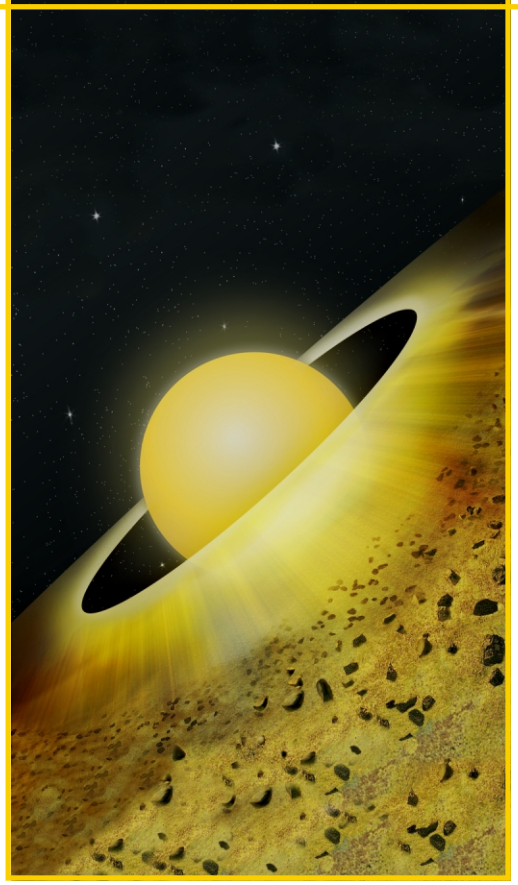
Quarterly Report

April - June 2005

National Radio Astronomy Observatory



NATIONAL RADIO ASTRONOMY OBSERVATORY

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Cover Image: Artist's Conception of Dusty Disk Around Young Star TW Hydrae.
Credit: Bill Saxton

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Executive Summary

ALMA

Overall this has been another very busy and productive period for the ALMA project. During this period the two biggest issues facing the project have continued to be antenna procurement and overall cost. Consequently the rebaselining activities and work towards placing an antenna contract have continued to receive the highest priority.

Although strictly outside the time coverage of this quarterly report, we are delighted to announce that a contract for 25 Antennas with options for up to 32 was signed between AUI and Vertex on July.11. This is a very significant milestone for the ALMA project. With the successful placement of the antenna contract, North America's largest risk has been successfully retired.

Start of construction of the AOS Technical Building Foundation awaits NSF approval of the contract. Construction should begin in August 2005, after the winter season. Completion of the bidding and "For Construction" documentation (Drawings and Technical Specifications) for the AOS building by architects M3 is ongoing, to be finished by August 2005. Work is progressing.

The successful demonstration of a prototype cable wrap and line length corrector has significantly reduced the risk associated with the Photonic LO.

Progress was made on the development of a North American ALMA Operations Plan. Planning has begun for ALMA activities at the next two meetings of the AAS. Phase I of the ALMA Proposal Submission Tool has been completed for NRAO telescopes other than ALMA. A workshop on "Z-Machines" has been scheduled for early January 2006; other ALMA-related workshops are in the early planning stages. The ANASAC met twice during this period.

EVLA

The redesigned Digital Transmission System module, which has delayed the project for several months, was installed and successfully tested on two EVLA antennas and is now moving into full production. Work is proceeding on the fourth EVLA antenna. A contract has been awarded for the construction and installation of the new shielded room which will house the EVLA correlator. The Canadian partners are making good progress on the design and prototyping of the correlator, with the first prototype circuit boards now starting to be tested. The company designing and fabricating the new correlator chip is now in the process of final design verification prior to prototype chip fabrication. Funding for several new programmer positions for an enhanced e2e effort has been identified and recruitment of the new positions is underway. A new Proposal Submission Tool, written by the staff in the EVLA Software Division for eventual use by all of NRAO, was successfully used for 50 proposals during the most recent GBT proposal deadline. The contract for the first increment of Mexican funding for the EVLA project has been completed. A Reverse Site Visit for the EVLA Phase II Proposal was held at the NSF in June and we are waiting to hear from the NSF concerning Phase II funding possibilities.

Executive Summary

Green Bank Telescope

The fraction of the time the GBT spends observing continues to improve, with the most recent improvements due to continually improving hardware and software reliability. Excellent Q-Band (~43 GHz, ~7mm) observations were made during this quarter, both for astronomical programs and to continue the commissioning work to improve the surface efficiency.

Observing and data analysis software continues to improve, with two general releases of the GBTIDL data analysis package, and the first formal release of Astrid, the new Observing Interface, to visiting observers. A very successful in-progress review of GBT software was held in May 2005. Considerable progress has been made on both the Caltech Continuum Backend, and completion of the Ka-Band receiver. These are on schedule for planned testing and commissioning activities this fall.

Formal agreement has been reached with MIT/Lincoln Labs to use the 43m (140 Foot) Telescope to perform bistatic radar experiments to study the earth's ionosphere. One of the first tasks was to demonstrate that the 43m could be quickly brought back into operation; this has now been achieved

Very Large Array & Very Long Baseline Array

The azimuth bearing was changed on VLA Antenna 18. This was the 10th such bearing change carried out on a VLA antenna. Four SAO-supplied prototype 190 MHz receiving systems were installed on VLA antennas, and considerable testing took place to determine whether the RFI environment would enable searches for neutral hydrogen at the Epoch of Reionization.

Severe rust damage, particularly to the quadrupod legs holding the subreflector in place, was observed during a long maintenance visit to the VLBA St. Croix station. The subreflector positioning system at St. Croix also was repaired. Three VLBA stations now have been converted to full-time operation with Mark 5 disk recording, and two more stations are using Mark 5 for a large portion of their observations. The fractional scientific observing time is beginning to turn upward as the tape constraints are removed, and will increase substantially after the majority of the VLBA stations are equipped with disk recorders.

Central Development Laboratory

New low-noise amplifiers optimized for the best available transistors (from the JPL CHOP program) have been developed for EVLA bands up to 18 GHz. The ALMA Band 6 cartridge #1 has been successfully tested in the first ALMA cryostat, and cartridge #2 has been assembled and DC tested. ALMA front-end local oscillators were delivered for all four authorized bands, and development of LOs for Japanese bands 4 and 8 was started. Measurements of a hot electron bolometer mixer at 650 GHz were carried out. Good progress was made for fabrication and measurement of EVLA feeds for 4-8, 8-12, and 40-50 GHz. The first quadrant of the ALMA correlator was completely populated and tested, a

prototype of the new tunable filter bank card was received and tested and preparations were made for installing the final inter-rack signal cables. Regular observations of the sun at 20-70 MHz continued with the Green Bank Solar Radio Burst Spectrometer. The 300-2500 MHz receiver was installed on the 45 Foot Telescope and testing was begun.

Computing and Information Services

Although this has been a tight year, we have managed to make some progress on modernizing our infrastructure, including support for Apples and PDAs. The System Administrators meeting in Charlottesville provided a good start to developing a five-year operations plan. A new email facility to reduce unwanted and unsolicited messages (spam) is being deployed. The upgraded NRAO intranet backbone at 20 Mbps should be deployed in the coming quarter.

Education and Public Outreach

To engage the astronomical community in the Observatory's efforts to increase the number of visually compelling radio astronomy images available for EPO, the Legacy Imagery Project announced the first annual NRAO/AUI Image Contest at the summer 2005 American Astronomical Society meeting. Contest submissions are due September 1, and the contest results will be announced by October 15, 2005. Design and development of the NRAO ViewSpace press release program module was completed in June 2005, and all scientific research press releases accompanied by high-quality imagery, graphics, and/or animation will now also be released via the ViewSpace network. The NRAO EPO staff hosted the Southwest Consortium for Observatories in Public Education (SCOPE) at the VLA on April 15-16. Six press releases were produced and distributed by EPO PIO staff this quarter. Four of these releases described scientific research conducted at the NRAO. Compared to the same months in 2004, visitation and revenue at the Green Bank Science Center increased by 9.0% and 17.5% respectively. Visitation and revenue at the VLA Visitor Center decreased by 5.0% and 9.0%, respectively, compared to 2004. Planning continued for the 2005 West Virginia Governor's School for Mathematics and Science (GSMS), which will be held this summer at Green Bank. The NRAO, White Sands Missile Range, and New Mexico Institute of Mining and Technology are collaborating on a series of events celebrating the 100th anniversary of Albert Einstein's annus mirabilis. The annual NRAO Chautauqua program was held at the Green Bank Science Center May 23-25. Funding for GEAR UP (Gaining Early Awareness and Readiness for Undergraduate Programs) Camp was renewed for 2005 by the U.S. Department of Education. Three teachers are participating in the 2005 NRAO Research Experiences for Teachers (RET) program: one in Socorro, and two in Green Bank. The Society for Amateur Radio Astronomers held their annual meeting at Green Bank, June 19-21, and enjoyed numerous programs at the Science Center.

Executive Summary

Environment, Safety and Security

This quarter, ALMA management provided an additional ¼ FTE for support at the ALMA Test Facility located at the VLA. The ES&S manager made preparations for the development of the global ALMA Safety Program. In New Mexico, the VLA Emergency Medical Services group was reorganized this quarter and a new medical director was selected. A surplus fire engine was obtained and outfitting efforts were initiated. This quarter, development of the VLA Rope Rescue Team was initiated. In Green Bank, ES&S efforts were directed to evaluation of the 140 Foot Telescope for fire safety and start up activities later this summer. ES&S also worked on preparation of a sewer line project including safety issues such as confined spaces, excavation-trenching, and access-egress. Additionally, this quarter the Green Bank annual fire alarm system preventive maintenance check was completed. And a site wide compliance inspection documenting various safety concerns was completed. In Charlottesville, the NTC facility was inspected to determine areas where personnel hazards could exist. In the next quarter, ES&S will begin development of the ALMA Safety Program. In Socorro, efforts will be directed toward redevelopment of the EMS group, while efforts in Green Bank will be focused on prevention and training programs.

Science Highlights

Very Large Array

White Dwarf's Re-Ignition Spurs New Stellar Evolution Model - In 1996, V4334 Sgr, better known as Sakurai's Object, rapidly brightened. Initially thought to be a nova explosion, the event soon was recognized as the first modern observation of a white dwarf re-igniting after its nuclear burning had ceased. This provided a once-in-a-lifetime opportunity to study the type of event that may be a significant source of carbon and carbonaceous dust in the Galaxy. The re-ignition, only the third ever observed (the others were in 1918 and possibly 1670), is believed to result when a small, hydrogen-rich envelope is convectively ingested into the white dwarf's helium shell, triggering a renewed nuclear flash. Earlier models predicted that this would cause the star's luminosity to increase over a few hundred years. However, this evolution occurred 100 times faster, prompting development of a new model that predicts rapid reheating. The VLA observations revealed radio emission from freshly ionized matter, confirming that the rapid reheating has begun.

Investigators: M Hajduk (Manchester and Centrum Astronomii UMK, Poland); A. Zijlstra (Manchester); F. Herwig (Queen's University Belfast); P. van Hoof (Queen's University Belfast and Royal Observatory of Belgium); F. Kerber (ESO); S. Kimeswenger (Innsbruck University); D. Pollacco (Queen's University Belfast); A. Evans (Keele University, UK); J. Lopez (UNAM); M. Bryce (Jodrell Bank); S. Eyres (University of Central Lancashire); and M. Matsuura (Manchester).

Very Long Baseline Array

Stellar-Wind Collision Region's Motion Is Tracked - The motion of a wind-collision region in the binary pair WR140 has been tracked. The pair consists of a Wolf-Rayet star and an O star. The region where their stellar winds collide is seen as a bow-shaped arc of radio emission that rotates as the orbit progresses. This observation has allowed refinement of the orbit's inclination and a definitive determination of the system's distance.

The new data, which is inconsistent with model predictions, will ultimately allow better understanding of the nature both of Wolf-Rayet stars and of wind-collision regions.

Investigators: A. Beasley (ALMA); M. Claussen (NRAO); B. Zauderer (University of Maryland); and N. Bolinbroke (University of Victoria, BC).

Green Bank

Observations of 9P/Tempel 1 During Deep Impact - The GBT has been used to carry out eight days of L-Band OH spectroscopy of comet 9P/Tempel 1 in the days immediately following the highly successful Deep Impact mission. Somewhat surprisingly, the impact released considerably lower amounts of volatile gases into the coma than were expected - two orders of magnitude lower production

than some pre-mission estimates. In the first week after impact, GBT spectra stood alone offering the only ground-based radio detections of OH. Lines were variable in strength, in part due to the unique nature of the solar UV excitation of OH in cometary atmospheres, and in part due to real variations in gas production. Some days the lines were undetected below a 2 mJy limit, while on July 6 and July 9, lines were detected in excess of 5 mJy. Radio spectra offer information about the kinematics of gases in the coma, and although the data thus far are low signal-to-noise and thus cannot reveal jet structures or small asymmetries, preliminary analysis of the lines reveals that OH is somewhat redshifted from the cometary orbital velocity, and the general outflow of gas from the nucleus is around 0.8 km/s. Analysis is underway to see if variations in gas production are correlated with the favored 40-hour rotation period.

Investigators: Amy Lovell (Agnes Scott College), Bryan Butler (NRAO), Ellen Howell (Arecibo) and Peter Schloerb (FCRAO).

Management IPT

The rebaselining exercise has continued to progress rapidly following a huge effort on all sides and the numbers are now stable and have been frozen. The next step is a detailed walk-though and scrub of all the costs followed by an analysis of proposed changes in the baseline scope. It is clear that some very hard decisions about the overall scope of the project are ahead. Once the baselining exercise is complete and approved, ALMA schedules and milestones will be reported at Level 3 in the Quarterly Report.

Following the ALMA Board meeting in Pasadena the two Executives have passed Management Control of the Site IPT over to the ALMA Project Manager and the Systems IPT to the ALMA project engineer. As such all related purchases, contracting and hiring require the authorization of the ALMA Project Manager (for Site) or Project Engineer (for Systems). This delegation of authority allows the *initiation* of actions that are then implemented by the relevant Executive according to normal Executive procedures.

Personnel

Antony Davies has joined the project as NA Project Controller and has now relocated to Charlottesville. This has permitted David Hubbard (who has been filling the post on an interim basis) to exit the ALMA NA Controller role. Bill Porter has taken up the combined role of the ALMA NA Deputy Project Manager and ALMA NA Business Manager. This has also allowed David Hubbard to transition out of the ALMA NA Deputy Project Manager role and return full-time to Head of the NRAO's Program Management Office. The NRAO Program Management Office (including David) will continue to support ALMA fully as part of NRAO's matrix management process. Stefan Michalski has been appointed to the role of Planner/Scheduler for the ALMA Project, based in Charlottesville as part of the NRAO Program Management Office and with a start date of 5th July. These changes mean that the NA ALMA Project Office is now fully staffed.

Site IPT

Status

Antenna Stations at the AOS

The antenna station (foundation) design prepared by M3 based on the approved antenna station ICD exceeds the budget substantially. An alternative foundation design based on the same ICD documentation has been elaborated by EIE and has been presented at the IPT meeting in Charlottesville on October 2, 2004 for analysis by the Executives and the JAO. There is need to reach a consensus between the two Executives as to how to proceed with the implementation.

Both designs were subjected to budget estimates prepared by local Chilean firms. The budget estimates have been completed and are being analyzed. Revised estimates have been submitted by both contractors. A construction start prior to or by September 2005 will assure that a sufficient number of antenna stations will be completed to accommodate early operations.

Technical Building at the AOS

Start of construction of the AOS Technical Building Foundation awaits NSF approval of the contract. Construction should begin in August 2005, after the winter season. Completion of the bidding and "For Construction" documentation (Drawings and Technical Specifications) for the AOS building by architects M3 is ongoing, to be finished by August 2005. Work is progressing.

Permanent Access Road

During the reporting period road maintenance operations continued. As of to date approximately 28 km of modified road formation level has been constructed. This represents approximately 65% of the total length of the road of 43 km. The contract for the construction of the remaining 15 km of modified road formation level has been signed. Contract kick-off meeting will be on July 7, 2005. Work will start immediately thereafter. The road pavement will be contracted out later (2007-2008).

Tender documents for the construction of culverts and drainage structures at canyon crossings of the road to the OSF and the AOS have been released to Contractors. Construction start of culverts at km 7 will be in September 2005.

ALMA and Contractors Camps at the OSF

The ALMA Camp with a total of 30 beds, office, dining room and first aid facilities has been completed and all services including water supply, fuel supply, power supply, garbage removal, catering, lodging and cleaning services, safety and security services, camp and maintenance and management services are functioning. The ALMA Camp extension of 15 beds was substantially finished in May 2005.

Figure 1. ALMA Camp expansion of 15 beds.

The bidding process for the completion of the contractor's camp and the implementation of architectural features for the camps has been completed. The NSF approval for the contract award is under way. Cost sharing between NA and EU for the running of the camps and associated safety, security and other services will be implemented.

Technical Facilities at the OSF

The tender documents for the construction of the Technical Facilities at the OSF were released to Contractors. Closing date of the tender will be in August 2005 in order to obtain ESO FC approval for contracting in September-November 2005. Contract signature and start of Work will be late 2005/early 2006 and Provisional Acceptance is scheduled to be in late 2007.

Mass excavation, crushing, selection of material for filling and filling work was contracted and the Work started in February-March 2005. Completion is scheduled for August-September 2005. This will include the transport to and the deposit and leveling of excess material at a canyon at km 18.

Figure 2. Crushing operations.

Figure 3. Fill operations.

Figure 4. Fill platforms 1 through 4.

ALMA Project Power Supply

The contract for the design of the power generation and transmission systems has been awarded to Lahmeyer International, Germany. The Contract kick-off meeting was on June 14, 2005. Design work is in progress, beginning with a study reviewing the energy supply situation in northern Chile.

Construction Site Safety Services

The service contract has been prolonged until the end of 2005. The permanent safety engineer will be on-site in September 2005.

Environmental Aspects

Blasting Work for road construction needs to be coordinated with authorities and consultants. A survey of further colonies of vizcachas at areas above km 30 has been started on July 4, 2005. Proposals for a small museum and interpretive center for local cultures and history located at km 21 are being solicited.

ALMA

Configuration Review

The layout of antenna foundation locations at the AOS area is being changed. Apparent discrepancies between the aerial photographic survey and actual UTM locations will require a check of locations and soil conditions. This check will be completed by the Site IPT after availability of the changed layout.

Budget

Re-estimating of the Site IPT project budget (version October 16, 2002) has been completed in February-April 2005. Review and analysis by the JAO will be during July 2005.

Concerns & High Level Risks:

- Resolution/ Consensus of antenna stations design.
- Fiber Optics design by BE and Computer group.
- Budget issues - OSF Technical Facilities.
- Natural gas availability for the permanent power supply.
- Environmental issues possibly requiring the re-routing of the permanent access road above km 30 (vizcacha colonies).
- Changed antenna station layout.

