10-Oct-06	
Site Development	8380	1.02.025.0215	Provisional Acceptance - PPS Gas Pipeline	Planned	31-Dec-06	27-Sep-07	
Site Development	8380	1.02.025.0215	Provisional Acceptance - PPS (Date TBD)	Planned	31-Dec-06	31-Dec-09	
Site Development	8282	1.02.025.0225	Contract Award - AOS Site Roads-Phs II	Planned	1-Mar-08	2-Apr-09	ESO
Site Development	8350	1.02.025.0240	Design Contract Award - Residence Design	Planned	1-Oct-08	16-May-08	ESO
Site Development	8312	1.02.025.0260	Provisional Acceptance - OSF to AOS Road	Planned	31-Dec-08	14-Oct-09	ESO
Site Development	8352	1.02.025.0240	OSF Facilities Phase 2 (Res. / Visitor) EU CDR Complete	Planned	31-Mar-09	16-Jan-09	
Site Development	8354	1.02.025.0240	Perpare Tender Docs - Residence	Planned	1-Jul-09	16-Jan-09	ESO
Site Development	8356	1.02.025.0240	Const. Contract Award - Residence	Planned	1-Jan-10	10-Jun-09	ESO
Site Development	8284	1.02.025.0225	AOS Site Roads NA Provisional Acceptance-Phs II	Planned	1-Oct-11	29-Jan-10	ESO
Site Development	8358	1.02.025.0240	Provisional Acceptance - Residence	Planned	1-Oct-11	4-Apr-11	ESO
Site Development		1.02.025.0220	Mgmt "Go-Ahead" on AOS Tech Bldg	Planned		15-Mar-05	
Site Development		1.02.025.0220	Contract Award - AOS Hanger	Planned		30-May-06	NRAO
Site Development		1.02.025.0220	Provisional Acceptance - AOS Hanger	Planned		17-Nov-06	NRAO
Site Development		1.02.025.0225	Arrary Site Infrastructure - Complete	Planned		19-Jul-10	
Site Development		1.02.025.0210	1st ALMA Camp Expansion Decision	Planned		15-Jun-05	

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IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
Site Development	8330	1.02.025.0210	Tender Docs Submitted to bidders - Contractors Camp Compl.	Planned		1-Mar-05	ESO
Antenna Subsystem	8502	1.03.035	Shared Access VertexRSI Antenna	Complete	15-Nov-02	15-Nov-02	NRAO
Antenna Subsystem	8505	1.03.035	Provisional Acceptance of VertexRSI Antenna	Complete	20-Jan-03	20-Mar-03	NRAO
Antenna Subsystem	8500	1.03.045	RFQ for VertexRSI Antenna Delivered to Project Office	Complete	3-Feb-03	20-May-03	NRAO
Antenna Subsystem	8503	1.03.045.0480	Deliver Foundation Design requirements	Complete	15-Feb-03	2-May-03	ESO & NRAO
Antenna Subsystem	8569	1.03.070.0600	Transporter Critical Design Review (CDR) Complete	Planned	15-Mar-03	24-Nov-05	ESO
Antenna Subsystem	8510	1.03.035	Complete Technical Performance Report-VertexRSI Antenna	Complete	20-Mar-03	18-Jun-04	NRAO
Antenna Subsystem	8530	1.03.035	Shared Access AEC Antenna (Preliminary Acceptance)	Complete	28-May-03	1-Dec-03	ESO
Antenna Subsystem	8525	1.03.045	CFT/RFQ Bid Package Submitted to Project Office (AEC/VertexRSI)	Complete	31-May-03	17-Dec-03	ESO & NRAO
Antenna Subsystem	8535	1.03.045	Issue CFT/RFQ for Production Antenna Design's)[merge with line 55-M/S 8560]	Complete	30-Jun-03	17-Dec-03	ESO & NRAO
Antenna Subsystem	8540	1.03.035	Provisional Acceptance of AEC Antenna	Complete	24-Jul-03	1-Dec-04	ESO
Antenna Subsystem	8545	1.03.035	Complete Technical Performance Report-AEC Antenna	Complete	23-Sep-03	1-Mar-05	ESO
Antenna Subsystem	8555	1.03.065.0580	Nutator Critical Design Review (CDR) Completed	Planned	8-Oct-03	1-Feb-06	NRAO
Antenna Subsystem	8550	1.03.045	Closing Date for Production Antenna Bids (Competitive Tender)[merge with line 54-M/S 8550)	Complete	30-Oct-03	30-Apr-04	ESO & NRAO
Antenna Subsystem	8560	1.03.045	Bid Evaluations Due to Project Office	Complete	27-Jan-04	16-Jun-04	ESO & NRAO
Antenna Subsystem	8565	1.03.045	Executives Sign Contract for 32 North Am. Production Antennas	Planned	28-May-04	15-Jun-05	NRAO
Antenna Subsystem	8575	1.03.045	Executives Sign Contract for 32-Euro Production Antennas	Planned	30-May-04	15-Jun-05	ESO

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Antenna Subsystem	8524	1.03.045	Prototype Antenna released to Contractor for Refurbishment / Transport to Chile	Planned	28-Jul-04	31-Mar-05	ESO & NRAO
Antenna Subsystem	8580	1.03.070.0600	First Transporter Accepted at OSF	Planned	30-Sep-05	20-Nov-06	ESO
Antenna Subsystem	8585	1.03.050.0500	First Antenna Arrives at OSF (Retrofitted prototype TBC)	Planned	31-Oct-05	14-Jul-06	ESO & NRAO
Antenna Subsystem	8590	1.03.065.0580	All Nutators Accepted at OSF	Planned	15-Jun-06	21-Dec-06	NRAO
Antenna Subsystem	8595	1.03.070.0600	Second Transporter Accepted at OSF	Planned	15-Sep-06	21-May-07	ESO
Antenna Subsystem	8600	1.03.060.0560	8th Antennas Preliminary Accepted at OSF	Planned	28-Feb-07	3-Jan-07	ESO & NRAO
Antenna Subsystem	8605	1.03.060.0560	20th Antennas Preliminary Accepted at OSF	Planned	12-Jun-08	3-Jan-08	ESO & NRAO
Antenna Subsystem	8610	1.03.060.0560	30th Antennas Preliminary Accepted at OSF	Planned	12-Jun-09	12-Feb-09	ESO & NRAO
Antenna Subsystem	8615	1.03.060.0560	50th Antennas Preliminary Acceptance at OSF	Planned	31-May-10	23-Mar-10	ESO & NRAO
Antenna Subsystem	8620	1.03.060.0560	All Antennas Preliminary Accepted at OSF	Planned	30-Jun-11	16-Nov-10	ESO & NRAO
Antenna Subsystem	8625	1.03.060.0560	All Antennas Provisionally Accepted in Chile at AOS	Planned	16-Dec-11	23-Jan-12	ESO & NRAO
Antenna Subsystem		1.03.050.0500	Antenna Contract Implemented (Contract Award)	Planned		15-Apr-05	
Antenna Subsystem		1.03.070.0600	Transporter Contract Awarded	Planned		13-Jul-05	ESO
Front End	8870	1.04.258.1101	LO review	Complete	21-Nov-02	21-Nov-02	ESO & NRAO
Front End	8740	1.04.085.0680	Prototype Cartridge Bodies (plus dummies) Delivered	Complete	1-Jan-03	1-Jan-03	ESO
Front End	8810	1.04.100.0782	Deliver Lab Prototype Cartridge Bias Module Circuits	Complete	1-Mar-03	24-Apr-03	NRAO
Front End	8880	1.04.258.1101	Deliver lab prototype LO chain to each cartridge man.	Complete	1-Mar-03	22-Aug-03	NRAO
Front End	8835	1.04.100.0782	Deliver Lab Prototype M/C Circuit	Complete	1-Apr-03	22-May-03	NRAO
Front End	8835	1.04.100.0782	Deliver Lab Prototype M/C Circuit	Complete	1-Apr-03	22-May-03	NRAO
Front End	8995	1.04.075.0640	All FE Contracts / Agreements in place - FE #1 - #8	Planned	1-Apr-03	1-Mar-05	ESO & NRAO

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IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
Front End	8700	1.04.075.0640	Initial set of FE specs and interface-control documents discussed	Complete	1-Apr-03	1-Apr-03	ESO & NRAO
Front End	8705	1.04.075.0640	FE specifications and requirements plus ICD's submitted for approval	Complete	15-Apr-03	1-Sep-03	ESO & NRAO