Next Period/Goals

- Complete tender actions for the AOS Building.
- Complete tender actions and drainage structures as part of the access road.
- Complete tender for complete catering services (board, lodging, laundry, camp management and maintenance services) as part of the ALMA and Contractors Camp operations. Projected service start is late 2005.
- Construction of the modified formation level of the access road all the way to the AOS until late 2005 – early 2006.
- Start construction work for the foundations and structural steel of the AOS Building.
- Complete Contractor's Camp and architectural features of both camps by November 2005.
- Design and preparation of tender and construction documentation for the power generation and transmission system (the power plant).
- Complete tender action for the construction of the OSF Technical Facilities.
- Start of construction of the OSF Technical Facilities

Antenna IPT

Status

Production Antenna Procurement

The on-going tests at the Antenna Test Facility (ATF) on the two antenna prototypes were concluded at the beginning of April with the examination of the surface accuracy of both antennas, following the dynamic stress test. This test was the conclusion of the campaign performed by the Joint Antenna Testing Group, generated in December under the auspices of the JAO following the first test campaign. The results were positive, dissipating the existing doubts regarding the prototype antenna performance, and were collected in a summary report issued in mid April. The report examined various performance issues, with emphasis on surface accuracy and pointing for both antennas measured under near identical conditions.

The Antenna IPT lead and deputy continued to be involved in the selection process of the production antenna contractor(s). The two Executives in close collaboration with the JAO jointly led this effort. The bidders were requested to provide updated financial offers, in case of ALMA providing specific services to the contractor at the OSF site. In addition, the new financial offers were based on the possible reduction of the number of antennas which had been endorsed by ASAC and ESAC. All these activities were coordinated between the two Executives in interaction with their respective Contract Award Committees.

The Antenna IPT in collaboration with System Engineering personnel performed an extensive exercise at the ATF to probe in detail the maintenance of the two antennas in order to assess the final workload with the array in operation. This has allowed an update of the evaluation of the life cycle costs, which had been previously produced, in autumn 2004.

As a result, and following the ALMA Board meeting in Pasadena, ESO and AUI prepared recommendations to the Finance Committee and National Science Foundation, respectively, on the selection of VertexRSI and VertexVA as the contractors for the antennas.

To support the decision process ESO has performed a comprehensive Finite Element Analysis of the performance of the Vertex antenna. This has allowed ESO to get an independent view of the capability of this design, without relying on the Critical Design Review data provided to AUI in the framework of the prototype contract.

The ESO Finance Committee endorsed the ESO recommendation, conditional on the reassurance of the funding by the ESO Council. ESO Council however postponed the decision until the rebaselining work is more complete in order to have a more firm estimate of the Cost at Completion.

ALMA

The National Science Foundation agreed to the recommendation of the ALMA Director and the ALMA Board that AUI enter in negotiations and place a contract with VertexRSI for the North American procurement. Negotiations were in progress at the close of this reporting period and a contract was signed at AUI headquarters on the July 11, 2005.

Vertex Prototype Antenna

At the completion of the JATG testing, the Vertex prototype has been handed over to Prototype System Integration and is in regular operation at the ATF. Of particular relevance currently are the activities linked to integration and test of the latest ALMA Software.

The Antenna IPT has performed a programmed preventive maintenance of the antenna. These maintenance activities were part of a complete assessment of the maintenance workload of the two prototypes.

AEC Prototype Antenna

The antenna performed well during the entire period of JATG testing. At the end of this period the prototype was handed over to Prototype System Integration and is in regular use at the ATF. Again the activities linked to ALMA Software are receiving priority.

An inspection of the antenna status was completed on the occasion of the above mentioned assessment of the maintenance work load of the two prototypes. (A detailed report has been generated).

Transporter

The Call for Tender was issued by ESO mid March 2005, with original due date May 31st. Upon requests from bidders the tender period has been extended until mid July 2005. The Antenna IPT has been active in answering questions from the bidders.

Nutator and Optical Pointing Telescope

Due to the unsatisfactory performance of the nutator used with the prototype antennas it has been decided not to fabricate identical "build to print" units but to establish Technical Specification and a Statement of Work documents for the commercial production of revised units. Experience and design inputs from the existing nutator will flow into the revised design. Work has started on these documents, but input from the System Engineering and Science Groups on the final science related performance is not yet complete. The collection of the input includes the Japanese requirements.

A similar situation is occurring with the Optical Pointing Telescope, with final requirements not yet fully defined; the ALMA Project Engineer is spearheading this effort.

Rebaselining

A major advancement was achieved in the rebaselining process with the establishment of the Antenna IPT SOW, the generation of an updated Work Breakdown Structure, the associated cost sheets and the first version of the Risk Register.

Personnel Issues

Marc Rafal has stepped in as North American IPT leader, following the resignation of Victor Gasho at the end of February. Interviews were performed with both internal and external candidates. At the time of writing this position has been offered to Jeff Zivick, who has accepted.

Technical and Managerial Risks and Concerns

All antenna bids exceed the allocated budget. This has forced both AUI and ESO to seek a reduction in the number of antennas to be procured as a baseline with options to increase up to 64 if later conditions permit.

In the case of AUI, NSF approved the placing of the contract for the North American share of the production antennas with Vertex RSI and contract signature is due in early July.

For Europe the additional funding needed to complete the ALMA Construction phase needs to be agreed by ESO Council in order for Europe to move forward in placing the contract for its portion of the ALMA antennas. A contract signature does not appear possible before October 2005.

The de-phasing between the two Executives represents a risk in the first phase of the Contract, which is intended to be a design phase. This design phase should be followed jointly by the Antenna IPT, and this is partially restricted by ESO having not completed their procurement process.

Tasks during the Next Quarter

Production Antenna Procurement

- Continue the activity related to the procurement and obtain ESO Finance Committee approval to negotiate and place the contract.
- Support the start of the North American contract with VertexRSI to ensure that all technical issues are agreed in order to obtain a fully compliant design.

Transporter

- Analyze bids, ask questions of clarification, and possibly visit bidders in order to prepare the paper to Finance Committee to request approval to place the contract.

Front End IPT

Planned versus Actual Achievements

Integrated Product Schedule / Project rebaselining

The Front End (FE) IPT schedule inside the IPS is now in full operational use. The schedule continues to be updated and refined; in particular, intensive work on alternative plans for FE integration and test is in progress. The three alternatives being planned in detail are two parallel integration centers, serial integration beginning in Europe, and one super-integration center.

A preliminary meeting between ALMA-J representatives and ALMA-B FE IPT management was held in April to discuss activities required to support Bands 4 and 8 and to support the ACA Front Ends. The LO support is now beginning to be entered into the IPS. At this meeting it was identified once more that it **is** urgent to receive from ALMA-J a complete list of the FE deliverables, including delivery dates, they expect from ALMA-B.

In collaboration with EU and NA institutes, cost updates for the production work packages were refined.

FE sub-system engineering

Front End sub-system engineers provided support to various ongoing activities, including:

- Interaction with ALMA-Japan for Band 4 and 8 cartridges.
- Extensive update of existing and definition of new ICDs in preparation for the delta PDR in July 2005.
- Front End integration and verification.
- Front End sub-system MTBF analysis (in close collaboration with PA engineer from SE&I IPT) intended to lead to a recommendation on spares policy.

ALMA

Cryostat

The production of both pre-production cryostats and cartridge bodies is becoming more mature. At the end of this reporting period the assembly and verification of cryostat #2 had been completed and preparations were being made for the formal acceptance of this unit. Assembly of cryostat #3 was well under way at that time.

Production of GFRP parts, based on an improved design for manufacturing, for the cartridges bodies is running well. Cartridge bodies with these new GFRP parts have been delivered in this reporting period to the Band 3 and 7 cartridge groups while delivery to the Band 6 cartridge group is imminent.

Close out of the action items from the cryostat CDR was not completed as planned. The main reason for this was that not all documentation to be updated and released was made available although progress was definitely made with this task.

A more essential action item was the validation of the lifetime of the nylon clamp rings. ESO specified in close collaboration with RAL a suitable test method. Using this test method RAL has performed experimental tests on nylon samples with a satisfactory outcome.

Optics

Verification testing, including loss, return loss and burst test, of newly moulded windows for Bands 3 and 4 is underway.

The Band 3 mirror assembly has been returned to the manufacturers for re-inspection. The first inspection indicated that the elliptical mirror was outside the tolerance specifications. Band 3 and 4 adjustment tools have been made and delivered to IRAM.

Problems with relatively high sidelobe levels in the Band 6 optics have not been resolved. The next step is to make beam measurements of the Band 6 cartridge mounted in an ALMA cryostat at IRAM/Grenoble as soon as possible.

Cartridges

Band 3: Extensive testing was carried out on Cartridge #1. It was outfitted with a pre-production Warm Cartridge Assembly and DC Bias module. Work was performed on automating both mixer and cartridge testing.

Band 6: After extensive testing in the Cartridge Test System, Cartridge #1 was installed in Cryostat #1 and connected to the Cartridge Test System electronics for early integrated testing. Results for noise temperature, sideband ratio, and beam pattern were found to be comparable to those measured in the Cartridge Test System cryostat. Since the beam sidelobe still appears, plans were made for pattern

measurements at IRAM using Cryostat #2. Cartridge #2 was assembled and DC tests were made. Mixer assembly and test continued, and several units are ready for installation in cartridges.

Figure 5. Cryostat #1 and Band 6 Cartridge Test System Electronics in use for early integrated testing of Band 6 Cartridge #1

Band 7: The first Band 7 cartridge has been completed and is being subjected to an extensive series of verification tests. Noise measurements on the completed unit, using the first local oscillator delivered by NRAO, show exceptionally good performance with a large margin compared to the requirements (see figure below). Production of other components for the following pre-production cartridges progresses **to** schedule. At the end of the reporting period, 5 complete Band 7 double sideband mixer assemblies were available.

Band 9: A first Band 9 pre-production cartridge was also completed in this reporting period (see figure below). This has been slightly delayed due to the unavailability of the first local oscillator assembly to be delivered by NRAO. The time that became available while waiting for the first local oscillator assembly has been used to make some design modifications. These design modifications will optimize future production.

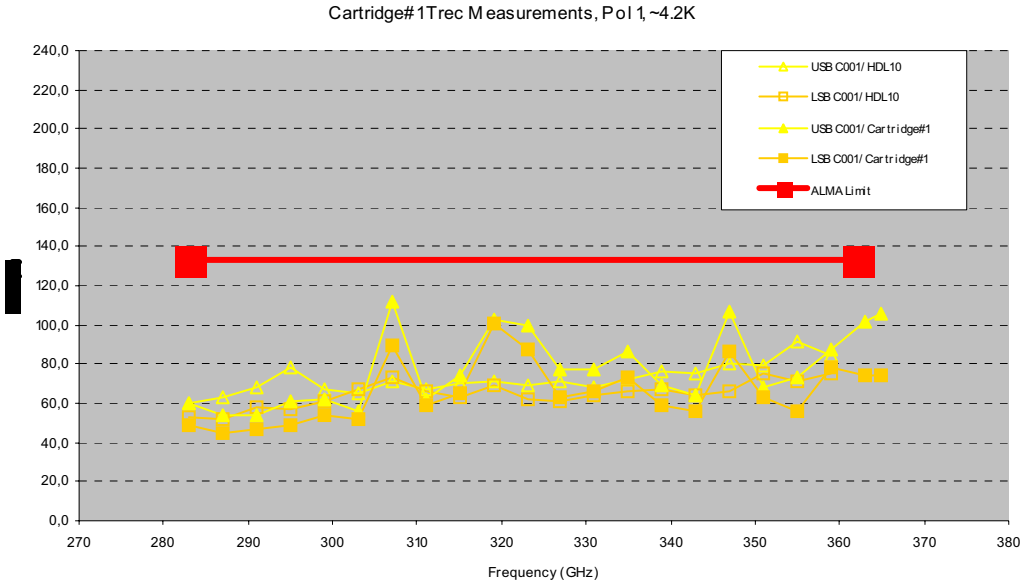

Figure 6. Band 7 Cartridge #1, Polarization 1T_{rx} measurements comparison with the mixer assembly T_{rx} obtained in a test cryostat.

Figure 7. Band 9 cartridge.

Front End Integration and Test

A Finite Element Model analysis of the Front End Support Structure (FESS) was performed, assuming a rigid antenna and with realistic modeling of the Front End itself (cryostat and electronics). This showed that the existing flat-plate FESS design was not stiff enough to meet the optical pointing specifications. A design with a reinforcing ring was analyzed and shown to be much closer to meeting the specifications; work on this subject will continue in conjunction with an ongoing assessment of the entire mechanical tolerance budget.

A stiffer version of the pre-prototype electronics chassis was designed and fabricated, and this will be used in FE #1. Significant progress was made in designing, fabricating, and delivering the support electronics, including DC Bias, Monitor and Control, IF Switch, and Power Supply and Distribution.

The IF Processor for the Test and Measurement System was designed and fabrication began. The specifications for special handling equipment (Tilt Table and Cartridge Loader) and Beam Scanner were written and procurement began.

Amplitude Calibration Device

The experimental tests, part of the feasibility study carried out by IRAM in Grenoble, were completed. A report summarizing these tests and the viability of a calibration system meeting the stringent science requirements is in preparation.

Water Vapor Radiometer

Both prototype Water Vapor Radiometers (WVR), the Dicke-switched WVR built by Onsala Space Observatory and the correlation WVR built by Cambridge, became available to the project after completing the lab testing programs. The test results have been reported as part of the WVR PDR documentation package prepared for the review that took place on May 4-5, 2005, at OSO in Sweden. This WVR PDR was very successful; details will be made available in the PDR report that was under preparation at the end of this reporting period. The demonstrated performance of both types of WVR meets requirements, and based on this result the simpler and cheaper, Dicke-switched radiometer, design can be selected for ALMA.

Technical status / performance achieved

There has been good progress in achieving the performance specifications for the cold cartridges, although some parameters remain to be verified. The FE local oscillators are in good shape except for the power problem with Band 9. The cryostats work exceptionally well. Pre-production versions of most of the support electronics are in regular use, and design of the remainder is mostly complete. There are only a few outstanding design issues to be resolved.

Highest Level Technical and Managerial Risks and Concerns

Band 9 First Local Oscillator

A prototype Warm Cartridge Assembly and X6 frequency multipliers were shown to give satisfactory performance over 80% of the Band 9 frequency range, and these components are in use for testing at SRON. A higher-power final amplifier was designed and fabrication began. This is intended as an interim solution to the Band 9 LO power problem. Another alternative is to develop a higher-efficiency frequency multiplier, and work on this is in progress at Virginia Diodes Inc., with delivery expected in the next quarter. Alternative power amplifier and frequency multiplier configurations are also being designed and fabricated.

Mechanical tolerance budget

Concerns have been raised about the mechanical tolerance budget and its effect on optical pointing, i.e., how well the cartridge beams are aimed at the subreflector and the effects of elevation angle. These questions cannot be fully analyzed within the Front End because of interactions with the antenna, and a unified effort to understand the tolerance budget is being coordinated by the System Engineering IPT.

WVR field testing

The substantial delay in the availability of the prototype ALMA interferometer at the VLA site for testing the prototype WVRs seriously jeopardizes the original plan. First fringes on the test interferometer are only expected in early 2006, this meaning that WVR testing can only take place in winter 2006/2007. To avoid a serious delay in the following detailed design phase and production phase of the WVRs several mitigation plans have been defined. A final choice for one of these plans is expected to be made as a result of the WVR PDR.

Planned activities for next period

- The delta PDR for the Front End will be held in Garching July 6-7, 2005.
- Completion of assembly, verification and delivery of first cartridge pre-production units, Bands 3/6/7/9, is nearly done. Delivery of these cartridges is awaiting final testing and is expected in the next quarter.
- Assembly of the first Front End including cryostat, chassis, and support electronics will begin.
- Production of the remaining pre-production cryostats and cartridge bodies will continue. Cartridge bodies will be based on a modified design further optimized for production.
- The delayed (due to the project rebaselining activity) detailed Front End integration and test plan will be completed.

- Formation of the European FE integration centre at Rutherford Appleton Laboratory in the UK will start with the installation of the fixed infrastructure.

Back End IPT

Planned versus actual accomplishments over the period

The rescheduling exercise showed a tight production schedule to complete by 2009 when NA BE IPT funding ends, so the schedule was extended to 2011. Contingency was also increased for an updated overall budget increase recommendation of 15%.

Verification test plans were completed for NA except for LO (Local Oscillator) Photonics, Digitizer Clock, and Optical Modules. Procurement for pre-production modules was continued where practicable.

Re-design and fabrication of TP (Total Power) digitizer for IF (Intermediate Frequency) processor was completed and is being tested.

Verification tests of prototypes are being performed and results loaded to EDM (Electronic Data Management). Tests to date have uncovered intermittent problems with DTS (Digital Transmission System) operation; specifically, intermittent clock problems on the formatter and deformatter circuit boards. The formatter board has been re-designed as a result of the problem and the new design is being tested. Re-design of the deformatter (for the DTS receiver board) has been initiated. A CRE has been submitted to investigate consequences of possible DTS receiver board options.

Some re-work has been performed on 2 GHz LO reference products; the need for the re-work resulted from phase noise tests.

A new BE System Technical Requirements and allocation of requirements within the BE design has been prepared but needs further SE (System Engineering) input. Issues are to be addressed at System Requirements Review in July.

A draft ALMA Memo "The ALMA 4Gsps, 2-4GHz Input Bandwidth, 3-bit Flash A/D converter" was issued.

Detailed comparison of Vega 1 and Vega 2 sampler performances showed that the salicided polisilicon adopted for the Vega 2 sampler ladder resistance results in a too much dispersed poly resistivity and only a few of the assembled Vega 2 samplers exhibit Gaussian responses. A concluding design meeting was held on April 28, 2005 with ST to recommend that the Vega 1 and Phobos chips which meet system specifications are adopted for the project.

ALMA

Testing of the two prototype laser synthesizers will continue in Socorro. Phase noise performance improvements to the Line Length Corrector have delayed release of the design to P-SI (Prototype-System Integration). Delivery of both products for P-SI testing is now scheduled by Q4 2005.

Work has continued at UKC (University of Kent, Canterbury) on the LPR optical amplifier and on PMD-related problems on phase. The first WR-08 photomixers have been constructed at RAL using standard u^2t photodiodes. The anticipated performance has been realized.

The delivery of the final prototype integrated IF processors from the vendor is scheduled for July. Delivery of the assembled units to P-SI is scheduled for August. The gain performance requirements will need to be better understood to order pre-production units.

Numerous external ICDs (Interface Control Documents) between Back End and Computing/Site/Front End are in draft form, awaiting clarifications or requirement definition.

Studies of the fiber optic cable system in the EVLA (Expanded VLA) project show that the elimination of EDFA (Erbium Doped Fiber optic Amplifier) amplifiers from the ALMA design needs careful consideration because an additional power margin may be necessary to compensate for connector performance in the presence of dirt and humidity.

The requirements for the Central Variable Reference input to the Laser Synthesizer were identified except for the tuning range. The tuning range for the laser synthesizer may change as the result of a design proposal being prepared by the slave laser vendor for the laser synthesizer.

Two prototype fiber optic cable antenna wrap-ups were tested; another is under construction for testing next quarter.

LO Photonics has been moved from Tucson to Charlottesville. All BE Tucson effort will cease in July.

A revised plan for IPT-level approved documentation suitable for CDR and production has been released.

An RFI (Radio Frequency Interference) analysis showed the need to increase shielding of modules, racks, and connectors. That re-design work has been complete and procurement initiated.

Completed rebaselining work.

Technical status and technical performance results

Preliminary tests on a prototype Line Length Corrector (LLC) appear to prove the concept. More work is necessary, however, to reduce phase drift. The same LLC has been successfully demonstrated with a prototype cable wrap. Although only laboratory measurement with 180 degrees of wrap motion, this "proof of concept" has significantly reduced the risk associated with the Photonic LO.