Front End	8765	1.04.090.0720	Freeze Optics Design (includes feeds, lenses, windows, filters and mirrors)	Complete	30-Apr-03	10-Oct-03	ESO
Front End	8770	1.04.090.0720	Freeze Windows / IR Filters Design	Complete	30-Apr-03	17-Jun-03	ESO
Front End	8720	1.04.080.0660	Freeze Dewar (Cryostat) design (Project MS)	Complete	15-Jul-03	11-Sep-03	ESO
Front End	8750	1.04.080.0660	Cartridge Body Design Frozen (Project MS)	Complete	1-Sep-03	16-Feb-04	ESO
Front End	8990	1.04.075.0640	FE Sub-System Delta PDR Passed	Planned	1-Sep-03	27-May-05	ESO & NRAO
Front End	8820	1.04.100.0782	Freeze the Design of the DC Support Electronics	Planned	1-Oct-03	1-Mar-05	NRAO
Front End	8920	1.04.100.0780	Freeze the Design of the FE Chassis	Planned	1-Oct-03	9-Aug-05	NRAO
Front End	8845	1.04.100.0780	Freeze Hardware Design M&C Circuit	Planned	1-Oct-03	27-Jan-06	NRAO
Front End	8775	1.04.095.0740	Band 3 Mirrors for Cryostat #1 Delivered to FEIC	Planned	1-Jan-04	13-Apr-05	ESO
Front End	8755	1.04.085.0680	Cartridge bodies for first receiver delivered (Project MS)	Complete	1-Jan-04	12-Nov-04	ESO
Front End	8760	1.04.085.0680	Cartridge Bodies for FE #8 Delivered (Project MS)	Planned	1-Jan-04	18-Oct-05	ESO
Front End	8860	1.04.100.0782	Deliver Software for DC Support Electronics to Users	Planned	1-Jan-04	4-Apr-05	NRAO
Front End	8825	1.04.105.0800	Deliver Prototype DC Bias Electronics for Cartridge #1	Complete	1-Jan-04	15-Dec-04	NRAO
Front End	8925	1.04.105.1660	Deliver the FE Chassis for FE #1	Planned	1-Jan-04	21-Sep-05	NRAO
Front End	8895	1.04.258.1101	Deliver LO WCA for Cartridge #1	Complete	1-Jan-04	3-Feb-05	NRAO
Front End	8922	1.04.100.0780	Freeze FE Design	Planned	1-Jan-04	7-Nov-06	ESO & NRAO
Front End		1.04.100.0780	Deliver Main FE M&C Software Req. to Computing IPT	Planned	1-Jan-04	20-Oct-05	NRAO
Front End	8780	1.04.095.0760	Windows (3,4,6,7,& 9) set for FE #1 Delivered (to RAL)	Complete	1-Jan-04	7-Jun-04	ESO

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IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
Front End	8850	1.04.105.0840	Deliver the M&C Module for Front-End #1 to FEIC	Planned	1-Mar-04	27-Jan-06	NRAO
Front End	8830	1.04.105.0800	Deliver DC Bias Electronics for FE #8 (set of 4)	Planned	1-Jul-04	19-Oct-05	NRAO
Front End	8790	1.04.095.0760	Windows (6,7,& 9) set for FE #8 Delivered (to RAL)	Complete	1-Jul-04	17-Feb-05	ESO
Front End	8855	1.04.105.0840	Deliver the M & Cl Module for Front-End #8 to FEIC	Planned	1-Sep-04	5-Jul-06	NRAO
Front End	8935	1.04.145.1323	3.1 Deliver Band 3 Cartridge #1 to FEIC	Planned	1-Oct-04	26-May-05	NRAO
Front End	8945	1.04.165.1326	6.1 Band 6 Cartridge #1 delivered	Planned	1-Oct-04	4-Apr-05	NRAO
Front End	8955	1.04.175.1420	Band 7 Cartridge unit #1 delivered to Integration Centre (Project MS)	Planned	1-Oct-04	15-Jun-05	ESO
Front End	8965	1.04.195.1460	9.1 Band 9 Cartridge Unit #1 Delivered to FEIC (Project MS)	Planned	1-Oct-04	6-Jul-05	ESO
Front End	8910	1.04.105.0820	Deliver the IF Switch / Processor - FE #1	Planned	1-Oct-04	23-May-05	NRAO
Front End	8785	1.04.095.0740	Band 3 Mirrors for Cryostat #8 Delivered to FEIC	Planned	1-Jul-05	13-Apr-05	ESO