The integrated IF (Intermediate Frequency) processor procured from a vendor demonstrates gain flatness performance of 3-4 dB, better than specification and improvement to 2 dB in the next version looks possible. Once requirements are understood, a gain equalizer circuit may be added to correct for gain slope introduced by cabling, variations in performance of circuitry, and gain differentials in the signal from the FE receivers. The re-design reduced the IF downconverter count from eight modules per antenna to two.

Preliminary results for an end-to-end LO performance analysis was released by System Engineering and Integration IPT (SE & I IPT). Some additional work needs to be done to define allocations for gain and phase between modules.

A new plan for a simplified DG assembly (3 PCBs instead of 5) has been proposed and prepared with the industrial assembler selected for the preproduction DG assemblies.

Highest level technical and managerial risks and concerns

To meet the current timescale for delivery of modules for the first two antennas, the BE IPT plans to provide pre-production modules which may require revision for the full production run. The pre-production modules will be produced in parallel with completion and testing of prototype modules. The existing prototypes and the pre-production modules will perform adequately for science operations.

The University of Bordeaux has concluded the DG ASIC design phase. There is a managerial risk if the full acceptance procedure of the ALMA chips is too long that the ST microelectronics production line is not available to the project. Close discussions with ST are planned to mitigate the risk.

System level IF processor specifications for gain flatness have changed since release of the contract for construction of prototype integrated modules. An order of pre-production modules will permit a second cycle of prototyping and testing before the final production module is procured. The existing prototypes and the first set of integrated prototypes are expected to work adequately for initial testing and science operations.

Polarization mode dispersion and acoustic sensitivity problems with components in the Photonics LO design could result in phase noise performance less than requirements. Prototypes and pre-production modules for the first two antennas may not meet specification for the highest planned

frequency and the most distant antenna, but will be adequate for initial testing and science operations at the Array Operations Site (AOS).

An e2e LO analysis must be completed to confirm current design.

Planned activities for next period

- Continue procurement for pre-production modules where practicable; complete SoW and specification for antenna racks.
- Complete testing of TP digitizer re-design for IF processor.
- Continue verification tests of prototypes for prototype SI.
- Continue tests of antenna fiber cable wrap prototype.
- Commence build and test of photomixers with new batch of u^2t photodiodes.
- Deliver line length corrector LRU (line replaceable units) and laser synthesizers to prototype SI.
- Complete testing of new designs for LO Reference Receiver, Central Reference Generator and Distributor.
- Begin P-SI testing of first versions of integrated IF processors.
- Complete external ICDs.
- Finalize fiber optic cable choice and fiber optic cable management plan for AOS. Conduct review of fiber optic cable management plan for cable inside the AOS TB (Technical Building).
- Begin testing of DTS formatter re-work and complete re-design of deformatter to correct intermittent clock problems.
- Received a draft transportation plan and delivery schedule from Management IPT. The information will be used to update Production Plan and PMS (Program Management Schedule).
- Begin planning for incorporating ACA in BE production plans. This is carried over from previous report awaiting permission to begin design coordination.
- Refurbishment of two DG assemblies is scheduled for P-SI DTS tasks. This includes bandpass slope corrections and M&C board.
- Continue conducting DTS system tests to the extent possible.
- Continue RFI analysis.
- Complete e2e LO analysis.
- Continue identification of missing or incorrect technical specifications.
- Complete SoW and Specification for pre-production integrated IF downconverters and initiate procurement.

North American ALMA Science Center Highlights

Progress was made on the development of a North American ALMA Operations Plan. Planning has begun for ALMA activities at the next two meetings of the AAS. Phase I of the ALMA Proposal Submission Tool has been completed for NRAO telescopes other than ALMA. A workshop on "Z-Machines" has been scheduled for early January 2006; other ALMA-related workshops are in the early planning stages. The ANASAC met twice during this period.

North American ALMA Science Center

The initial work breakdown structure (WBS) for the NAASC completed last quarter was used as the basis for an estimate of the cost to the NSF (and NRC) of ALMA operations. This estimate was presented to the NSF and is being incorporated in the materials for the NSF Senior Review. The WBS is now being refined to eliminate any potential inconsistencies with the ALMA construction plan, with special attention paid to commissioning of antennas and the transition from construction to operations. A visit was made to the Chandra Science Center. Together with the data we have from the Spitzer Science Center, we now have good benchmarks for science center requirements that can be applied to the NAASC. Assuming that the JAO completes its Operations Plan and underlying WBS, our goal is to have a North American ALMA Operations Plan complete by the end of the calendar year.

An application was filed with the American Astronomical Society (AAS) for a Town Meeting at the Washington, DC meeting of the Society, January 9-12, 2006. That application has been approved. The 2006 summer meeting of the AAS will be held in Calgary, Canada, with the first day a joint meeting with the Canadian Astronomical Society (CASCA). With colleagues in Canada taking the lead, we are planning a special session on ALMA for that day.

The NAASC staff together with interested parties met every two weeks during this quarter to discuss progress on various activities. The status of each working group (leader shown in parentheses) is as follows:

Proposal Functions (E. Fomalont): The development of a tool for proposal submission for all NRAO telescopes, including ALMA, has been completed by a group in Socorro led by D. Frail. It has been thoroughly tested by many users outside the NRAO. It was used for proposal submission to the GBT at the June 2005 deadline and will be used for the VLA/VLBA at the October 2005 deadline. It will be used for ALMA as well and is known as Phase I of the ALMA proposal function software. Phase II is under development, mostly by European groups. It will take input from the Phase I tool in order to produce an observing schedule and the beginnings of a proposal database. The interface between Phase I and II is complicated and much more work is needed, but progress is being made on schedule.

ALMA

Science Functions (J. Hibbard): Test2 of off-line software was completed and Test3 is planned for November 2005. For Test3 it was decided to recruit additional testers and include more diverse, challenging data sets. Test3 of pipeline data reduction is scheduled for October 2005. Following discussions with the Herschel Mission, it was agreed that we would work jointly in developing a spectral line database for ALMA. W. Latter is the point of contact at the Herschel Science Center for this activity. A "Science Goals" page was added to the NAASC website, including links to presentations at relevant conferences, to provide ready access to material on new ALMA science drivers. The Science IPT reported progress in recommending a technique for amplitude calibration.

Community Functions (P. Vanden Bout): A workshop has been scheduled on the topic "From Z-Machines to ALMA: (Sub)millimeter Spectroscopy of Galaxies", to be held at the Charlottesville, January 12-13, 2006. Scientific and local organizing committees have been appointed. Workshops being considered include joint workshops with the Herschel and James Webb Space Telescope missions. An ALMA presence is being planned for IAU Symposium 231: "Astrochemistry – Recent Successes and Current Challenges", August 29 - September 2, 2005, and for the Spitzer Science Symposium "Infrared Diagnostics of Galaxy Evolution" to be held in Pasadena CA, November 14-16, 2005, to consist of the ALMA display and/or scientific poster papers with an emphasis on ALMA's potential for astrochemistry and galaxy evolution, respectively. Finally, possible formats for ALMA "summer schools" were discussed.

The ALMA North American Science Advisory Committee (ANASAC) met twice during this quarter, in a telecom on April 29, 2005 and a face-to-face meeting at the Center for Astrophysics, Harvard University, on June 12, 2005. The telecom was largely concerned with informing the ANASAC of the status of the construction project and planning for the face-to-face meeting. The membership of the ANASAC is listed below:

Andrew Blain (ASAC Member) (2007)
Chris Carilli (ASAC Member) (2006)
Dick Crutcher (2006) – Chair
Jason Glenn (2006)
Xiaohui Fan (2007)
Christine Wilson (ASAC Member) (2007)
Lee Mundy (ASAC Member) (2007)
Jean Turner (ASAC Chair) (2007)
Min Yun (ANASAC Chair) (2006)
Doug Johnstone (2007)
Doug Johnstone (2007)
Mark Gurwell (2006)
Joan Najita (2006)
Paul Ho (2008)
Crystal Brogan (2008)
Andrew Baker (2008)
John Bally (2008)
Mel Wright (2008)
Jonathan Williams (2008)

At the meeting in Cambridge in June, R. Crutcher agreed to chair the ANASAC. Following a briefing from A. Wootten on the status of the ALMA Project, the ANASAC re-affirmed its strong support for the Project and wrote a letter to the NRAO Director urging that a procurement of antennas proceed with all possible dispatch.

Expanded Very Large Array

Expanded Very Large Array (EVLA) Highlights

The redesigned Digital Transmission System module, which has delayed the project for several months, was installed and successfully tested on two EVLA antennas and is now moving into full production. Work is proceeding on the fourth EVLA antenna. A contract has been awarded for the construction and installation of the new shielded room which will house the EVLA correlator. The Canadian partners are making good progress on the design and prototyping of the correlator, with the first prototype circuit boards now starting to be tested. The company designing and fabricating the new correlator chip is now in the process of final design verification prior to prototype chip fabrication. Funding for several new programmer positions for an enhanced e2e effort has been identified and recruitment of the new positions is underway. A new Proposal Submission Tool, written by the staff in the EVLA Software Division for eventual use by all of NRAO, was successfully used for 50 proposals during the most recent GBT proposal deadline. The contract for the first increment of Mexican funding for the EVLA project has been completed. A Reverse Site Visit for the EVLA Phase II Proposal was held at the NSF in June.

Expanded Very Large Array Milestones

Milestones	Original Date	Revised Date	Date Completed
ACU/FR interface w/MIB installed on Antenna 16	04/05/05		04/05/05
L-Band feed VSWR test	04/06/05		04/06/05
Voice over IP phone tested	04/13/05		04/07/05
Start VLA old computer floor removal	04/15/05		04/07/05
DTS revision E formatter tested	05/05/05		04/07/05
LO/FE racks installed in Antenna 13	04/12/05		04/12/05
L-Band feed horn installed on Antenna 16	04/12/05		04/12/05
Operators EVLA M&C training	04/15/05		04/21/05
T304/T305 base band converters ready to install	05/02/05		04/21/05
L352 RTP side by side tests	04/18/05		04/26/05
Antenna 16 move to Array	02/04/05	04/19/05	04/26/05
Move Antenna 18 into AAB	05/03/05		04/26/05
Verify signal clearance of 45 GHz feed in tower	04/08/05		05/02/05
T304 digital control board assembled & tested	04/18/05		05/02/05

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
L301 and L302 integrated module ready for Antenna 16	02/22/05	04/15/05	05/04/05
L, K and X-Band receiver installed on Antenna 16	05/04/05		05/05/05
Electronics hardware installed w/1 IF-Band on Antenna 16	04/14/05		05/10/05
Control and Monitor Processor (CMP) accessible on AOC network	05/11/05		05/11/05
First fringes on Antenna 16	03/02/05	05/05/05	05/12/05
Routine test observing	05/13/04	04/11/05	05/16/05
Verify linearity of RF designs – receiver to correlator	05/27/04		05/16/05
UX converter (Norden's) evaluated	04/11/05		05/27/05
Reprioritization of software requirements	05/31/05		05/31/05
Develop plan for feed horn moisture control	05/31/05		05/31/05
Delivery of 12 low noise receivers to CONACyT	06/01/05		06/01/05
Draft common project software model MOU	05/06/05		06/01/05
Pattern measurements of metal version C-Band horn	05/03/05		06/02/05
VLA site test of CMP completed	06/06/05		06/06/05
C-Band feed installed on Antenna 16	05/05/05		06/09/05
WBS Updates	05/23/05		06/10/05
Primary CMP installed at VLA, backup installed at AOC	06/14/05		06/14/05
Next two F320 modules ready for MIB software	05/20/05		06/15/05
M302 Utility module design complete	06/16/05		06/16/05
VLA monitor data to EVLA monitor data archive in EVLA format	06/20/05		06/20/05
L305 antenna reference module assembled for ant. 18	05/31/05		06/28/05
2nd C-Band receiver ready to install w/new card cage	04/12/05		06/30/05
Complete assembly - M301 DAQ1 board	05/16/05		06/30/05
Start production F320 FE transition module	03/28/05	06/01/05	06/30/05
WBS Schedule Updates	06/20/05		06/30/05
75/328 MHz converter module ready for test antenna	10/24/03	07/08/05	
New time synchronization reliability	02/15/05	07/08/05	
Antsol solutions available to EVLA M&C system	07/11/05		
Correlator PDR	07/13/05		

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
Requirements for final version of Observation Executor complete	07/14/05		
C-Band receiver installed on antenna 16	07/14/05		
C-Band receiver installed on Antenna 16	05/06/05	07/14/05	
4 IF's on Antenna 16 working	03/09/05	07/15/05	
Fabricate NRAO Q-Band MMIC post amplifier	07/16/04	07/19/05	
MIB control band select switches on Antenna 13	10/21/04	07/21/05	
M301 hardware, ICD ready for software	05/27/05	07/22/05	
M301 converter interface module ready for software	10/07/04	07/22/05	
4 IF's on Antenna 14 working	09/13/04	07/22/05	
D30x ICD (revision E) ready for software	04/18/05	07/26/05	
Hardware acceptance tests on antenna 16 complete	07/27/05		
Antenna 16 turnover to Operations	07/28/05		
New shielded room grounding & ESD plan	07/29/05		
RTP data multicast from L352, w/ listener thread in interim Obser-X	07/29/05		
Pointing offsets available to EVLA M&C system	07/29/05		
VLA archive tool to interact w/ user database	08/01/05		
Modcomp independent format for archive records specified	08/01/05		
Functional prototype M302 available	08/01/05		
Complete Part 2 hardware bench integration	03/03/03	08/05/05	
M301 module ready to install on antenna	06/08/05	08/05/05	
4 IF's on Antenna 13 working	03/31/05	08/10/05	
Check for interference and bandpass shapes: 8, 22 & 45 GHz	03/15/04	08/12/05	
Receiver stability tests: 8, 22 and 45 GHz	12/19/03	08/12/05	
Report on Receiver stability, bandpass shapes, linearity of RF design	08/12/05		
Final version of antenna VOIP phone	08/15/05		
M302 ICD complete	08/15/05		
D30x MIB software ready	05/20/05	08/16/05	
New VLA correlator controller operational, controlled from Modcomps	08/30/05		

Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
Hardware acceptance tests on antenna 14 complete	08/30/05		
EVLA outfitting complete on antenna 18	08/30/05		
Move Antenna 20 into AAB – start EVLA outfitting	08/31/05		
Proposal tool - VLA	09/01/05		
Agreement on common project software model	09/01/05		
Antenna 14 turnover to Operations	09/01/05		
FY 2006 Budget Plan due	09/16/05		
L-Band dewar assembled & tested	09/23/05		
Start transition mode observing	03/15/05	09/27/05	
Hardware acceptance tests on antenna 13 complete	09/28/05		
Front Ends CDR	05/05/05	11/17/05	
Two F317 modules w/ MIB tested and ready for software	09/08/04	01/13/06	

Management

The first of two deliveries for EVLA equipment funded by the Mexican CONACyT was completed. Assembly of 12 low noise receivers was completed before the deadline and was verified by a representative of the Mexican UNAM visiting the VLA on June 5. This increment of Mexican funding is approximately $570 K. Delivery of the final part of the contract, valued at approximately $1.2 M, is scheduled for October, 2005.

On June 13-14 a Reverse Site Visit for the review of the Proposal for the EVLA Phase II Project was held at the NSF in Washington, DC.

Systems Integration

EVLA Antennas 14 and 16 are now being used for routine testing. Each antenna has one new Digital Transmission System (DTS) module installed in IF-A. These contain the new single chip 8-bit digitizer and upgraded formatter boards. Initial testing with these modules indicates the new digitizer and some updated formatter/deformatter software has solved the image problem that had been occurring with the system. In July, these two antennas will be populated with the full complement of hardware to support operation with four IF's.

Modifications to improve performance of the round trip phase (RTP) system are almost complete. Two updated RTP modules (L352) and a redesigned offset generator module (L351) will be installed for testing in early July.

Expanded Very Large Array

Retrofits to Antennas 13 and 18 are well underway. Antenna 13 was the early prototype antenna and is now being re-outfitted with the latest set of hardware. It should be fully operational with four IF's in August. Antenna 18 is the fourth EVLA antenna and is currently in the antenna assembly building undergoing the mechanical portions of the refit. Electronics should be installed and tested in early fall 2005.

Civil Construction

The demolition of the old VLA computer room, the location for the new correlator room, was completed in April. The bids for the new correlator shielded room package were received. After reviewing the packages, the contract to build and install the shielded room was issued to Universal Shielding. After a timeline is established for the shielded room additional RFQs will be issued for the fire suppression system, HVAC equipment, computer flooring, power distribution equipment, and other miscellaneous items.

A meeting was held to discuss the philosophy of maintaining power to the new correlator after a commercial power failure. It was determined that with an adequate uninterrupted power supply in place proper shutdown of the correlator can be done without failure to its components. It was decided to take power for the new correlator off the existing building distribution bus. The additional transformer earlier proposed will not be required at this point.

Antennas

The mechanical outfitting of the fourth EVLA antenna, Antenna 18, was started. Feed cone #4 was installed. Feed de-icers were installed on the third EVLA antenna, Antenna 16. Feed tower alignment fixtures have been designed and are being tested. Additionally, pre-assembly of structural subassemblies of the EVLA design continued through the quarter.

Front End

One of the recommendations from the Feed CDR was that the mounting towers used to support the Ka and Q-Band receivers might affect the feed beam patterns. A series of tests carried out at the antenna range in Green Bank has determined that there is no interference seen at Q-Band. The towers are now ready to be mass-produced.

The third L-Band feed was installed on Antenna 16. The fourth L-Band feed horn has been assembled and will soon undergo pattern testing on the Outdoor Antenna Test Range (OATR) in Socorro before installation on Antenna 18. The fifth L-Band feed is currently in the process of being laminated.

The third and fourth C-Band feeds, both of which use the new machined all-aluminium design as opposed to the laminated rings and bands process used on the first two units, are complete. Preliminary

tests were carried out on the third feed at the OATR prior to its installation on Antenna 16. Further beam tests on the fourth feed, which is slated for Antenna 18, are planned.

Two prototype 8-12 GHz X-Band feed horns have been built and successfully tested at Green Bank.

A series of efficiency and spillover tests have begun on the K and Q-Band systems installed on Antenna 14. Pointing errors and variable summer weather have tended to make the analysis of the G/T performance at these frequencies difficult. The existing VLA L-Band dewar design is currently being modified so that it can accommodate the EVLA 1-2 GHz Ortho-Mode Transducer prototype. A third VLA L-Band receiver (S/N 01) has been upgraded with new broadband balanced amplifiers from CDL, the second receiver to be outfitted with these low-noise, high-power gain blocks and was installed on Antenna 16. The phase-match for the hybrid coupler in S/N 21 was significantly improved and the polarization performance of the receiver will be measured in the lab shortly, after which the receiver will be installed on Antenna 18.

One of the VLBA S-Band receivers (S/N 3) was outfitted with new 2-4 GHz balanced amplifiers from CDL. The receiver temperature was decreased by 3-5ºK across the band and the headroom was improved by over 10 dB. These new amplifiers were designed specifically for the EVLA Project and have been made available for use on the VLBA first.

The second C-Band receiver continues to undergo tests in the lab. It is the first receiver to utilize the new EVLA Card Cage design. Problems with the Bias Card have resulted in slightly higher receiver noise temperatures than are seen when the old Card Cage is used. Efforts to isolate and eliminate the excess noise are on-going. The fabrication of the third C-Band receiver is nearing completion.