Front End	8735	1.04.085.0680	FE Dewar #8 Delivered to Integration Center (Project MS)	Planned	1-Jul-05	6-Feb-06	ESO
Front End	8915	1.04.105.0820	Deliver the IF Switch / Processor - FE #8	Planned	1-Jul-05	14-Dec-05	NRAO
Front End	8940	1.04.145.1323	3.8 Band 3 Cartridge #8 delivered	Planned	1-Jan-06	16-Mar-07	NRAO
Front End	8950	1.04.165.1326	6.8 Band 6 Cartridge #8 delivered	Planned	1-Jan-06	5-Sep-06	NRAO
Front End	9023	1.04.075.0640	FE Production authorization	Planned	1-May-06	7-Nov-06	ESO & NRAO
Front End	9020	1.04.075.0640	Front End CDR	Planned	15-Aug-06	7-Nov-06	ESO & NRAO
Front End	8805	1.04.215.1560	Deliver WVR #8 to OSF	Planned	15-Dec-06	3-May-07	ESO
Front End		1.04.115.0880	Receive results of semi-transparent vane study (from SCI)	Planned		12-May-05	ESO
Front End		1.04.125.0980	Solar Filter - Receive Design Specs from System Engr IPT (input from Science)	Planned		1-Jun-05	ESO
Back End	9115	1.05.302	LO Phase Correction Demonstration	Complete	31-Dec-03	5-Jan-04	NRAO

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Back End	9105	1.05.262	Install BE Hardware on Two ALMA Prototype Antennas at the ATF	Planned	1-May-04	4-May-06	ESO & NRAO
Back End	9110	1.05.262	Complete BE Critical Design Review	Complete	1-Jul-04	9-Jul-04	ESO & NRAO
Back End	9110	1.05.262	Final Report submitted to JAO	Complete	1-Jul-04	19-Jul-04	ESO & NRAO
Back End	9106	1.05.260.0055	Deliver Back End Production Plan	Complete	1-Sep-04	30-Sep-04	ESO & NRAO
Back End	9122	1.05.305	Deliver Back End Assembly, Test, & Verification Plan	Planned	30-Nov-04	30-Nov-05	ESO & NRAO
Back End	9117	1.05.302.3810	End-to-End LO test (Prototype Photonic LO)	Planned	31-Dec-04	1-Mar-05	NRAO
Back End	9117	1.05.302	End to End LO Demonstration	Planned	31-Dec-04	4-May-06	NRAO
Back End	9120	1.05.260.0055	All NA BE Production Contracts Placed	Planned	1-Jan-05	5-Mar-07	NRAO
Back End		1.05.305	1st antenna racks (A & D) ready for shipment to OSF	Planned	15-Mar-05	27-Jun-06	ESO & NRAO
Back End		1.05.305	1st Central LO Reference & timing Racks ready for shipment to OSFTB	Planned	15-Mar-05	2-Feb-06	ESO & NRAO
Back End		1.05.305	Central LO Racks ready for testing at OSF-TB	Planned	15-Mar-05	2-Feb-06	ESO & NRAO
Back End	9125	1.05.305	All ALMA assembly, test and verification equipment in place in Chile	Planned	1-May-05	27-Jul-06	ESO & NRAO
Back End	9130	1.05.305	Deliver BE antenna hardware for first two antennas	Planned	1-Nov-05	27-Jun-06	ESO & NRAO
Back End	9135	1.05.305	Deliver BE central electronics hardware for first two antennas	Planned	1-Nov-05	24-Sep-07	ESO & NRAO
Back End	9140	1.05.305	Deliver BE antenna and central hardware for antennas #3-8	Planned	1-Jul-06	12-Dec-07	ESO & NRAO
Back End	9145	1.05.305	Deliver BE antenna and central hardware for antennas #9-16	Planned	1-Jan-07	24-Jun-08	ESO & NRAO
Back End	9150	1.05.305	Deliver BE antenna and central hardware for antennas #17-36	Planned	1-Jan-08	21-Sep-09	ESO & NRAO
Back End	9155	1.05.305	Deliver BE antenna and central hardware for antennas #37-56	Planned	1-Jan-09	28-Oct-10	ESO & NRAO

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Back End	9160	1.05.305	Deliver BE antenna and central hardware for antennas #57-64	Planned	1-Oct-09	15-Apr-11	ESO & NRAO
Correlator	9200	1.06.315.2460	Complete design of pre-production boards for prototype Correlator	Complete	30-Dec-02	30-Dec-02	NRAO
Correlator	9205	1.06.315.2460	Begin integrated testing of prototype Correlator	Complete	6-Jan-03	6-Jan-03	NRAO
Correlator	9208	1.06.315.2460	Correlator ICDs submitted for approval	Complete	13-Aug-03	13-Aug-03	NRAO
Correlator	9215	1.06.315.2460	Pass Critical Design Review	Complete	27-Oct-03	27-Oct-03	NRAO
Correlator	9222	1.06.320.2480	Contract signed for Correlator PCB assembly - 1st Quad.	Complete	19-Nov-03	19-Nov-03	NRAO
Correlator	9230	1.06.320.2480	Begin assembly of first quadrant - 1st Quad	Complete	19-Nov-03	19-Nov-03	NRAO
Correlator	9220	1.06.320.2470	Contract signed for Custom Correlator Chips	Complete	19-Dec-03	19-Dec-03	NRAO
Correlator	9225	1.06.315.2460	Prototype Correlator shipped to ATF	Complete	2-Feb-04	2-Feb-04	NRAO
Correlator	9235	1.06.320.2480	Begin board testing for first quadrant	Complete	26-Apr-04	30-Mar-04	NRAO
Correlator	9240	1.06.320.2480	Begin integrated testing for first quadrant	Complete	15-Jul-04	17-Aug-04	NRAO
Correlator	9260	1.06.320.2500	Begin board testing for - 2nd Quad	Complete	1-Apr-05	12-Aug-04	NRAO
Correlator	60404	1.06.320.2480	All Correlator PCBs assembled	Planned	29-Jun-05	9-Jan-06	
Correlator	9255	1.06.320.2500	Begin Assembly of second quadrant	Planned	5-Jul-05	17-Mar-06	NRAO
Correlator	9265	1.06.320.2500	Begin integrated testing for second quadrant	Planned	2-Nov-05	17-Jul-06	NRAO
Correlator	9285	1.06.320.2520	Begin board testing for third quadrant	Planned	3-Apr-06	31-Mar-06	NRAO
Correlator		1.06.320.2480	First Quadrant enters shipping queue	Planned	5-Apr-06	20-Jul-06	NRAO
Correlator	9250	1.06.320.2480	First quadrant shipped to Chile	Planned	5-Apr-06	12-Feb-07	NRAO
Correlator	9280	1.06.320.2520	Begin Assembly of third quadrant*	Planned	1-Jun-06	21-Jul-06	NRAO
Correlator	9290	1.06.320.2520	Begin integrated testing for third quadrant	Planned	21-Aug-06	13-Oct-06	NRAO
Correlator	9310	1.06.320.2540	Begin board testing for fourth quadrant	Planned	31-Oct-06	6-Oct-06	NRAO
Correlator	9275	1.06.320.2500	Second quadrant shipped to Chile	Planned	21-Dec-06	1-Aug-07	NRAO

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Correlator	9305	1.06.320.2540	Begin Assembly of fourth quadrant*	Planned	5-Jan-07	2-Aug-07	NRAO
Correlator	9315	1.06.320.2540	Begin integrated testing for fourth quadrant	Planned	1-Jun-07	13-Mar-08	NRAO
Correlator	9320	1.06.320.2540	Fourth quadrant shipped to Chile	Planned	1-Aug-08	12-Jan-10	NRAO
Correlator	9300	1.06.320.2520	Third quadrant shipped to Chile	Planned	1-Aug-08	24-Sep-08	NRAO
Correlator		1.06.320.2540	All Correlators installed and Available at AOS	Planned		13-Apr-10	NRAO
Computing	9400	1.07.340.2640	MS#9400 Computing Subsystem Start (T0)	Complete	1-Jun-02	1-Jun-02	ESO & NRAO
Computing	9405	1.07.340.2640	MS#9405 Internal Design Review (IDR)	Complete	9-Dec-02	9-Dec-02	ESO & NRAO
Computing	9410	1.07.340.2640	MS#9410 Preliminary Design Review (PDR)	Complete	11-Apr-03	8-May-03	ESO & NRAO
Computing	9415	1.07.340.2920	MS#9415 Subsystem pre-release (R0)	Complete	1-May-03	16-May-03	ESO & NRAO