Two Downconverter Modules for the new Ka-Band receiver have been assembled at Caltech. These multi-function modules utilize two custom and six commercial MMIC's to provide RF and IF post-amplification, as well as the active tripler for the LO signal and the block conversion mixer. Both units will be evaluated once the DC bias circuits are declared functional.

Local Oscillator (LO)

Modules with the new boards for the L305 and L350 were assembled and are currently undergoing tests. The layout for the new L353 boards was started and will be completed in the third quarter. Although integrated assemblies have been qualified for the L301 and L302 synthesizers we have not received the production order from MITEQ. These assemblies, which are two months behind schedule, are due in August. Initial tests with the round-trip phase system have shown some instability problems with temperature so some redesign has become necessary.

Expanded Very Large Array

Fiber Optics

The formatter and 8-bit digitizer boards in the Digital Transmission System (DTS) module were redesigned, fabricated, and successfully tested on Antennas 14 and 16. The DTS module can now move into full production. Antennas 13 and 16 were completely outfitted with fiber and work had begun on antenna 18. Fiber optic pad boxes have been set at all VLA antenna pads but significant splicing work remains to outfit these boxes for EVLA use

Intermediate Frequency System

The UX converter T303 prototype unit was received from the vendor and has been tested and approved for production. The 4P converter has a new board layout, which has been tested. This module is currently under construction. The LSC converter was placed into full production. The base-band down-converter now has functioning total power digitizers although there are still some software issues to be resolved. The M301 converter interface has slipped schedule and will not be completed until the third quarter.

Correlator (HIA report)

Delivery of the first prototype circuit boards for the 1 Gbps data transmission system test was delayed until mid-June because of late component delivery from suppliers and because of delays in shipping components to the U.S. assembler through U.S. customs. Nevertheless, the prototype boards have now been delivered and are undergoing tests. Initial results indicate the signaling, cable and FPGA are working as designed, but there are some problems with the 1 Gbps signal fanout board that are expected to be solved shortly. After a long period of design, testing of the first real hardware represents a major milestone for the project.

Station and baseline board place-and-route is expected to be nearly complete by the PDR to be held from July 11-13 in Penticton. The formal bidding process for the PCB and assembly contract manufacturer is now closed with contract award planned for August. Prototype station and baseline board delivery is expected in October.

The correlator chip place-and-route is going well with a progress review meeting with Innotech Systems planned for late July. The design now appears to be frozen since no more changes are likely to be required to meet timing closure. Execution of all of the validation test cases on the most recent design has been completed. Verification testing of the gate-level netlist remains to be done prior to prototype fabrication.

In late May, the NRAO software engineers were in Penticton for software installation and testing. Backend software was successfully installed on the HIA high-speed computer in preparation for handling real data from the correlator. Good progress was made on the mapper function that translates high-level correlator configuration requests to actual correlator hardware allocations and configurations.

This will be a powerful piece of software that is a critical component of utilizing the correlator to its full potential.

Monitor and Control (M/C)

The layout of the Module Interface Board (MIB) has been redesigned for better manufacturability and lower cost. The first board of the new design passed functional and RFI tests. Four F320 (Front End Transition) modules and 20 M304 modules (Slot ID Module) were built. Testing is underway for monitor and control of the new designs of the M301 (Converter Interface) module and T305 (Baseband Converter Interface) module.

The "EVLA Monitor and Control Transition Software Development Plan, Version 1.0.0" was expanded and reissued as the "EVLA Monitor and Control Near-Term Software Development Plan, Version 1.1.0". A detailed report on the status of this software development plan is given in the document entitled "EVLA Monitor and Control Software, Status as of Q2 2005". Both documents are available on the EVLA Computing Working Documents web page.

The interim Observation Executor is now used more widely and supports even more of the capabilities that can be specified in a VLA Observe file. VLA Operators, some astronomers, and some engineers now use a web-based interface to the interim Observation Executor to submit jobs for EVLA antennas. EVLA antennas have been included in some the standard observing sessions—such as the pointing runs used to determine coefficients of the pointing models for the antennas. Requirements have been issued for the final version of the Observation Executor. This version of the Observation Executor will factor out a separate layer of antenna servers.

Work on an interim Antsol/Telcal program that will make complex antenna gains and on-the-fly pointing offsets available to the EVLA Monitor and Control System progressed well beyond the proof-of-concept stage during the quarter. The production quality version of this work is scheduled for completion in the third quarter.

The Control and Monitor Processor (CMP) achieved operational status during the quarter. The CMP is the path by which the EVLA Monitor and Control System receives monitor data from and sends commands to VLA antennas. VLA monitor data is now being stored, in EVLA format, in the EVLA monitor data archive, and an initial test of the command path from the EVLA Monitor and Control System to a VLA antenna was successful.

Significant progress was made during the quarter on the new VLA Correlator Controller. This controller will provide the means by which the EVLA Monitor and Control System will control the current VLA Correlator. It is expected to be operational, under the control of the VLA Control System, by the end of the third quarter, with control of the VLA Correlator passing to the EVLA Control System by the first quarter of 2006.

Expanded Very Large Array

Data Management

The Interferometry Software Division (ISD) initiated work towards a memorandum of understanding between the EVLA and ALMA about the development of common models. This is a logical continuation of previous efforts to come to a common Science Data Model, and a necessary condition for sharing software between the projects. Initially the effort will focus on the Science Data Model and the Project Model.

Formation of a High Level Architecture team was delayed because of a lack of e2e staffing and competing higher priorities, primarily the interim Observation Executor. Two new e2e positions were approved and active recruitment is ongoing. The scientific requirements for all e2e subsystems for the EVLA were examined in detail and re-prioritized. These requirements and their time-scales will form the basis of EVLA e2e software planning for the next five years.

Testing of EVLA specific applications in AIPS++, in particular wide-field imaging, took place and a report is about to be released.

The new NRAO-wide proposal tool integrated with the also newly developed NRAO user database was released in the beginning of May and used for the June 1 GBT proposal deadline. Close to 50 GBT proposals were created and submitted without major problems. The same tool will be further developed for the VLA and VLBA, and at a later date for the EVLA as well. A VLA release in time for the October 1 deadline is being considered but may be postponed until spring 2006.

Green Bank Telescope

Green Bank Telescope (GBT) Highlights

The fraction of the time the GBT spends observing continues to improve, with the most recent improvements due to continually improving hardware and software reliability.

Excellent Q-Band (~43 GHz, ~7mm) observations were made during this quarter. In astronomical observations, an astrochemistry experiment was performed with the 4 x 800 MHz mode of the spectrometer with the bands placed end-to-end in frequency, so covering over 3 GHz of instantaneous bandwith. The experiment covered most of the Q-Band range from about 40.5 to 48 GHz. The receiver was reported as very stable and the baselines flat; pointing and focus stability was also excellent. In commissioning observations, the receiver was used for another, very successful campaign of "out-of-focus" (OOF) holography.

Observing and data analysis software continues to improve, with two general releases of the GBTIDL data analysis package, and the first formal release of Astrid, the new Observing Interface, to visiting observers. A very successful in-progress review of GBT software was held in May 2005. Considerable progress has been made on both the Caltech Continuum Backend and completion of the Ka-Band receiver. These are on schedule for planned testing and commissioning activities this fall.

Formal agreement has been reached with MIT/Lincoln Labs to use the 43m (140 Foot) Telescope to perform bistatic radar experiments to study the earth's ionosphere. One of the first tasks was to demonstrate that the 43m could be quickly brought back into operation. This has been achieved; the hydraulic systems have been restored to full operations, and a new control computer system has been installed. We expect to install the Lincoln Laboratories feed and front end system in September 2005 and make the first test observations in October 2005 .

GBT Milestones

GBT Antenna & Operations

Milestones	Original Date	Revised Date	Date Completed
Complete development of new rail concepts	12/31/03	08/01/05	
Hold panel review meeting	01/31/04	12/07/04	12/07/04

Green Bank Telescope

Milestones	Original Date	Revised Date	Date Completed
Receive quotations and recommend awards	08/30/05		
Receive AUI/NSF approvals and make awards	10/30/05		

GBT Electronics

Milestones	Original Date	Revised Date	Date Completed
Spectrometer Upgrades			
Cross-correlation/poln. test fixture constructed	03/01/04	3/01/05	05/01/05
Begin polarization mode checkouts	06/01/04	03/01/05	05/01/05
LTA Test and Debug	04/15/05	08/15/05	
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
GBT RFI Antenna Mount Design	10/29/04	08/1/05	
Test Building Receiver Handler	10/15/04	07/15/05	
3 mm Quartz Windows	10/31/05		06/22/05
Penn Array Electronics Crate GBT Mount	03/31/05	04/29/05	04/26/06
EVLA X-Band Feed	04/29/05		04/28/05
CCB Chassis and Front Panel	06/31/05		06/27/05
Solar Burst Antenna (large)	06/30/05	Pending Design	
EVLA L-Band Ring Loads	07/29/05		

GBT Software & Computing

Milestones	Original Date	Revised Date	Date Completed
Integrate GFM/IDL; Deprecate IARDS	03/31/04	08/15/05	
Integrate Pulsar Modes into Astrid	12/31/05		
Complete Linux Migration	06/30/05		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	project on hold	
Ready for prototype W-Band operation under benign conditions	10/01/04	project on hold	
Ease of Use			
Production Release of HLAPIs & Online Filler	Task reorganized Q4 04	06/30/05	06/30/05
Complete "Phase 4" of Observing API (near-earth objects, source catalogs)	06/30/05	12/31/05	
Data Handling			
Generate requirements for imaging	12/31/03	12/01/05	
Analysis Conceptual Design Review (In-Progress Software Review)	05/30/05		05/03/05
Production release of IDL package to GBT users	05/15/05	05/30/05	05/31/05
First draft of GBT Science Data Model	03/31/05	09/30/05	
Ka Band (1 cm Rx)			
Develop LO Distribution Module	06/01/05	07/15/05	
Refurbish Receiver	08/04/05		
Install on GBT	10/03/05		
Penn Array Receiver			
Detectors Delivered to Penn	05/17/04	08/2005	

Green Bank Telescope

Milestones	Original Date	Revised Date	Date Completed
Full Lab integration at Penn	09/06/04	09/2005	
GBT Commissioning	02/21/05	11/2005	
3 mm Receiver			
Design/Fab Cryostat	11/10/05		
Final Receiver Assembled	02/01/06		
Caltech Continuum Backend			
Master Board laid out	04/2004	05/2005	05/2005
FPGA program synthesized and simulated	03/2004	04/2005	06/2005
Finish Packaging drawings	05/2004	05/2005	05/2005
Construction and lab testing complete	08/27/04	10/2005	
Commission on GBT	09/06/04	11/2005	

GBT/Green Bank Overview

The fraction of total time used for successful GBT observations continues to improve. The time scheduled for astronomy remains around 70%, the lost time during this quarter was only 66 hours (~4.5%), a significant drop from previous quarters. This reflects the continually improving stability and reliability of both the hardware and software systems. Another significant step taken at the start of Semester 05B (May 1) was to drop the setup time from one hour to thirty minutes. In fact, for the last month, the average setup time has been ~22 minutes.

Observing and data analysis facilities continue to make great progress. GBTIDL was formally released for general use on May 30, with the first update released on July 7. Early user feedback has been very positive. We have also now formally released the new observer's interface, Astrid (Astronomers Integrated Desktop) for use by visiting observers. Astrid is a unified workspace that incorporates both the GBT's new scheduling block-based observing system and the real-time quick-look display, GFM (GBT Fits Monitor & data display tool). Currently, Astrid supports most types of GBT observations, with the exception of non-sidereal sources (e.g. solar system ephemeris) and the data taking control of the pulsar spigot. Working on adding both of these capabilities is now underway. We will be encouraging all observers to switch to Astrid as soon as possible, with a goal of phasing out use of GO by October 1.

Development work continues apace. The focus of our technical development continues to be the high frequency instrumentation, with work continuing on the Caltech Continuum Backend and the Ka-Band receiver. We have an ambitious commissioning schedule this fall, with the Q-Band receiver, Ka-Band receiver, Caltech Continuum Backend, and Penn Array to be commissioned and/or made available

for production use. We are working hard to ensure we will be ready for the high-frequency observing season to commence on October 1.

Work continues on the azimuth track project, with a view to having the complete proposal agreed by NSF and contracts awarded by October. Finally, we have formally entered into a collaborative agreement with MIT/Lincoln Labs to enable the use of the 43m (140 Foot) Telescope for studies of the earth's ionosphere by bi-static radar.

GBT Azimuth Track

Estimates for components and services to implement NRAO's and the independent review panel's recommendations for the new design have been collected and put together. This has involved many discussions on how to minimize costs for material and fabrication, and how to accomplish the field work. Some work continues on finite element analysis of some portions of the design, but should finish by mid-July. Work is currently in progress on assembly drawings and specifications for formal quotation packages. Our goal is to have formal quotations for components by the end of August or sooner, and to present these to NSF and obtain their concurrence by the end of October. We are working to make sure we have the necessary resources in place prior to awards as well.

Telescope Operations Activities

Annual - interval preventive maintenance activities began on the GBT at the start of June. Our focus this summer is structural painting, and we have already made very good progress, with eight painters. The weather this summer has been more favorable. Motor inspections and brake servicing are also in progress.

Along with work on the GBT Azimuth track project, Telescope Operations has put a good bit of effort into re-commissioning of the 45 Foot and 140 Foot Telescopes, to perform the Solar Radio Burst Spectrometer project and ionospheric studies for MIT/Lincoln Labs. The 45 Foot is currently in service four hours per day.

Green Bank Electronics

Green Bank Electronics provides support for all electronic systems at Green Bank, including telescope controls, back-ends, 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.

Green Bank Telescope

Digital Group Activities

Most of the digital group's time was spent on 45-Foot and 43m Servo support, Spectrometer support and development, and the Caltech Continuum Backend project.

The 45-Foot servo system work for this quarter consisted of construction of the new servo system for the telescope, as well as support for getting the antenna running under control 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 construction of the first board, and firmware and hardware debugging continues. Cross-correlation testing concentrated on the development of a test fixture, including final assembly and testing of the test fixture. The spectrometer is fairly reliable although it occasionally produces bad data that is usually obvious. Thus, trouble-shooting and repair accounted for only a small amount of the time spent on the spectrometer. About 2 FTE's are provided to the Spectrometer in either upgrade or repair mode.

The Digital Group is supplying engineering to assist the Caltech Continuum Backend project. We are designing the hardware, including the packaging design. About 4.5 FTE 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 Activities

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

The 26-40 GHz receiver was removed from the telescope, and modifications to bring it up to its full complement of spectral channels and continuum detectors are underway. The receiver will be integrated with the Caltech Continuum Backend before being reinstalled in the fall.

The IF system received some attention this quarter as well. New IF amplifiers are being built and tested. Various module instabilities and failures were repaired, and investigations continue to improve gain stability with better temperature control and other steps, such as adding isolation amplifiers to the optical receiver module splitters.

The outdoor antenna range upgrade was completed. This will provide better positioning, instrumentation, and software for doing antenna measurements on the outdoor range. The range is in use now by Green Bank and CDL engineers. The indoor antenna range was for the first time used to

make W-Band measurements, and will continue to be used to support the 68-92 GHz receiver development.

The Microwave group is supplying expertise to the 43m NRAO-MIT Lincoln Labs telescope project. The group is restoring, installing, and testing RF components at the telescope for use by the project.

Development of a 68-92 GHz correlation receiver continues. Construction of the cardcage and waveguide test fixtures was completed. Design of an optical table providing thermal calibration standards and other selectable optical elements is ongoing, as is assembly of quartz vacuum windows with anti-reflection matching layers. Design of the cryostat nears completion and fabrication will start in the third quarter.

RFI Management

The RFI group worked on observer support, NRQZ administration, and on and off-site RFI mitigation.

Observer support was provided to the SRBS project, as well as to the prototype EoR array.

NRQZ administrators processed 26 regular applications, and 11 preliminary applications. ERPd restrictions were placed on eight sites. Two site inspections were completed. Objections were raised to several government transmitters.

Several problems with cable TV and power line RFI were identified and fixed. Wireless networks in the area are being identified and mitigated. NRAO's replacement of light ballasts at the Green Bank library was completed.

The GBT RFI Monitoring station continues to come together. The electronics has been built and tested. Design and construction of the mount is almost complete. Testing of the electronics will continue this quarter, and we hope to install the station during this quarter. We have installed our new OASIS spectrum monitoring software and are beginning to use it.

The group gave talks to several outside groups, including the summer students, SARA, Chautauqua groups, and others. Several local emergency services planning meetings were attended.

Mechanical Engineering and Central Instrument Shop

The Mechanical Division and the Operations Division have been working together to assist contractors in the process of quoting track materials and repairs. The Mechanical and Operations Divisions have also been working on mapping out the track repair processes and methods. The

Mechanical Division has also been involved in maintenance and upgrading of several exhibits in the Science Center.

This quarter the Central Instrument Shop completed work on a pair of EVLA X-Band feed horns. These are the largest machined feed sections ever fabricated in the shop. The process development for the fabrication of quartz windows for the 3 mm receiver was very successful. The processes, developed by the shop and Bob Simon from Electronics, have worked out nicely and the fabrication of the production windows was completed this quarter. One of a pair of antennas for the Solar Burst Antenna was completed with the other larger antenna still pending a design.

Software Development Division (SDD)

The primary SDD accomplishments in Q2 2005 were: (a) a successful release of GBTIDL for spectral line data analysis on May 30; (b) significant work towards achieving a July 1 date for visiting observers to start transitioning to Scheduling Block based observing with the Astronomer's Integrated Desktop (Astrid) application; (c) two releases of the control system software; and (d) completion of the 2005 GBT Software Review on May 3.

Work on the Ease of Use project focused on transitioning Astrid to visiting observers, which is a joint effort between the SDD and scientific staff. Several software items identified during staff astronomer evaluation of Astrid use were resolved this quarter; updates and additional details are described in the projects section of the report. The focal activity for the Data Handling project this quarter was releasing GBTIDL v0.0 on May 3, v1.0 on May 30 and v1.1 on July 1. The focus of maintenance activities was the continuation of the Linux Migration project including the completion of ported DCR code, and additions to the control system required for Astrid support.

The SDD produced two regular releases of its key product, M&C, with v5.3 on May 25, 2005, and v5.4 on June 28, 2005. In v5.3 only minor updates were included. A new parameter was added to the DCR (and the Configuration API made to update it) to support the fully specified capabilities of the AutoPeak and AutoFocus scan types available in Scheduling Blocks. Configuration was also enhanced to support the use of user-specified bad devices, for example, if the user wishes to avoid a particular optical driver in his or her observational setup. For v5.4, there were some major additions, including the release of the Linux-based DCR software which included improved Tsys calculations using Tcal values from the receiver calibration database and a higher maximum switching rate of at least 100Hz. Additional problems were also identified and resolved with the DCR code which could have contributed to decreased reliability of that device in the past. A supplemental utility called dcman was prepared to allow manual updates to dynamic corrections, and if the dynamic corrections are not updating properly, a message will appear in the operator's message window.

Commissioning the Ka-Band Receiver, Caltech Continuum Backend, and Penn Array are key priorities of the GBT over the upcoming months, and software work is underway for each of these efforts.

In particular, a data simulator was written for the Penn Array, which was used to generate a FITS writer for the simulated data. Additionally, software was written to enable the output of written data independent of a scan in the control system. A software tested machine was also set up, and in Q3 significant work will be done with this tested, particularly after the hardware arrives and the FITS writer for engineering tests and commissioning can be written. For the Caltech Continuum Backend, a manager to support engineering tests was released as part of M&C v5.4. Low-level support was provided for the Ka-Band receiver software.

With the release of the ported DCR code, only the LO1 and the software on the replacement machine for vortex must be completed to finalize the Linux Migration project, which has been active for several quarters. However, significant work is required throughout the remainder of 2005 to make the Caltech Backend ready for production use, and to ensure that all remaining functionality is added to the Scheduling Block execution programs. Since the primary reliability and exception handling benefits of porting to Linux have all been achieved with the release of the new DCR code, the remaining ports (which are all smaller magnitude efforts) will be completed as software maintenance time permits. A software test was also prepared for the Electronics division to support their work on several receivers over the summer. This was necessary due to the mass porting of receivers to Linux earlier in the year.

In total, the SDD delivered 88% and 91% of committed tasks respectively in C3 and C4 (comparable to 93% and 83% of committed tasks delivered in the first two development cycles). This is measured as the proportion of deliverables committed to, versus the total number of deliverables completed and approved by the task's sponsor by the end of the cycle.

The 2005 In-Progress GBT Software Review was held on May 3, 2005 in Green Bank. Several members of the e2e Oversight & Advisory Committee and others from around NRAO evaluated the progress of GBT software since August 2004 to ensure that GBT software work is adequately aligned with Observatory-wide expectations and software priorities. Status and project details were prepared for the following: the GBT Science Operations Plan, the high-level software development plan and continuing maintenance & enhancement (CM&E) work, Penn Array and Caltech Backend software, the new Scheduling Block based observing process, GBTIDL, the data capture process and quick look data display, the GBT Science Data Model, Linux migration, antenna improvements, and data quality diagnostics. The review report was generally favorable, applauding the GBT SDD's well-organized and efficient approach to development, and noting that the new Scheduling Block based system (and underlying interfaces to the control system) has progressed well. The reduction in the maintenance backlog over the past year was also recognized. Though GBTIDL progress was applauded, the panel did caution against open-ended development and suggested that the commitment of resources be bounded even further. The committee also pointed out inaccuracies in GBT's data capture process which will be remedied in Q3 and Q4 2004, and advised that sufficient attention be given to antenna issues which impact high-frequency observing with the GBT.

To accomplish GBT goals, it was also noted that the current SDD staffing vacancies must be filled, and adoption of technologies from other telescopes should be pursued.

Computing

Hardware

As usual for this quarter a number of new machines have been purchased for the use of the summer students including a high-end workstation. Some of these are set up in the basement and will be redeployed once they leave. Several other personal workstations have also been upgraded this quarter.

There have also been printer upgrades this quarter. The public printer's pslaser and hp4mv have both been upgraded as well as some office printers. Also due for upgrading is the main backup tape library. This upgrade will increase our backup capacity by a factor of three and allow us to consolidate all windows and unix users home directories in the same place. At the same time it will allow us to relax the space limitations somewhat. Windows users will also then have access to the snapshot facility.

Software

New Linux machines are now being installed with Redhat Enterprise Linux release 4. This comes with the 2.6 kernel and should provide better performance. When all parties are satisfied with the new operating system release a more general deployment will begin.

The migration to the Windows AD domain is now essentially complete and the number of NRAO domain machines continues to shrink.

Network

Plans have been made for the upgrading of network services at the 140 Foot Telescope including a new local switch and this will be purchased once the MIT/LL contract is in place.

General

The entire division traveled to Charlottesville this quarter for the annual sysadmins conference. This year we were looking to the future to see what services we can add, improve, or eliminate. One of the most pressing items identified was controlling 'spam' and action can be expected on this in the near future.

A job description was drawn up for a new junior sysadmin post and it is hoped to be advertised soon.

Development Projects

PTCS

Surface Efficiency/Holography

As noted in the previous report, we finally managed to obtain some excellent data during an extended commissioning run on April 10-11. This allowed us to perform out-of-focus (OOF) maps on 3C84, 3C279, 3C286, and 3C345 over a range of elevations and thermal conditions. These observations were made at Q-Band (43GHz, 7mm), using look-up table corrections for the active surface derived from earlier data obtained in March. Application of the large-scale OOF corrections makes a significant improvement to the aperture efficiency, ranging from ~10% (benign night-time conditions at the rigging angle) to ~60% (low elevation and/or daytime). Absolute efficiency measurements are complex, and the analysis is still underway. However, preliminary results suggest a peak Q-Band efficiency after large-scale corrections of ~0.51, yielding a surface accuracy of ~320 μm. Perhaps not surprisingly, one of the main aberrations during the daytime appears to be astigmatism due to displacement of the subreflector. We are hopeful that we will be able to use the radial focus and elevation pointing corrections (either as predicted from the dynamic corrections system, or as measured) to determine and correct for this effect. This should allow us to correct for the bulk of the daytime mis-collimation, without the need for a real-time OOF measurement. At the same time, we expect to have the OOF measurement and analysis process completely automated by the fall, so that a full round of measurement and adjustment can be made in ~ 20 minutes.

Servo Performance and Antenna Trajectory Calculations

As part of the efforts to understand Ka-Band and Q-Band efficiency measurements, we have started investigating the performance of the antenna servo in more detail. During "nodded" efficiency observations, it is clear that the servo performance when slewing to the positive beam is significantly better than slewing to the negative beam. This appears especially obvious when the azimuth component of the sidereal velocity of the source cancels the azimuth motion required to reach the other beam, leaving a net azimuth velocity demand of ~ zero. The poor servo performance under these conditions is assumed to be due to static friction on the azimuth drive wheels; this potential problem was noted in early GBT memos. A similar effect may explain the poor servo performance when performing "daisy-petal" and other continuous raster scans; the worst performance again occurring when the net azimuth velocity demand crosses zero. Techniques to ameliorate the impact of this effect on observing are being investigated. At the same time, we have begun a low-level investigation into other antenna control related issues, particularly problems with antenna trajectory calculations. We are being assisted in this area by Fred Schwab and Rick Fisher in Charlottesville.

Ease of Use Project

The Ease of Use project has been conducted over the past several quarters to make it simpler for observers to configure the telescope and perform observations with the GBT. Efforts to date have included adding the ability to define observations in advance of observing using Scheduling Blocks, the ability to execute those observations, improved monitor and status information while observations are executed, and an improved real-time display.

In Q1 2005, the Astronomer's Integrated Desktop (Astrid) was released to staff astronomers for evaluation. The vision for Astrid is that the astronomer launches one application and has access to all of the applications, documentation, and feedback facilities that are required to conduct an interactive local or interactive remote observing session using Scheduling Blocks. Similarly, the astronomer whose programs are scheduled in an automated dynamic fashion will be able to use the integrated desktop to manage their observations in the future. It was discovered in Q1 that adoption of the tools by staff scientists was lagging, despite the extensive online documentation available. The cause of this was identified primarily as lack of dedicated SDD training of the staff scientists one-on-one.

Because adoption by the local staff is a prerequisite to transferring the technology to visiting observers, the Observing Issues Group was organized in Q2 to facilitate the transition to the new observing paradigm, as well as to address items of critical importance to GBT support scientists. After participating in several Astrid training sessions, the group identified software issues requiring resolution before the system could be transitioned to visiting observers. Throughout Q2 2005, the items which were addressed included the following:

- Online/Offline modes of operation were added, which include the ability to be online but only to monitor the observation in progress, not to control the telescope. The operator has full override permission to change modes as appropriate. Addition of these modes helps to ensure that users will not interfere with live observations.
- Security data was added to the Observation Management database to support these modes of operation.
- Scheduling Blocks were made to respond more gracefully to control system issues through the addition of intuitive, consistent, and reliable Stop and Abort functions at the Scheduling Block level. Stop or Abort now cleanly exits the Scheduling Block, clearing any leftover data in the antenna which might interfere with upcoming observations. The system does not behave differently if the exit commands are sent during a configuration or observation. The user has the option of exiting at the scan or sub-scan level.
- The ability to Pause a Scheduling Block was added. This is useful in cases, for example, where intermittent weather shutdowns would otherwise require a Scheduling Block to be resubmitted in its entirety. Now, the SB can be paused, and the observation can be continued once the shutdown is lifted, improving the efficiency of telescope usage.

- Better handling of SBs after aborting a configuration were implemented, preventing the observation from continuing without the antenna actively included in the observational setup.
- Failed configurations are now detected and reported during Scheduling Block execution.
- The Validator was enhanced to detect illegal configurations.
- A new scan type, AutoPeakFocus, was added to combine the ability to Peak and Focus with default parameters in one action.
- Parameters were added to breakpoints within Scheduling Blocks so that the user can control (or eliminate) timeout periods.
- Usability improvements for the user interface were specified and documented in a Modification Request, to be implemented in C5 2005. Requested changes include modifications to the layout of the panels in the application to make them more intuitive, making the control system status panel always visible, and making SB submission more like a "palette" where one SB can be submitted and resubmitted multiple times with ease.

With the transition to Scheduling Block based observing via Astrid, applications which do not employ Scheduling Blocks (e.g. GO) are being phased out by the end of Q3 2005, achieving the primary goal of the Ease of Use project. There are now several new applications in place which make the GBT much easier to use than it was in 2003, including: Astrid, which provides a unified desktop for all the applications an astronomer needs; the Turtle Observation Management System utilizing the Configuration, Observing and Balancing APIs, which collectively enable the execution of single Scheduling Blocks; GFM, a combined online/offline data display visible from within the Astrid framework; and GBT Status, which provides a snapshot of current telescope operations.

There is much work yet to be done to make this a fully functional system. Source catalogs and non-sidereal sources are scheduled for implementation in Q3 along with the user interface remodel, and in Q4 we expect to improve balancing behavior and enhance the Scheduling Block validation capabilities to encompass checks for completeness, configurability and appropriateness in addition to syntactic validity.

However, the framework has been largely completed and the applications have reached a level of stability where visiting observers can start observing with Scheduling Blocks starting July 1. The scientific focus in the upcoming months will be to use and adapt this framework for improved manual dynamic scheduling, and eventually to enable automated dynamic scheduling. For this reason, additions to Astrid will be managed as software maintenance tasks in the future, and major new improvements (e.g. implementing the management of Scheduling Blocks with Science Programs) will be done under the directives of the Dynamic Scheduling project, which is currently being scoped out and organized. The "Ease of Use" project as currently constituted is therefore considered complete.

Data Handling Improvements

This project covers all aspects of observer-facing software that are encountered after an observation is successfully made, from data quality assessment through imaging. The IDL development process is being used as a means to generate 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. The by-product is a package for offline spectral line data reduction to support analysis of data from the majority of GBT's Standard Observing Modes.

This quarter was marked by a number of major accomplishments, with releases of the initial versions of the GBTIDL spectral line data analysis package. GBTIDL will be the recommended data analysis package for spectroscopy observations (except for mapping) beginning July 1, when visiting observers will be required to use Astrid applications. Drawing on lessons learned during the Astrid development and release process, technology transfer was taken into consideration and three releases were conducted: v0.0 on May 3, intended for early review by GBT support scientists, v1.0 on May 31 for the general user community, and v1.1 at the end of the quarter which incorporated fixes and usability enhancements requested immediately after the v1.0 release. The package consists of a set of straightforward yet flexible calibration, averaging, and analysis procedures (the "GUIDE layer") modeled after the UniPOPS and CLASS data reduction philosophies, a customized plotter with many built-in visualization features, and Data I/O and toolbox functionality that can be used for more advanced tasks. The entire package is written in IDL.

In addition to providing offline data analysis, services were also implemented to generate GBT data in SDFITS format automatically (an "online filler") and to read that data into GBTIDL with minimal user effort. Thus GBTIDL is available as a quick look display. The user only needs to enter "online" mode, and then spectral scans can be viewed and processed as soon as they are written to disk by the online filler.

The package is accessible from installations in both Green Bank and Charlottesville, and copies of NRAO's IDL license are available for checkout from a dedicated machine in Charlottesville for users who do not own a copy of the IDL package. GBTIDL is also available for distribution to observers' home sites. The distribution includes all source code.

Complete information about the project and the GBTIDL product, including bug tracking and discussion forums, can be found on Sourceforge at *http://gbtidl.sourceforge.net*. Future updates, including the integration of user-contributed code, will be accessible from this web location.

In the coming quarter, the data analysis routines generated in IDL will be used to feed the GFM data display, providing a real-time quick look at all of the standard spectral line observing modes. After this, data analysis work will focus on generating generic flagging and calibration capabilities, which will be useful both in IDL and in support of Observatory-wide software objectives.

Green Bank Telescope

Penn Array Receiver

A prototype (1x4) detector array with lightly passivated bismuth absorber was produced at Goddard Space Flight Center. We expect the recipe will be suitable for the 8x8 engineering array that will be used in winter 2005/2006 GBT "first light" prototype array tests. Two SQUID MUX columns were installed in the dewar and successfully tuned & operated, with test data acquired to disk. Configuration and readout of the MUX was accomplished fully under computer control, and to our knowledge this is the first time this has been done with the NIST MkIII SQUID MUX. Several new versions of the firmware were produced and much was learned about SQUID MUX operations. Software was written to interface the Penn Array DAQ software (IRC) with the GBT YGOR control system, and successfully tested using the GBT tested simulator. Work was begun writing an IRC native data archiver suitable for commissioning; a duplicate set of warm electronics was obtained at Green Bank to facilitate the eventual development of an YGOR-native DAQ system for the Penn Array. At Penn the warm electronics were installed in the RFI crate that will go on the GBT, and other work was done in preparation for an end-of-August fit check of the complete system on the GBT.

New Receivers and Backends

Recent work has included more thorough characterization of the Ka-Band receiver's continuum capabilities, in preparation for commissioning and science with the Caltech Continuum Backend, and early spectral line science with this receiver. Work on the Caltech Continuum Backend has proceeded and several significant milestones have been achieved, including: completion of the daughter card layout, completion of the master card schematic, and completion of the first version of the FPGA firmware in full (now undergoing testing and refinement via simulation). Assembly and testing of the CCB is scheduled for the summer and early fall, with commissioning over the winter.

Spectrometer Upgrades

The cross-polarization test fixture for the spectrometer has been completed and testing has begun of the spectrometer's cross-polarization (spectral line) modes. A number of the modes have been through engineering checks and mode checkout will continue. The goal is to run engineering tests for all possible xilinx personality combinations during the coming quarter.

The first of the new LTA cards has been delivered. Unfortunately, problems with short-circuiting on the board were found, delaying the introduction of this card into the spectrometer. The problems were further exacerbated with the failure of the LTA test fixture, and considerable time was spent during Q2 on this problem. The new LTA test fixture board has been received and is being assembled. The repair is now complete, and the diagnosing the problems with the LTA board continues.

Significant improvements have been made this last quarter with respect to Spigot ease-of-use and data processing. Spigot setup, calibration, and data-taking are all now almost completely automated using a

python script that communicates over ssh with the computers "earth" and "spigot2". These scripts greatly improve setup times and reliability (steps are always complete and in the correct order) and also allow highly efficient survey observations to take place (80-85% observing efficiency for scans as short as 2 min). In addition, processing of Spigot data has been improved in PRESTO by allowing windowing of the lags, limited protection from lag "wrapping", and automatic clipping of transient RFI bursts.

MIT/Lincoln Labs 43 m Project

NRAO and Lincoln Laboratories have entered into a collaborative agreement to measure the properties of the Earth's ionosphere using bi-static radar techniques. The program will consist of two phases: (I) System Development and Implementation, and (II) Operations. Phase I is expected to be completed this fiscal year, to be followed by a minimum of one year and a maximum of five years of operations. Lincoln Laboratories is building a special wide-band (150 to 1700 MHz) feed and front end system that will be installed on the NRAO 43 m (140 Foot) Telescope. The NRAO is developing an automated system to follow Lincoln Laboratory's spacecraft coordinates. The 43m will track satellite beacons and also spacecraft illuminated by the Millstone Radar at Haystack, Massachusetts.

Lincoln Laboratory's engineers will drive a semi-trailer full of high speed electronics to Green Bank, where it will be installed at the base of the 43m telescope. The trailer is shielded to contain any radio frequency interference the electronics may generate. The Lincoln Laboratory's electronics will select and sample the RF signals and write the digital data to a disk recording system. The disk packs will be mailed to the Lincoln Laboratories office in Lexington Massachusetts for further analysis.

The 43m operation was shut down in 1999, and one of the first tasks for NRAO was to demonstrate that we could fully restore the 43m to operation. Detailed tests of the hydraulics system were required before the collaboration could begin. The 43m hydraulic systems have now been restored to full operations, and a new control computer system has been installed. We expect to install the Lincoln Laboratories feed and front end system in September 2005 and make the first test observations in October 2005.

This work is being funded by MIT Lincoln Laboratories through a contract with the United States Air Force.

Very Large Array and Very Long Baseline Array

Very Large Array (VLA) Highlights

The azimuth bearing was changed on VLA Antenna 18. This was the tenth such azimuth bearing change carried out on a VLA antenna. Two new bearings remain in stock for the two antennas that require replacement of their old bearings, as shown by excessive metal pieces found during the periodic sampling of the bearing grease.

Four SAO-supplied prototype 190 MHz receiving systems were installed on VLA antennas, and considerable testing took place to determine whether the RFI environment would enable searches for neutral hydrogen at the Epoch of Reionization. This testing included negotiation with digital radio stations to turn their signals off at night, which produced significant improvement. During the third quarter, a review will be held to determine whether to move forward with a complete installation for observations to be made in D configuration during the upcoming winter.

Very Large Baseline Array (VLBA) Highlights

Severe rust damage, particularly to the quadrupod legs holding the subreflector in place, was observed during a long maintenance visit to the VLBA St. Croix station. The subreflector positioning system at St. Croix also was repaired. Discussions are underway regarding the necessity of an annual maintenance visit to St. Croix to stay ahead of the rust problem in the very humid environment near the sea.

Three VLBA stations now have been converted to full-time operation with Mark 5 disk recording, and two more stations are using Mark 5 for a large portion of their observations. The VLBA Operations group is taking advantage of this improvement to streamline their observation processing, reducing the total turnaround time for VLBA observations and thus reducing the number of disk modules required for full-time disk operation of the VLBA. During the quarter, purchase orders were issued for six more Mark 5 recording/playback units and 60 more disk modules. With the improved processing efficiency, these purchases should result in a total of 7-8 VLBA stations running full-time on disk recording by about the end of calendar year 2005. The fractional scientific observing time is beginning to turn upward as the tape constraints are removed, and will increase substantially after the majority of the VLBA stations are equipped with disk recorders.