Computing	9420	1.07.340.2640	MS#9420 Subsystem Critical Design Review 1 (CDR1)	Complete	9-Jul-03	1-Aug-03	ESO & NRAO
Computing	9495	1.07.340.2920	MS#9495 Subsystem Major Release 1 (R1)	Complete	9-Oct-03	9-Oct-03	ESO & NRAO
Computing	70323	1.07.340.2780	MS#70323 Prototype correlator software demonstration (to 1_06 Corr)	Complete	1-Dec-03	1-Jan-04	NRAO
Computing	9515	1.07.340.2920	MS#9515 Integration Release 1 (IR1)	Complete	1-Dec-03	1-Dec-03	ESO
Computing	70322	1.07.340.2640	MS#70322 Software release to support lab system integration	Complete	15-Dec-03	1-Jan-04	ESO & NRAO
Computing	9422	1.07.340.2640	MS#9422 Submit Computing Communications Study	Complete	1-Jan-04	31-Mar-04	ESO & NRAO
Computing	9425	1.07.340.2640	MS#9425 Deliver ALMA Operations Plan, Software Aspects	Complete	1-Jan-04	1-Jan-04	ESO & NRAO
Computing	9430	1.07.340.2920	MS#9430 Subsystem Minor Release 1.1 (R1.1)	Complete	1-Apr-04	1-Apr-04	ESO & NRAO
Computing	9435	1.07.340.2640	MS#9435 Critical Design Review 2 (CDR2)	Complete	1-May-04	16-Jul-04	ESO & NRAO
Computing	9500	1.07.340.2920	MS#9500 Subsystem Major Release 2 (R2)	Complete	1-Oct-04	1-Oct-04	ESO & NRAO

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IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
Computing	9520	1.07.340.2920	MS#9520 Integration Release 2 (IR2)	Complete	1-Dec-04	20-Dec-04	ESO & NRAO
Computing	9440	1.07.340.2920	MS#9440 Receive Subsystems Minor Releases 2.1 (R2.1)	Planned	1-Apr-05	16-May-05	ESO & NRAO
Computing	9445	1.07.340.2640	MS#9445 Subsystem Critical Design Review 3 (CDR3)	Planned	1-May-05	14-Jun-05	ESO & NRAO
Computing	9505	1.07.340.2920	MS#9505 Receive Subsystems Major Releases 3 (R3)	Planned	1-Oct-05	4-Nov-05	ESO & NRAO
Computing	9525	1.07.340.2920	MS#9525 Integration Release 3 (IR3)	Planned	1-Dec-05	12-Jan-06	ESO & NRAO
Computing	9450	1.07.340.2920	MS#9450 Subsystem Minor Release 3.1 (R3.1)	Planned	1-Apr-06	1-May-06	ESO & NRAO
Computing	9455	1.07.340.2640	MS#9455 Subsystem Readiness Review (RR)	Planned	1-Jun-06	6-Jul-06	ESO & NRAO
Computing	9460	1.07.340.2920	MS#9460 Receive Subsystems Major Releases 4 (R4.0)	Planned	1-Oct-06	6-Nov-06	ESO & NRAO
Computing	9465	1.07.340.2640	MS#9465 Subsystem Preliminary Acceptance Review (PAR)	Planned	1-Dec-06	8-Jan-07	ESO & NRAO
Computing	9530	1.07.340.2920	MS#9530 Integration Release 4 (IR4)	Planned	1-Dec-06	12-Jan-07	ESO & NRAO
Computing	9480	1.07.340.2640	MS#9480 Computing Preliminary Acceptance (CPA)	Planned	1-Mar-07	28-Mar-07	ESO & NRAO
Computing	9510	1.07.340.2920	MS#9510 Receive Subsystems Minor Releases 4.1 (R4.1)	Planned	1-Apr-07	28-Mar-07	ESO & NRAO
Computing	9475	1.07.340.2640	MS#9475 Support Completion (T1)	Planned	1-Jun-07	1-Jun-07	ESO & NRAO
Computing	9470	1.07.340.2640	MS#9470 Software Agreements, Final Construction Phase	Planned	1-Jun-07	1-Jun-07	ESO & NRAO
Computing	9485	1.07.340.2640	MS#9485 Computing Readiness for Interim science observation	Planned	1-Jun-07	1-Jun-07	ESO & NRAO
Computing	9535	1.07.340.2920	MS#9535 Integration Release 4.1(IR4.1)	Planned	1-Jun-07	31-May-07	ESO & NRAO
Computing	9490	1.07.340.2640	MS#9490 Complete Subsystem Upgrade	Planned	1-Jun-11	1-Jun-11	ESO & NRAO