Very Large Array and Very Long Baseline Array

Management and Scientific Milestones

Milestones	Original Date	Revised Date	Date Completed
AIPS++ Stable Release 11	03/15/05	04/01/05	04/01/05
VLA Public Tours	04/02/05		04/02/05
Completion of VLSS Survey on VLA	04/07/05		04/07/05
Global 3 mm VLBI Session	04/21/05		04/21/05
Rust Repairs Completed at St. Croix	04/22/05		04/22/05
New Proposal Tool Released for GBT	05/01/05		05/06/05
AIPS++ Stable Release 12	05/15/05		05/14/05
VLA/EVLA Transition Operations Plan, Version 1	05/27/05		05/27/05
VLA/VLBA Proposal Deadline; VLA Large Proposals	06/01/05		06/01/05
Assess Proposal Evaluation Method for Hi-redshift	02/28/05	05/25/05	06/09/05
Complete Global cm VLBI Session	06/20/05		06/20/05
Three VLBA Stations to Mark 5 Full Time	12/15/04	06/30/05	06/30/05
VLA Dynamic Scheduling Trial	07/08/05		
AIPS++ Stable Release 13	07/15/05		
World Year of Physics VLA Tours	07/16/05		
NRAO/.AUI Input Submitted to NSF Senior Review	07/31/05		
Global cm VLBI Session	08/04/05		
Decision on Outfitting VLA with 190 MHz Systems	08/05/05		
Trial Proposal Tool Released for VLA	05/01/05	09/01/05	
AIPS++ Stable Release 14	09/15/05		
VLA/VLBA Large Proposal Review Completed	09/16/05		
VLBA Site Technician Workshop	09/16/05		
Completion of Dwarf Galaxies Large VLA Project	09/26/05		
Completion of Virgo HI Large Project on VLA	09/26/05		
Five VLBA Stations Full Time on Mark 5 Recording	09/30/05		
VLA/VLBA Proposal Deadline	10/01/05		
VLA Public Tours	10/08/05		
Global cm VLBI Session	11/10/04		
AIPS++ Stable Release 15	11/15/05		
AIPS 31DEC05 Frozen; 31DEC06 Released	12/31/05		
Full Proposal Tool Release for VLA	09/01/05	01/05/06	
Global cm VLBI Session	03/09/06		
Host International SKA Steering Committee Meeting	03/17/06		
Retire VLA Modcomp Computers	03/31/06		

Computer Infrastructure Milestones

Milestones	Original Date	Revised Date	Date Completed
Outfit 3rd EVLA antenna network	01/30/05	04/30/05	04/20/05
Enable VoIP EVLA/AOC phones	04/15/05		04/20/05
Assist with and attend PeopleSoft training	05/15/05		06/15/05
Expand archive to full capacity of 30TB from 17TB (1)	08/31/05	07/15/05	
Examine OS/X support (2)	09/30/04	07/30/05	
Develop NRAO/AOC Computing Infrastructure Long Range plan(3)	05/01/05	08/01/05	
Replace approx 80 older systems(4)	07/31/05	09/30/05	
Migration to Windows 2K domain(5)	07/31/05	10/31/05	
Phase 1 of renumbering AOC IP address space	10/31/05		
Upgrade all NRAO/NM Linux machines to Redhat Enterprise 4	12/31/05		

1) In progress, the hardware is on order and should be completed in a few weeks.
2) In progress, date changed to reflect a broader scope of support
3) Project has been rolled in with NRAO wide Computing Infrastructure plan.
4) In progress, original date was overly optimistic.
5) In progress, approximately 70% done, primarily waiting on hardware to replace older systems that won't run newer versions of Windows.

Operations Software Support Milestones

Milestones	Original Date	Revised Date	Date Completed
Correlator Controller Transition Plan	02/28/04	06/01/05	03/25/05
Track program modifications for Mark 5	10/30/03	05/01/05	05/03/05
Correlator controller operational by Modcomps	04/04/05	09/30/05	
Transcribe VLA observe/system files	11/30/02	01/01/06	
Correlator controller operational by EVLA Monitor and Control	04/04/05	03/31/06	
Translate and copy stores VLA monitor data from 9-track to DAT	03/01/04	06/30/06	

Electronics Milestones

Milestones	Original Date	Revised Date	Date Completed
Projects			
Determine the plan for a reliable WyeMon and WyeCom System for the VLA	06/03/05		05/15/05
Upgrade VLBA FRM System, Concept Test at PTVLBA	11/15/05		
Maser Maintenance			
Install Maser #2 at the VLA	08/01/05		
Retrieve repaired Maser #1	11/11/05		
Receivers (FE)			
Install four 190 MHz receivers on VLA antennas	05/31/05		05/31/05
Performance Review of 190 MHz Prototype System	08/15/05		
Replace the L-Band 20 cm receiver at BR	09/15/05		
Replace the P-Band 90 cm receiver at HN	09/15/05		
Improvements			
Upgrade the TAC and Servo Boards at SC	05/16/05		04/20/05
Upgrade the TAC and Servo Boards at NL	09/28/05		
Upgrade the TAC and Servo Boards at LA	10/15/05		
Upgrade the TAC and Servo Boards at MK	07/30/06		
VLBA			
Install new elevation servo motor at OV	04/15/05		02/15/05
Replace the dry air compressor at FD	04/25/05		04/25/05
Complete maintenance visit and major overhaul at SC including FRM upgrade	06/09/05		04/19/05
Replace the dry air compressor at SC	06/16/05		04/19/05
Workshop for VLBA Site Technicians at AOC	08/09/05	09/15/05	
Scheduled Maintenance Visit NL	09/28/05		
Scheduled Maintenance Visit SC	04/30/06		
Scheduled Maintenance Visit MK (ACU Upgrade)	07/30/06		
Scheduled Maintenance Visit HN (ACU Upgrade)	09/30/06		

Engineering Services Milestones

Milestones	Original Date	Revised Date	Date Completed
Electrical Group			
Complete Control Building UPS PMs			05/10/05
Rewire Control Building Electrical Room	05/10/05		05/10/05
AAB Antenna Pad Electrical Feed Upgrade	05/15/05		05/15/05
Rewire Sewage Lift Station	06/10/05		06/10/05
Seal Mechanical Room Floor			06/30/05
A and B Array Transporter PMs	07/05/05		
Rebuild Spare VLBA Encoder	08/30/05		
Install VLA Site Power Monitors	08/30/05		
C and D array Transformer PMs	11/30/05		
Antenna Group			
Complete Saint Croix Antenna Structure Repairs	04/20/05		04/26/05
Transporter Generator Replacement	04/30/05		04/30/05
Antenna 18 Bearing Change	05/30/05		05/23/05
Complete CnB array reconfiguration	06/17/05		06/09/05
Complete Antenna 16 Overhaul/Upgrade	06/16/05		06/16/05
Repair Cracked Transporter Axles	07/05/05		06/30/05
Complete C array reconfiguration	07/08/05		
Los Alamos Maintenance Visit	08/06/05		
Complete Antenna 18 Overhaul/Upgrade	08/22/05		
Antenna 20 Bearing Change	09/30/05		
North Liberty Maintenance Visit	09/30/05		
Complete DnC array reconfiguration	10/14/05		
Complete Antenna 20 Overhaul/Upgrade	11/16/05		
Site & Wye Group			
MC-9 Tune-up and fuel injector replacement	05/30/05		05/30/05
National Crane Repair AC Install	07/15/05		
Fire Truck Cylinder head replacement	07/22/05		
Tie Extractor Initial checkout/repair	07/22/05		
Spike Driver Initial checkout/repair	08/05/05		
Jackson Tamper Repair	08/30/05		
Surplus Vehicle (3 trucks) Initial checkout/repair	09/30/05		
Complete track repairs between BN6-AN5	12/31/02	11/30/05*	

*Lining and leveling pending Jackson Tamper repairs. North arm track is usable.

Very Large Array and Very Long Baseline Array

Interferometry Software Division

AIPS

Key Developments

1. Methods were developed in the last quarter of 2004 to allow for binary distribution of AIPS. In the first half of 2005, 31 sites downloaded the frozen 31DEC04 version and 123 sites downloaded the development 31DEC05 version of AIPS using this capability. So far, a total of 174 sites have downloaded 31DEC04, 460 sites have downloaded 31DEC05, and 541 sites have used the AIPS cvs code management facility. In all, 856 different sites (different IP addresses) appear in one or more of these lists.
2. The task that corrects VLBI phases for the measured ionospheric electron content was changed.
3. The task that merges and smooths solution tables and applies them to the calibration table was changed to do a true merger rather than simply a concatenation and sort into time order.
4. Miscellaneous changes included changing the calibration tasks to ignore other sources in the calibrator model when scaling fluxes of the calibration sources, correcting the table plotting and flagging tasks for a variety of minor errors and inconveniences, correcting the task that makes Clean box files to handle simple imaging cases, and changing the task that constructs image cubes to allow the user to override the normal coordinate handling. The largest allowed image in AIPS was raised to 32768 on a side. The GNU software that allows the user to do in line editing while typing, called readline, was updated so that it will install on modern operating systems.

Goals

1. Continue user support and bug fixes, as the major portion of AIPS effort. Add the Intel compiler for Linux if license issues can be resolved.
2. 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.
3. Provide support for pipeline data reduction, especially new automatic editing algorithms.
4. Begin investigations of new/improved imaging algorithms, including those dealing with spectral index and multiple pointings.
5. Install modern world coordinate handling software to enhance and replace the original AIPS coordinate handling.

AIPS++

The key activities for this cycle were the development for the SS12-SS13 releases, execution of ALMA TST2.0 (3rd external user test) and EVLA TST2.0 (1st test) tests, delivery of the monthly integrations of the Offline subsystem, ALMA CDR3, and ASDM framework implementation.

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- SS12 *http://projectoffice.aips2.nrao.edu/ss12.html*

- SS13 Activity: *http://almasw.hq.eso.org/almasw/bin/view/OFFLINE/CurrentActivity*

- ALMA TST2.0 - Imaging of combined single-dish and synthesis data.
  http://projectoffice.aips2.nrao.edu/almatst2.0/ALMA_TST2.0.html
  (All needed information on testing goals, data sets, code installation, etc)
  Pre-testing commenced: 2/2005; concluded 3/2005
  Deployment scheduled: 4/2005
  Concluded: 5/2005

- EVLA TST2.0 - Wide-field imaging
  http://projectoffice.aips2.nrao.edu/evlatst2.0/EVLA_TST2.0.html
  (All needed information on testing goals, data sets, code installation, etc.)
  Pre-testing commenced: 3/2005
  Deployment scheduled: 5/2005
  Concluded: 6/2005

Highlights

- Support for wide-field imaging (w-projection)
- Baseline-based bandpass calibration
- Support for third external ALMA test
- Support for first project EVLA test
- Design of framework migration (Python/ACS interface)
- Prototype of task-based system (csh interface; using ACS)
- Deployment of ASDM framework to all dependent subsystems
- Stand-alone Qt viewer design
- Mac OSX support
- Resolution of key defects in visualization; migration of Glish code to C++

Goals

1. Initial framework implementation/migration (Python binding/interface to tools)
2. Fringe-fitting implementation
3. Multiple data set inputs to tools
4. Calibration Data Model implementation in ASDM
5. Preparation for ALMATST4
6. ASDM Filler prototype
7. Qt viewer stand-alone prototype
8. Msplot reimplementation
9. Pointing correction calibration in imaging
10. ASDM V3 documentation outline

Very Large Array and Very Long Baseline Array

Archive

The NRAO Data Archive has been operational since 15 October 2003 and allows everyone on-line access to all VLA data and some VLBA and GBT data (*http://archive.nrao.edu/archive*). To date, over 700 users from 250 institutions have downloaded over 4 Tbytes of telescope data (25,000 data files). The download data rate has climbed to about 200 Gbytes per month (1600 data files per month). Data files over one year old are in the public domain and accounted for over 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 Sept 1999, and some calibrated VLBA data going back to Oct 1999. Efforts to expand the VLBA archive back to 1992 are underway. GBT data from July 2002 through Oct 2004 are available.

We are in the process of constructing and loading an archive mirror-site at the National Center for Supercomputing Applications (NCSA). All VLA archival data have been transported to NCSA, and the daily VLA data files are transmitted to the NCSA via the internet. We intend to offer data download services from the NCSA in the very near future. This will take advantage of the NCSA high internet bandwidth and relieve the internet congestion at the Socorro-AOC.

An NRAO Virtual Observatory Plan has been written and near-term, mid-term and far-term goals have been identified. In the near-term we will identify and select processed data products to include in the archive and make available through VO services. In the beginning, these data products will mostly consist of images from NRAO surveys and large proposed observing projects. During the second quarter of 2005 we have made some progress on our near-term VO goals. Currently over 30,000 images from the NVSS and FIRST surveys are loaded and cataloged in the archive. A VO Simple Image Access service has been constructed for the NRAO Image Archive and will be available to VO users in mid-July 2005.

Proposal Tool

The goal of this project is to create an NRAO-wide proposal submission tool. Though it has been designed from the start such that adding support for other telescopes in the future will be relatively straightforward, it initially focuses on GBT proposal submission only.

A second, equally important element of this effort is the NRAO user database, developed concurrently with the proposal tool. Though the user database is currently integrated only with the proposal tool, it is our intention to use the database for all other NRAO applications requiring user authentication, e.g., access to the NRAO archive.

Very Large Array and Very Long Baseline Array

Following extensive tests by NRAO staff, a final period of testing by external (non-NRAO) GBT users took place in April, 2005, and both the proposal tool and the user database were officially released early May 2005, well in time for the June 1, 2005 GBT proposal deadline.

During May 2005 we conducted two 'stress-tests', during which 10 to 20 NRAO staff made intensive use of the database/proposal tool during a pre-arranged period of time, with the intent of reproducing the anticipated heavy use during the last hours before the deadline. This allowed us to uncover a few potential problem areas, which we were able to address in time for the actual proposal deadline.

As a result, the whole GBT proposal submission process went relatively smoothly: between 45 and 50 proposals were submitted without major problems. If staffing levels allow it, we will attempt to add support for VLA proposal submission at a later date.

Virtual Observatory

The NRAO is a partner in both the U.S. National Virtual Observatory (NVO) and in the International Virtual Observatory Alliance (IVOA). The NRAO is active in VO development on three fronts: 1) participation in development of the international VO framework (e.g., science data access and FITS standards development), 2) providing radio data and services to the VO, and 3) coordination of NRAO data management and science data post-processing development with the standards and technology being developed by the VO community.

The NRAO VO plan prepared last quarter was circulated within NRAO and AUI by the Director's office in late April. This was generally well received, however there is no concrete plan yet for how to proceed or for what new resources might be available. There is considerable overlap between E2E and VO, hence a broader effort to advance VO at NRAO is closely linked to planning for E2E, particularly in connection with archive development.

Work on integrating image data into the NRAO archive has begun. A simple image access (SIA) service for publishing atlas images from NVSS and FIRST to the VO has been implemented and was undergoing initial testing at the end of the quarter.

Work continues on the VLA archive imaging pilot project. Software is under development for staging data from the archive for pipeline runs. Production data processing has not yet begun.

The yearly week-long spring IVOA interoperability workshop was held this year in Kyoto, Japan. D. Tody attended, chairing the data access layer (DAL) working group. The main focus for DAL was the new simple spectral access (SSA) interface. This included definition of a second generation query interface for data access services, definition of query response metadata including data models for generic dataset identification and characterization, specification of the architecture required for future integration

of astronomical data query language (ADQL) capabilities into the data access services, and planning for the next version of simple image access.

SSA provides a uniform interface for data discovery and retrieval for spectrophotometric tabular data including 1D spectra, time series, and SEDs, complementing the SIA interface already available for image data. The first public working draft of the SSA query interface was released in early May and was a major topic for discussion in Kyoto.

SSA is the first major upgrade to the VO data access services since simple image access (SIA) was released over two years ago. Much work has gone into development of the technology used in SSA, particularly of data models for generic dataset identification and characterization, and representation of these data models in VOTable, FITS, native XML, and other data formats. An expanded query interface supports queries by spectral and time bandpass as well as position on the sky, as well as by other data attributes such as resolution in the spatial, spectral, or time axes, the calibration status of the data, and so forth. The query response is based on the new data models. The goal is to advance SSA to the Proposed Recommendation stage by the time of the next IVOA interoperability meeting this fall in Madrid.

A major upgrade of SIA is planned for early 2006. The revised interface will be based largely on the work which has been done for SSA. Initial planning meetings were held in Kyoto and at the EuroVO workshop in Garching at the end of June. The goal is to have a draft of the revised SIA interface ready for discussion in time for the Madrid meeting in October.

A second face-to-face meeting of the Option/VO working group on future data analysis environments was held at ESO in late June. Major topics for discussion were requirements, a reiteration of the system architecture, and the design of the component-container interface. A second version of a generalized parameter model was prepared for the meeting and discussed. Progress on framework prototypes being done by NRAO/ALMA and ESO (the SAMPO project) was reviewed. The next meeting is planned for Madrid in the fall, where we hope to have advanced the design sufficiently to plan a second cycle of development to go forward in 2006.

Preparation for the second NVO summer school to be held in Aspen in September 2005, is underway. This work is currently focused on developing the software and exercises to be used for the course.

E2E Coordination

E2E is an NRAO-wide effort to develop a modern end-to-end dataflow system for all NRAO telescopes. This is primarily a coordination activity, with most actual development taking place within the telescope construction projects.

A second review of GBT software was held on May 3 in Green Bank. A written report was completed in June. The review concluded that the GBT software group, which has lost a couple of FTEs

in the past six months, is doing very well overall. The major concerns were progress on defining a science data model for GBT data, required to have a quality data product to put in the archive and export to users, and limiting the extent to which IDL is used to process GBT data. Some support for IDL is desirable in the short term to support IDL usage by the single dish user community, but a dependence upon IDL is problematic in the longer term as GBT becomes a component of NRAO E2E serving a much broader user community. The baseline software architecture for future data processing elsewhere within NRAO is Python for scripting, with complied language components.

A preliminary written report of the ALMA archive review held last December was prepared and submitted.

Discussions are currently underway between ALMA and EVLA to organize a team to develop common models for observing projects and science data. This is a follow-up on to the E2E effort last year which defined a number of common models required to provide commonality for the data systems of each NRAO telescope.

Central Development Laboratory

Central Development Laboratory Highlight(s)

New low-noise amplifiers optimized for the best available transistors (from the JPL CHOP program) have been developed for EVLA bands up to 18 GHz. The ALMA Band 6 cartridge #1 has been successfully tested in the first ALMA cryostat, and cartridge #2 has been assembled and DC tested. ALMA front-end local oscillators were delivered for all four authorized bands, and development of LOs for Japanese bands 4 and 8 was started. Measurements of a hot electron bolometer mixer at 650 GHz were carried out. Good progress was made for fabrication and measurement of EVLA feeds for 4-8, 8-12, and 40-50 GHz. The first quadrant of the ALMA correlator was completely populated and tested, a prototype of the new tunable filter bank card was received and tested and preparations were made for installing the final inter-rack signal cables. Regular observations of the sun at 20-70 MHz continued with the Green Bank Solar Radio Burst Spectrometer. The 300-2500 MHz receiver was installed on the 45-Foot Telescope and testing was begun.

Major Developments

Milestones	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	4-01-06	
Electromagnetic Support:			
Design of EVLA Ku-Band feed	09-30-04	06-30-06	
EVLA S-Band analysis	03-31-05	06-30-05	05-31-05
Testing EVLA X-Band prototype feed horn	12-31-04	06-30-05	06-30-05
Develop dual frequency 300/600 MHz feed for the GBT	09-30-05		
Study sidelobe characteristics of the GBT at 1400 MHz	09-30-05		
Design EVLA S-Band feed	09-30-05		
ALMA Correlator:			
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	
Finish motherboard PCB layout of a modified SCC test fixture	12-31-04	09-30-05	

Milestones	Original Date	Revised Date	Date Completed
Populate and test at least 4 more first quadrant racks of the ALMA correlator	03-31-05	05-27-05	05-27-05
Revise station card FPGA personalities to support the new TFB card	03-31-05	04-29-05	04-29-05
Start testing of the first production TFB card in the first quadrant	03-31-05	07-29-05	07-02-05
Install final clock distribution cards in the first quadrant of the ALMA correlator	03-31-05	07-29-05	
Complete signal cabling of the correlator first quadrant	09-30-05		
Implement and test cable timing training software	09-30-05		
Install final system clock distribution card	09-30-05		
Start assembly of the second quadrant	09-30-05		
GB/SRBS Phase II:			
70-300 MHz, dual polarization, log-periodic on 45 Foot Telescope, new analog spectrometer	03-31-05	08-31-05	
300-1050 MHz, dual polarization, 45 Foot Telescope with log-periodic feed, new analog spectrometer	02-28-05	04-29-05	04-29-05
GB/SRBS Phase III:			
10-80 MHz, dual polarization, four crossed dipoles, new digital spectrometer	09-30-05	12-30-05	
80-300 MHz, dual polarization, log-periodic on 45 Foot Telescope, new digital spectrometer	09-30-05	06-30-06	
300-2500 MHz, dual polarization, 45 Foot Telescope with log-periodic feed, new digital spectrometer	09-30-05	06-30-06	

Amplifier Design and Development

The mechanical design of a 4-8 GHz amplifier has been completed, amplifier bodies have been manufactured and prototype assembly is currently proceeding. The 8-12, 4-12 and 12-18 GHz amplifiers have been redesigned using NGST/JPL Cryo-3 wafer 200-μm wide devices and MAP 100-μm wide devices. These designs are using bodies of the previous versions. The 4-12 GHz version has been assembled and successfully tested. The remaining two versions will be assembled once technician time becomes available.

Central Development Laboratory

Amplifier Production

The production of amplifiers and deliveries to Socorro continued. Four L-Band high-power amplifiers, four L-Band low-noise amplifiers, and four 4-12 GHz amplifiers have been manufactured and tested. One new K-Band amplifier was completed and several older amplifiers were repaired for total production of 16 amplifiers during the quarter.

The Chemistry Lab has continued to function well, meeting all production needs on a timely basis.

Superconducting Millimeter-Wave Mixer Development

ALMA Receiver Development

SIS wafer production: the University of Virginia (UVA) completed the production of nine wafers for ALMA Band 6 on time at the end of this quarter. Mixers from seven of these have given good results. Two wafers remain to be evaluated.

Band 6 mixer-preamps: Twelve mixer-preamps were tested in the Band 6 mixer test system this quarter. Another eight units were assembled but not tested because of problems detected during assembly and room-temperature testing.

4-12 GHz preamplifier production: Advanced Control Components (ACC) delivered two more batches of preamps this quarter, completing the original order for 24 units. All units meet specifications, and roughly 90% have been matched up in pairs as required for the sideband-separating SIS mixers. An updated Statement of Work and RFQ are being prepared for the next order. The Jet Propulsion Laboratory (JPL) has agreed on a pick-list for Cryo-3 devices and has begun selecting chips. We expect to receive the 800 devices requested for the Band 6 amplifiers soon.

The amplifier test system became fully operational early in this quarter. It is now being used for production testing of the Band 6 warm and cold preamps.

Band 6 cartridges: Cartridge #2 has been assembled and DC-tested. Because of a shortage of LO power at the lowest frequencies, it was decided to reduce the length of stainless-steel waveguide between the 300 K plate and the tripler mounted on the 110 K plate. The new stainless-steel waveguides were copper-plated inside to reduce their loss. The increased thermal loading on the 110 K stage was approved by RAL. The new stainless-steel waveguides have now been installed, and testing of this cartridge will begin the first week of July 2005.

The body of cartridge #3 was delivered by RAL during the third week of June. Modifications to the 300 K and 4 K plates are under way.

Central Development Laboratory

LO vacuum windows: Work has continued on the vacuum window assemblies for the Band 6 LO waveguides. These broadband window assemblies consist of a pair of short (~0.005") epoxy-filled waveguide sections separated by a (~λ/4) waveguide spacer. Cleaning and surface preparation have been improved, resulting in better adhesion of the epoxy to the waveguide walls and low helium leak rates.

Band 6 cartridge test system: Last quarter, beam pattern measurements appeared to indicate an unexpected sidelobe at the lowest frequencies. However, consistent beam pattern measurements were difficult with the manually-operated beam scanner. This has now been replaced with a fully automatic, 3-axis (x, y, rotation) scanner. Using the new scanner, it is clear that a sidelobe is present at the -15 dB level. It appears that the sidelobe is caused by interaction between the infrared filters and vacuum window in the cartridge test dewar (not technically part of the cartridge), and it was important to determine whether the sidelobe would also be present in the final RAL cryostat.

Many of the components of the cartridge test system were moved temporarily to the RAL cryostat to aid in the first tests of a cartridge in the final receiver. Beam patterns measured in the RAL cryostat confirm that the sidelobe, previously observed in the cartridge test system at the lowest frequencies, is still present (see Figure 1).

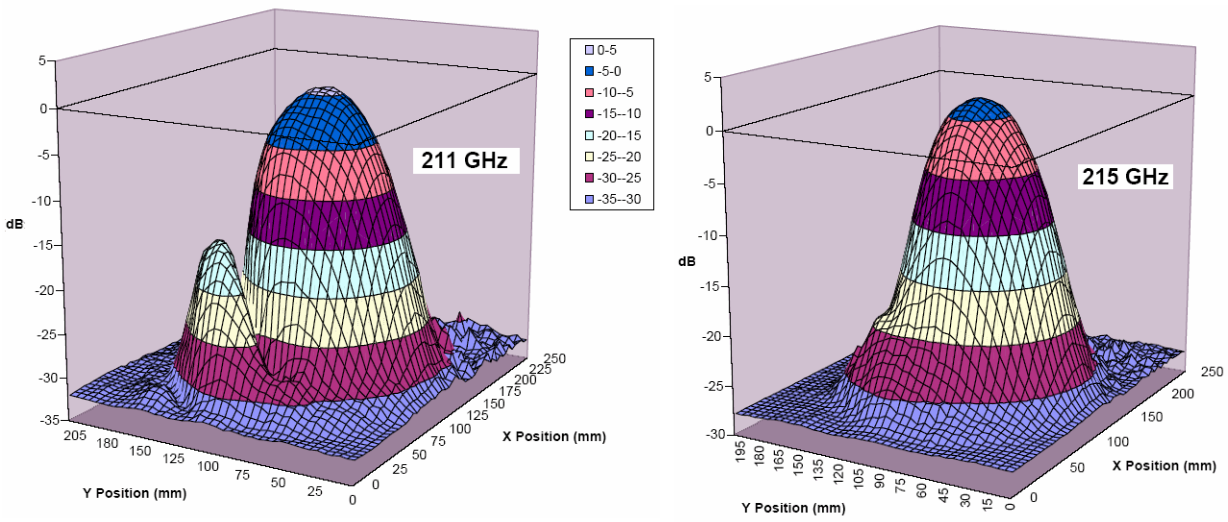

Figure 1. Beam patterns at 211 and 215 GHz, measured with the Band 6 cartridge in the RAL cryostat.

Central Development Laboratory

A cartridge loader for the cartridge test system has been completed and works well, allowing the smooth insertion and extraction of the cartridge with little operator effort. The only remaining cartridge test system tasks are to integrate the bias power supplies with the new bias module in the rack and to install the automatic liquid nitrogen fill system.

Non-ALMA Millimeter-Wave Development

350-μm receiver technology development: Funds have been earmarked for this project, but we are still awaiting the National Science Foundation's (NSF's) response to our formal request for approval submitted last quarter. There are two important reasons for undertaking this work: (i) Success in this project will put NRAO in a strong position to bid on the ALMA Band 10 receiver production; (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 operations phase in about three years, when there is expected to be funding available to support further receiver development.

385-500 GHz SIS mixer: This is a joint project between NRAO and the University of Virginia Microfabrication Laboratory (UVML) and is supported mainly by UVML through an NSF grant. In this quarter, UVML continued to optimize its junction fabrication process. Work on the design of the mixer block continued, but progress is severely hampered by the lack of resources (time). Work will continue on this task in the next quarter.

EVLA gain slope equalizer: The revised version of the 2-4 GHz gain slope equalizer has been successfully tested.

Investigation of Beam Lead 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.

A Research Experiences for Undergraduates (REU) student has been making more extensive measurements of the phonon-cooled HEB (pHEB) mixer on thin 3-μm Si, as well as improving the measurement setup. He assembled a beamsplitter using 0.0006" mylar (~5% coupling at 660 GHz). Using the beamsplitter, 500 K noise temperatures were measured from 1-2 GHz IF. We plan to measure up to 10 GHz IF to determine the IF bandwidth of this mixer. A paper was accepted and will be presented at the IRMMW-THz Symposium in September 2005.

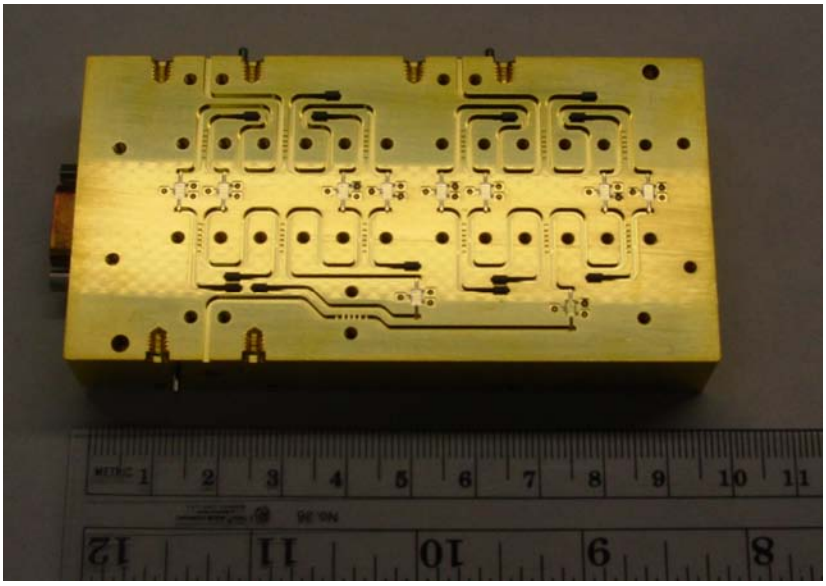

Figure 2. Photograph of a 10-chip, power-combined power amplifier for ALMA Band 9 LO driver. The output power of four InP MMIC power amplifiers is combined using waveguide branch-line couplers in each of two channels.

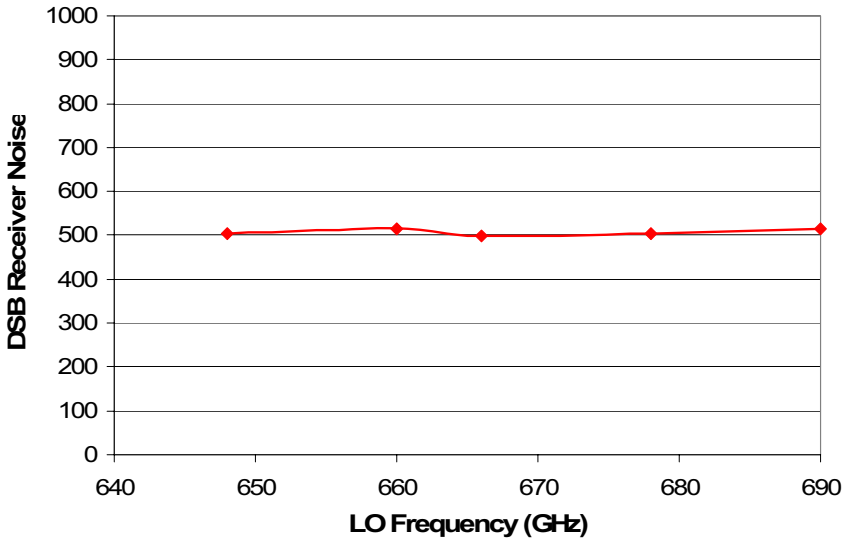

Figure 3. Measured DSB receiver noise temperature for the pHEB mixer with a 5% beamsplitter LO injection and 1.1-1.7 GHz IF.

Central Development Laboratory

Electromagnetic Support

EVLA

The Q- and Ka-Band receivers are attached to the new feed cone on the EVLA antenna through interface mounting tubes. The aperture of the feed in either one of the receivers is below the aperture of this tube. For the Q-Band receiver, this distance is 3.1". To check the scattering caused by the tube, if any, feed patterns were measured with and without the tube. In the E-plane, the taper at 9.3° with the tube varies between +1.1 dB and -0.4 dB compared to the feed by itself. In the H-plane, the variation is between + 0.6 dB and -1.8 dB. This is not likely to cause any significant change in aperture efficiency. The mounting tube affects the pattern more at the lower end of the band than at the upper end.

The first prototype feed at C-Band was measured in a compact range at MIT Lincoln Laboratory. The larger sections of this feed were fabricated using sheet metal rings and bands. Feed #4 was fabricated with machined sections. Feed #4 was measured at the Outdoor Antenna Test Range (OATR) on the grounds of the New Mexico Institute of Mining and Technology. Upon comparison of these two measurements, it was concluded that the differences present were due to the measurement distance that was used at OATR and not due to the two different fabrication methodologies used.

Far-field pattern measurements were completed on the EVLA X-Band (8-12 GHz) prototype feed at Green Bank. The average taper is about -14 dB at the edge of the subreflector. The patterns have good circular symmetry and the cross-polarized sidelobe in the 45-degree plane is below -33 dB over the entire 8-12 GHz band. Measured return loss is better than -35 dB.

Spectrometers/Correlators

ALMA Correlator

During the last quarter, construction and testing of the first quadrant of the ALMA correlator continued. All eight racks of the first quadrant were completed and tested extensively without any known problems. Retrofitting of some of the initial parts of the system to correct minor mechanical problems was completed.

System-clock timing and error-free testing of all motherboard data runs were done in May.

About 500 assembled production circuit cards of various types for the correlator were received. Due to a heavy workload, only about 50% of these were tested during the quarter.

A prototype tunable filter card was received from the European design group. This card was tested in the card test fixture. It was put into the first quadrant of the correlator and normal spectra obtained in an end-to-end test using the DTS receiver simulator card and analog signals as the input.

Central Development Laboratory

Ongoing software development for the system control cards and test fixtures continued. Lightning protection was installed for the building housing the correlator. Preparations were made for beginning installation of the final signal cables in the first quadrant.

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 investigation of the requirement of frequency multipliers for the recently added Bands 4 and 8.

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% spare units). The progress was close to the mutually-agreed schedule that called for the order to be completed by the end of December 2004

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All of the units ordered for Band 6 and Band 7 (139 each) have been completed, tested and delivered by VDI. Subsequently, these have been accepted based on cryogenic evaluation of randomly selected units (2 units were evaluated per batch of about 13 units) at the NRAO Technology Center (NTC).

The units that were evaluated as part of the acceptance testing have been made available for use in the receiver cartridges, while the remaining units are undergoing cryogenic evaluation in the laboratory prior to being made available for use. This evaluation work was interrupted in this quarter because the vacuum pump, as well as the dewar, had to be overhauled, but work has since resumed.

Band 9: As described in earlier reports, two frequency sextuplers were assembled and delivered to the Band 9 cartridge group after cryogenic evaluation for integration into the first cartridge. VDI is still in the process of fabricating devices for and assembling another pair of similar frequency sextuplers which will form the final deliverables for their current development contract.

Alternative approaches: Several alternatives (including the three varactor frequency doubler cascade based on the JPL Herschel design, relocating the power amplifiers inside the cold cartridge, power-combining existing amplifiers, see Figure 2, etc.) were investigated. Four approaches were selected based on the criteria of minimum cost and schedule impact on the project. The following paragraphs provide an update of the status presented in the previous quarterly report. The dates

provided for the scheduled completion of each approach are only indicative (they are based on amplifier development schedules) and should not be construed as a milestone.

1. Reverting back to the frequency quintupler: Measurements on the existing frequency quintupler blocks indicate that the 40 μW output power requirement could be met with an increased input drive level of 25 mW (requires 40 mW power amplifier output in the warm cartridge assembly, outside the dewar). This might be possible with the revised LSPA132 InP-HEMT-based power amplifier design. Evaluation results of the amplifier itself, as well as the overall performance of the quintuplers driven by this amplifier, should be available by the end of July 2005, when the chips are expected to be received.
2. An alternate drive source for the frequency quintupler could be a WR8x2 frequency doubler from VDI which could be pumped at a 200-mW level by a power amplifier (new design), producing 300 mW in the 61–71.2 GHz in the warm cartridge assembly (outside the dewar). The power amplifier should be available at the end of November 2005. The MMIC design has been completed, and a wafer run is expected to be available by the end of October 2005. Evaluation results of the amplifier itself, as well as the overall performance of the frequency doubler-quintupler chain driven by this amplifier, should be available by the end of March 2006.

   Simultaneously, measurements have been scheduled to measure the performance of the proposed chain by using the high-power source (adjusted to appropriate levels) available on VDI premises. This data should provide validation of the configuration by the end of July 2005.
3. Explore another level of power-combining in the power amplifiers for the integrated frequency sextupler: The existing power-combined amplifier power combines two individual amplifier chips per polarization/channel. The possibility of power-combining four chips per polarization/channel is being explored to achieve increased drive power level for the existing integrated frequency sextupler. Such a block was fabricated and a power amplifier assembled in this quarter, but the amplifier has thermal issues that are being resolved.
4. Two-frequency tripler cascade option: Without changing the drive requirements for the final tripler stage in the frequency sextupler, this approach would move the required input frequency range lower down in frequency where larger driver power could be achieved. However, existing frequency tripler data suggest that the efficiency loss in going from a frequency doubler to a frequency tripler would negate the benefit of improved input drive power. Consequently, such an approach could only be considered if the final frequency tripler were to be redesigned using a reduced-height barrier diode. But if that were done, the existing sextupler configuration would probably suffice as well. The move to the two-frequency tripler cascade would permit substitution of the more reliable GaAs-based power amplifiers instead of the InP-HEMT-based power amplifiers that have lifetime issues. These power amplifiers would need to be in the 67.8–79.1 GHz frequency which is very close to that of the Band 4 first LO driver output, for which the power amplifier has already been designed, and should be available for evaluation at the end of November 2005 (chips are

expected by the end of October 2005). A commercial chip (Velocium APH581) which has commensurate power in the required band was procured and is being assembled into a power amplifier block. The design of the AMC for such an option would mimic that being utilized for the Band 4 Warm Cartridge Assembly (WCA) as well. The progress with the development of the reduced-height barrier-diode-based frequency tripler being pursued by VDI was reviewed. VDI is close to completing a design iteration and a frequency tripler based on the reduced-height barrier device for the two sextupler deliverables due from them. Given these developments, the plan is to explore this option further in the coming quarter.

An investigation into the requirement of frequency multipliers for the Japanese bands was initiated in this quarter. A brief summary of the status is given in the following paragraphs:

Band 4: The requirement is to be able to provide 250 μW over the 133.0–155.0 GHz (inclusive) range. An existing VDI WR6×2 design was identified as being able to meet this requirement with about 10 mW drive level in the 66.5–77.5 GHz range, which is acceptable. Prototype units will be purchased and evaluated at cryogenic temperatures in the next quarter

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Band 8: The goal for this band is 100 μW over the 393.0–492.0 GHz (inclusive) range. A prototype frequency quintupler has been considered, but it does not meet specifications at room temperature. Measurements at cryogenic temperatures are planned for the next quarter to evaluate its suitability for the LO chain.