Computing	9490	1.07.340.2640	MS#9490 Complete Subsystem Upgrade	Planned	1-Jun-11	1-Jun-11	ESO & NRAO
System Engineering and Integration	9650	1.08.373.3000	Prototype Integration & Verification Plan Lab Complete	Planned	1-Aug-03	15-Mar-05	ESO & NRAO

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ALMA Level 2 Milestone Status

IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
System Engineering and Integration	9602	1.08.365.2960	ALMA System Requirements Review (SRR) - Reqmnts Finalized	Complete	1-Sep-03	1-Apr-04	ESO & NRAO
System Engineering and Integration	9605	1.08.365.2960	ALMA System Design Review	Complete	1-Dec-03	1-Apr-04	ESO & NRAO
System Engineering and Integration	9603	1.08.365.2960	ALMA System Requirements Review (SRR) #1	Planned	31-Dec-03	31-May-05	ESO & NRAO
System Engineering and Integration	9750	1.08.375.3020	ALMA Integration & Verification Plan - Q1 2005 thru Q4 2007 for OSF & AOS	Planned	1-Jan-04	15-Mar-05	ESO & NRAO
System Engineering and Integration	9721	1.08.370.2985	EU Prototype Evaluation Report	Complete	1-Jan-04	1-Dec-04	ESO & NRAO
System Engineering and Integration	9718	1.08.370.2985	NA Prototype Evaluation Report	Complete	1-Jan-04	1-Dec-04	ESO & NRAO
System Engineering and Integration	9653	1.08.373.3000	All Hardware for Prototype System Lab Integration Delivered & Accepted	Planned	1-Jan-04	4-Jan-07	ESO & NRAO
System Engineering and Integration	9604	1.08.365.2960	ALMA System Requirements Review (SRR) #2	Planned	29-Feb-04	31-May-05	ESO & NRAO
System Engineering and Integration	9656	1.08.370.2980	AEG Release Antennas to ALMA System Prototype Integration Group	Complete	1-Apr-04	1-Jun-04	ESO & NRAO
System Engineering and Integration	9659	1.08.373.3000	ALMA Prototype Electronics & Software Installed on ATF	Planned	1-May-04	12-Sep-05	ESO & NRAO
System Engineering and Integration	9662	1.08.373.3000	First Interferometer Fringes Using Prototype Antennas at ATF	Planned	1-Sep-04	9-Mar-06	ESO & NRAO
System Engineering and Integration	9753	1.08.375.3020	Establish Integration Office at OSF	Planned	15-Feb-05	12-Feb-07	ESO & NRAO
System Engineering and Integration	9615	1.08.365.2960	ALMA System CDR	Planned	1-Jul-05	31-May-05	ESO & NRAO
System Engineering and Integration	9756	1.08.375.3020	Integration Team & Infrastructure Ready at OSF.	Planned	1-Sep-05	12-Feb-07	ESO & NRAO
System Engineering and Integration	9759	1.08.375.3020	Initial Central Electronics & Computer - Integrated, Tested & Accepted at OSF	Planned	15-Nov-05	30-Jan-08	ESO & NRAO
System Engineering and Integration	9762	1.08.375.3020	Initial Antenna Electronics & Computer - Integrated, Tested &	Planned	15-Nov-05	30-Jan-08	ESO & NRAO

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ALMA Level 2 Milestone Status

IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
			Accepted at OSF				
System Engineering and Integration	9765	1.08.375.3020	First Fully Outfitted Antenna Integrated & Accepted at OSF	Planned	15-Feb-06	30-Jan-08	ESO & NRAO
System Engineering and Integration	9768	1.08.375.3020	First Fully Outfitted Antenna Integrated & Accepted at AOS	Planned	1-Apr-06	1-May-08	ESO & NRAO
System Engineering and Integration	9771	1.08.375.3020	Phase 2 ALMA Integration & Verification Plan Q1 2008 & Beyond	Planned	1-Jul-06	15-Mar-05	ESO & NRAO
System Engineering and Integration	9668	1.08.373.3000	Finish Testing of ALMA Prototype Hardware / Software on ATF	Planned	1-Jul-06	22-Jun-07	ESO & NRAO
System Engineering and Integration	9774	1.08.375.3020	Start Three Antenna Array Interferometry & Functioning at AOS	Planned	1-Aug-06	18-Aug-08	ESO & NRAO
System Engineering and Integration	9651	1.08.373.3000	Prototype Integration & Verification Plan ATF Complete	Planned		15-Mar-05	ESO & NRAO
System Engineering and Integration		1.08.365.2965	SRR System Requirements Review Complete	Planned		31-May-05	ESO & NRAO
System Engineering and Integration		1.08.365.2965	ALMA Project CDR Critical Design Review Complete	Planned		9-Nov-09	ESO & NRAO
			Start Operations Support - Full Science Operations Stage	Planned		2-Jun-08	
			Finish Operations Support - Full Science Operations Stage	Planned		28-May-12	
Science	9800	1.09.380.3040	Plan for compact and intermediate configurations submitted	Complete	27-Nov-02	27-Nov-02	
Science	9805	1.09.380.3040	Review of calibration requirements with science examples complete	Complete	15-Feb-03	28-Feb-03	
Science	9812	1.09.380.3040	Document on how calibration reqs flow down to instrumental specs	Complete	30-Jun-03	30-Jun-03	
Science	9815	1.09.380.3040	Plan for Y+ configuration submitted	Complete	30-Jun-03	30-Jun-03	
Science	9820	1.09.380.3040	Calibration strategy submitted	Complete	30-Sep-03	15-Feb-04	
Science	9825	1.09.380.3040	Science aspects of Ops. plan complete	Complete	31-Dec-03	31-Jul-04	
Science	9818	1.09.380.3040	ICD #??? between Science and Site Approved	Planned	31-Jan-04	1-Mar-05	

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ALMA Level 2 Milestone Status

IPT	Milestone Number	WBS	Activity Description	Status	Baseline Date	Forecast	Responsibility
Science	9830	1.09.380.3040	Plan for early science configurations complete	Complete	30-Jun-04	30-Jun-04	
Science	9835	1.09.380.3040	Report WVR strategy / implementation / Ops.	Complete	30-Sep-04	6-Dec-04	
Science	9840	1.09.380.3040	Review of tests of calibration strategies on prototype interferometer complete	Planned	31-Dec-04	26-Sep-05	
Science	9843	1.09.380.3040	Review of tests of calibration strategies on ATF interferometer	Planned	30-May-05	30-May-05	
Science	9845	1.09.380.3040	Demonstration Science plan for commissioning submitted	Planned	30-Jun-05	30-Jun-05	
Science	9865	1.09.380.3040	Final Demonstration Science complete array	Planned	31-Dec-11	2-Jan-12	
Management	8165	1.01.015.0160	Site available for Work	Complete	1-Apr-03	25-Jul-03	ESO & NRAO
Management	8227	1.01.015.0160	ALMA Groundbreaking	Complete	3-Nov-03	6-Nov-03	ESO & NRAO
Management	8105	1.01.010	Designation of responsibility for Phase 2 development work elements in Europe	Complete	16-Feb-04	17-Feb-04	ESO & NRAO
Management	8110	1.01.010	Designation of responsibility for Phase 2 production work elements in Europe	Planned	1-Aug-04	30-Jun-05	ESO & NRAO
Management	8410	1.01.010	Start Operations Budget	Planned	1-Jan-05	1-Mar-05	ESO & NRAO