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.

A paper entitled "Development of Electronically-Tuned Local Oscillators for ALMA" covering this work will be presented at the 2005 IRMMW-THz Symposium in September. Two papers on specific components developed for the LO were presented at the 2005 IEEE International Microwave Symposium in June.

The new Band 3 Power Amplifier (PA) was assembled, tested, and integrated with the modified Band 3 Active Multiplier Chain (AMC) into a Warm Cartridge Assembly (WCA) and is currently undergoing final testing before delivery to the Band 3 cartridge manufacturers. Several Band 6 and 7 power amplifier modules were delivered from two different micro-assembly subcontractors (one included testing). We now have in stock, assembled and tested, all the power amplifiers needed for these bands for the first eight cartridges.

The first pre-prototype Band 7 WCA was characterized over its full band in terms of sideband noise as compared to a Gunn oscillator and showed very little excess noise. Preliminary testing of a prototype Band 9 WCA with the Band 9 cartridge at SRON provided enough power to adequately pump the SIS mixer over 80% of the band. Several alternative approaches are being investigated to cover the entire band, including the development of multipliers with higher conversion efficiency at lower drive levels and the use of higher power GaAs PAs at lower frequencies to drive a higher order, x9 or x10, cold multiplier chain. Another approach, likely to be used in a second Band 9 WCA prototype, is to power-combine twice as many MMICs in the PA to provide higher drive levels to the cold sextuplers.

A post-doc from the ASIAA Institute in Taiwan has begun investigating the possible use of MMIC HBT VCOs for 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. He has successfully phase-locked a Hittite commercial 14-15 GHz VCO in a breadboard PLL. A prototype PLL board including the VCO is undergoing fabrication, and is based on the new digital PLL being made concurrently. A survey of MMIC VCO foundries has begun. We will be comparing their processes in the next quarter to determine who offers the highest potential tuning bandwidth with minimum phase noise.

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 in Charlottesville. Solar activity continues to be monitored over the 20-70 MHz band by GB/SRBS Phase I with excellent reliability.

Significant progress has been made on Phase II this quarter. The 300-2500 MHz feed and receiver have been installed on the Green Bank 45-Foot Telescope. The dual-polarization sweep-frequency spectrometer was installed in the control room. We entered the commissioning phase of the upgrade and have begun daily four-hour data solar tracking runs. Work has begun on updating the pointing model for the 45-Foot Telescope and addressing minor problems with the telescope control circuits. In addition, the 70-350 MHz antenna has been designed and will be deployed on the telescope during the next quarter.

The second iteration of a 30-350 MHz RF board for use with the new digital spectrometer (Phase III) has been assembled and evaluated. The board is functioning properly.

Computing and Information Services

Computing and Information Services (CIS) Highlights

Although this has been a tight year, we have managed to make some progress on modernizing our infrastructure, including support for Apples and PDAs. The System Administrators meeting in Charlottesville provided a good start to developing a five-year operations plan. A new email facility to reduce unwanted and unsolicited messages (spam) is being deployed. The upgraded NRAO intranet backbone at 20 Mbps should be deployed in the coming quarter.

Personnel

We say goodbye to two long-time colleagues, Dave Brown and Ernie Allen, who have taken early retirement. They will be missed personally. They will also be missed professionally until their replacements are hired and the other open positions in the computer divisions are filled. Progress on many targets has slowed noticeably as others have taken over their responsibilities in the interim.

Budget

Although this has been a tight year, we have managed to make some progress on modernizing our infrastructure. With the performance of personal computers largely static for a while, we have placed emphasis on replacing low-end systems. By the end of the fiscal year, most user systems at the Observatory with a speed less than 1 GHz will have been replaced. We will have replaced some Linux systems with Macintoshes. We also have a started a program to provide support for Palm PDAs.

Security

There were four separate computer security incidents during the past quarter. The security features installed on the networks and the servers together with the prompt response by the system administrators to the threats ensured that these had no impact beyond the individual infected systems.

Computing and Information Services

Common Computing Environment (CCE)

Milestone	Original Deadline	Revised Deadline	Date Completed
Deploy syslog on remaining win servers	04/29/05		04/29/05
Documentation for support of PeopleSoft systems	05/13/05		05/31/05
Firewall rules for off-domain systems	04/22/05		04/22/05
Decision on LDAP as replacement for NIS	04/26/05	Defer	
Identify services for LDAP retrofit	05/02/05	Defer	

The Common Computing Environment project this quarter has centered on the annual Systems Administration workshop in Charlottesville April 20-22. The focus for this meeting was on long-range planning. A good set of targets emerged from the meeting. This will be further refined and will become part of a 5-year plan for Computing Services at the NRAO.

A new and improved solution to the scourge of "spam" (unwanted junk e-mail) is currently being tested by mail administrators at three NRAO sites. Unlike the existing scheme which relies on a static software component (SpamAssassin) to merely tag the message with extra headers indicating whether or not it's likely to be spam, the (PureMessage) has the ability to quarantine any incoming message deemed to be above a certain threshold of "spam" probability. It also tags the remaining messages, so that mail clients can continue to perform individual mail filtering. A central quarantine server allows individuals to see via the web, and if desired, release quarantined messages.

This PureMessage system is totally integrated with our existing anti-virus mail gateway software (Sophos Anti-Virus), so deployment on our servers will be simple and will be a significant improvement over the existing complex scheme which integrates three separate products (MailScanner, Sophos, and SpamAssassin).

The PureMessage system is currently in "alpha" test mode, with the mail administrators working collaboratively with the vendor and the developers of the software to eliminate bugs from the system. A “beta” phase is imminent in which about 30-40 users will be asked to use the system, and finally, a rollout is anticipated next quarter.

Computing and Information Services

Web Infrastructure

Milestones	Original Date	Revised Date	Date Completed
Design of Next Generation Web Services	11/30/04	Defer	
Evaluate additional Groupware	04/01/04	Defer	
Purchase proxy servers for VLA	06/05/03	Defer	
Instant Messaging Server Pilot Project	12/31/04	Defer	
Deploy Next Generation Web Services	07/01/05	Defer	

There is little activity to report in this quarter. Due to time pressures and higher priorities in other areas, most of the individual targets were not addressed. It is likely that the future of web services at the NRAO will be addressed in a wider-ranging proposal led by EPO.

Charlottesville Computing

Most of the critical tasks to support relocation of personnel in the Edgemont Road building are complete, although the rewiring of the old part of the building still lingers on. The second floor rewiring is no longer a high priority since the computer support staff will, for the time being, remain in their first floor accommodations.

Observatory-wide Communications

Milestones	Original Date	Revised Date	Date Completed
Deploy new Ethernet switch in Green Bank	04/30/05		04/30/05
Deploy new Ethernet switch in Charlottesville	05/31/05		05/31/05
Upgrade network services to VLBA SC antenna	09/30/04	08/31/05	
20 Mbps service between the major NRAO sites	08/31/05	09/30/05	

We have decided to upgrade the intranet backbone between the three major sites from T1 service to T3/DS3 service. This will provide better communication between the sites, including increased support for data and video traffic, and will provide greater access from Green Bank to the Internet and Internet2. At present, the sites have two or three T1 (1.5 Mbps) connections. When the new network is installed, we will have 20 Mbps available at each location. The goal was to have this ready for deployment in April. However, because of delays between the three communication providers to Green Bank, the service will probably not be available there until September. The New Mexico Institute of Mining and Technology is

also upgrading its network connection, and this impacts the speed with which the service can be fully deployed in Socorro. To provide better communication in support of the Procure-to-Pay business services, we have deployed and two temporary T1s between Charlottesville and Green Bank.

As a result of lower costs for our intranet contract with AT&T, we decided to upgrade the service to the St. Croix VLBA antenna. This had been delayed by the local company in the Virgin Islands, but it is now scheduled to be completed by AT&T next quarter. Although the new circuit has been installed by the local company, it has not yet been activated for use with our frame relay network.

The network of video teleconferencing units continues to be a fundamental resource for inter-site meetings. Additional units for the new conference rooms in Stone Hall have been deployed. We have also acquired units for use in Washington, D.C. and Santiago, Chile to expedite communication for ALMA. This brings the number of video units in conference rooms to fourteen. We will also continue to investigate the deployment of equipment and software for use by individuals in their offices; we have three such facilities.

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 is now installed and in operation. A second switch will be acquired next quarter.

Education and Public Outreach

Education and Public Outreach (EPO) Highlights

To engage the astronomical community in the Observatory's efforts to increase the number of visually compelling radio astronomy images available for EPO, the Legacy Imagery Project announced the first annual NRAO/AUI Image Contest at the summer 2005 American Astronomical Society meeting. Contest submissions are due September 1, and the contest results will be announced by October 15, 2005. Design and development of the NRAO *ViewSpace* press release program module was completed in June 2005, and all scientific research press releases accompanied by high-quality imagery, graphics, and/or animation will now also be released via the *ViewSpace* network. The NRAO EPO staff hosted the Southwestern Consortium of Observatories for Public Education (SCOPE) at the VLA on April 15-16. Six press releases were produced and distributed by EPO PIO staff this quarter. Four of these releases described scientific research conducted at the NRAO. Compared to the same months in 2004, visitation at the Green Bank Science Center increased by 9.0%. Visitation at the VLA Visitor Center decreased by 5.0% compared to 2004. Planning continued for the 2005 West Virginia Governor's School for Mathematics and Science (GSMS), which will be held this summer at Green Bank. The NRAO, White Sands Missile Range, and New Mexico Institute of Mining and Technology are collaborating on a series of events celebrating the 100th anniversary of Albert Einstein's annus mirabilis. The annual NRAO Chautauqua program was held at the Green Bank Science Center May 23-25. Funding for GEAR UP (Gaining Early Awareness and Readiness for Undergraduate Programs) Camp was renewed for 2005 by the U.S. Department of Education. Three teachers are participating in the 2005 NRAO Research Experiences for Teachers (RET) program: one in Socorro, and two in Green Bank. The Society for Amateur Radio Astronomers held their annual meeting at Green Bank, June 19-21, and enjoyed numerous programs at the Science Center.

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, made good progress this quarter, including the first annual NRAO/AUI Image Contest. This contest seeks to engage the astronomical community in the Observatory's efforts to increase the number of visually compelling radio astronomy images available for education and public outreach. With prizes sponsored by AUI (First Prize: $1000, Second Prize: $500, and up to ten Honorable Mentions: $100 each), this contest is expected to result in the generation and submission of significant numbers of high-quality radio images to the NRAO.

In this quarter, EPO Scientist Juan Uson, EPO Division Head Mark Adams, and Information Services Coordinator Pat Smiley designed and printed a color brochure to announce the first NRAO/AUI

Image Contest. More than 200 of these contest brochures were distributed at the Minneapolis summer 2005 AAS meeting, and a brochure has been mailed with each of the 1,700 copies of the NRAO July 2005 Newsletter being distributed. Uson also designed, implemented, and carefully tested the NRAO/AUI Image Contest web site this quarter so that it flexibly supports image submissions via anonymous ftp, retrieval from websites, or submission via DVD or CD through the U.S. Mail.

Figure.1. The cover of the color NRAO / AUI Image Contest brochure.

EPO personnel Mark Adams, Dave Finley, Andrea Gianopoulos, William Saxton, Patricia Smiley, and Juan Uson collaborated on a display paper describing the Legacy Imagery Project. This display paper was presented by Adams in Session 5 at the Minneapolis American Astronomical Society meeting, where it was well-received.

The Observatory plans the NRAO/AUI Image Contest as an annual event. Images submitted to this contest will be included in the NRAO Image Gallery and will be readily available for use by scientists, students, teachers, the general public, the media, and EPO professionals. The best images will be published in a 2006 NRAO calendar. The submission deadline for the 2005 Image Contest is September 1; the results of the contest will be announced by October 15.

Education and Public Outreach

Science Museum Outreach

EPO staff continued to design and develop a program of radio astronomy outreach to science museums and planetariums. The Observatory's initial goals for this program will be accomplished through participation in *ViewSpace,* a free, readily-updated, multi-media electronic exhibit designed by the Space Telescope Science Institute (STScI) that is now available in more than 70 museums and planetariums (see *http://hubblesource.stsci.edu/exhibits/viewspace/*).

The first NRAO *ViewSpace* program, a press release module, was completed in June 2005. All NRAO scientific research press releases with compelling imagery can now be distributed via the *ViewSpace* network. For each NRAO scientific research press release accompanied by high-quality imagery, graphics, and/or animation, EPO Public Information Officers (PIOs) will quickly edit the original release to a suitable *ViewSpace* length (150 – 300 words) and coordinate distribution with the Space Telescope Science Institute.

Astronomical Community

The 2005 summer meeting of the American Astronomical Society (AAS) took place Sunday, May 29 through Thursday, June 2 at the Minneapolis (Minnesota) Convention Center with a typical summertime attendance of ~ 700 persons. The NRAO Education and Public Outreach personnel—Dave Finley, Andrea Gianopoulos, and Mark Adams—staffed the Observatory's three-panel exhibit throughout the meeting, with assistance from EPO Scientist Juan Uson, NRAO Director Fred K.Y. Lo, Assistant Director Jim Ulvestad, and scientists Paul Vanden Bout and Brian Mason. Finley and Gianopoulos also assisted in the AAS press room throughout the meeting; Ulvestad, Adams, and Mason represented the NRAO at the graduate student careers reception. A custom, continuously-running PowerPoint program describing ALMA running on a dedicated computer monitor helped attract astronomers, teachers, and students to the NRAO exhibit. This 20 minute ALMA program was created by Al Wootten and Paul Vanden Bout immediately prior to the meeting so that it accurately reflected ALMA's most recent progress and plans.

Education and Public Outreach

Figure 2. NRAO Public Information Officers Andrea Gianopoulos and Dave Finley staff the Observatory's exhibit at the summer AAS meeting in Minneapolis.

The 2005 NRAO/AUI Radio Image Contest was officially announced at this AAS meeting. Free large-format posters of the high-quality, color radio - optical composite poster of the Fornax-A / NGC 1316 radio source were also brought to the meeting and made available at the NRAO exhibit. This visually compelling poster proved popular and all 250 copies were soon claimed by meeting attendees. This Fornax-A poster is one of the first products of the Legacy Imagery Project.

The Observatory's Socorro-based EPO staff, Dave Finley and Robyn Harrison, hosted a meeting of the Southwestern Consortium of Observatories for Public Education (SCOPE) at the VLA on April 15 – 16, 2005. EPO colleagues from several observatories—the National Optical Astronomy Observatory, Apache Point Observatory, Whipple Observatory, and others—described their current education programs and plans and exchanged ideas for making their astronomical education programs more effective.

News / Media

The NRAO EPO staff collaborated with Observatory scientists and members of the external astronomical community to produce and distribute four press releases during the three month period covered by this report on excellent scientific research. These four press releases reported on results obtained at the Very Large Array and the Very Long Baseline Array. Two non-research press releases were also distributed this quarter that described important Observatory news. All NRAO press releases are available on-line at *http://www.nrao.edu/pr*.

Education and Public Outreach

Education

The busy spring and summer education program season began this quarter in Green Bank and Socorro. Numerous schools visited Green Bank, e.g., to participate in programs at the 40 Foot Telescope, including: Marshall Middle School, Glenville State College, Newburgh Free Academy, and Cross Lane Christian Academy.

Planning continued for the 2005 West Virginia Governor's School for Mathematics and Science (GSMS), which will be held at Green Bank, in collaboration with the National Youth Science Foundation. This program is funded by the West Virginia Experimental Program to Stimulate Competitive Research (EPSCoR). Sixty gifted eighth grade students from West Virginia schools were selected this spring through a competitive application process. More than 300 students applied to participate in this summer's GSMS, which will be held at Green Bank July 31 – August 13, 2005.

The National Radio Astronomy Observatory, White Sands Missile Range, and the New Mexico Institute of Mining and Technology collaborated this spring to plan a series of events celebrating the 100th anniversary of Albert Einstein's annus mirabilis. Activities will begin Friday, July 15, with a special exhibit in the Skeen Library on the New Mexico Tech (NMT) campus entitled "Warriors: the Navajo Codetalkers" on loan from the National Atomic Museum. There will also be an evening lecture on the history of the first atomic bomb. On Saturday, July 16, both the Very Large Array (celebrating its first 25 years of science operations) and the Trinity Site (celebrating its 60 anniversary) will be open for joint public tours. An evening lecture in the NMT Skeen Library by NRAO Assistant Director Jim Ulvestad will describe the history of the Very Large Array. Additional special events are planned for the first weekend in October, including a full-length, one-man play entitled "Einstein: A Stage Portrait," and additional joint VLA / Trinity Site tours.

A successful NRAO Chautauqua program was held at the Green Bank Science Center May 23 - 25. This three-day summer residential education program serves undergraduate science faculty and has been a key element of the NRAO education program for 18 years, during which time more than 580 faculty have been trained.

Students from the Women in Science and Engineering (WISE) program at the University of New Mexico spent April 27 shadowing NRAO employees at the Socorro Array Operations Center (AOC) to get a taste of how scientists and engineers spend their time. Assistant Director Jim Ulvestad welcomed the visitors and provided an overview of NRAO. Ulvestad addressed issues and challenges facing women in astronomy and science management, and those facing the NRAO in hiring women.

Figure 3. Assistant Director Jim Ulvestad with students from Women in Science and Engineering program (WISE).

The students represented a variety of majors: astrophysics, biology, biochemistry, computer science; and civil, chemical, mechanical/manufacturing and nuclear engineering. NRAO scientists Debra Shepherd and Rick Perley hosted Rhiannon Griffith and Natalia McIver, respectively, demonstrating imaging software and explaining their current research. The engineering students were treated to overviews of activity in the electronics labs. Engineers Chris Langley, Laura Newton and Gene DuVall toured the ALMA lab with Ana Gonzales. Everett Callan and Troy Jenson did the honors for the EVLA front-end lab with Sahar Abucker and Julie Archuleta. The morning's activities culminated with the women joining the Observatory staff for the regular Wednesday lunch talk series.

Figure 4. Students, mentors, and teachers participating in the 2005 GEAR UP camp at Green Bank. The group is at the 40-foot diameter educational radio telescope."

Education and Public Outreach

The second annual GEAR UP (Gaining Early Awareness and Readiness for Undergraduate Programs) Camp was held in Green Bank at the end fo June. Twenty-four rising high-school freshmen attended the 4-day camp. GEAR UP is funded b the U.S. Department of Education. Camp activities include behind-the-scenes tours of the working areas of the Observatory, observing projects at the 40-Foot telescope, an electronics workshop, and team-building events.

Three teachers are participating in the 2005 NRAO Research Experiences for Teachers (RET) program: one in Socorro, and two in Green Bank. Kurt Voss is a chemistry teacher on the Zuni Reservation in New Mexico. His RET advisor will be Mark Claussen, and they will work together on a study of low-mass star formation. This fall, Mr. Voss will teach the Zuni's first-ever astronomy course. Vincent Pereira (Englewood, NJ) and Eric Kearsley (Silver Spring, MD) are participating in the RET program at Green Bank this summer. Mr. Pereira's research advisor is Brian Mason, and their research project involves developing imaging algorithms for a new high-frequency Green Bank Telescope (GBT) receiver. Karen O'Neil is Mr. Kearsley's research advisor on a research project designed to measure dust in low surface brightness galaxies.

The Society for Amateur Radio Astronomers held their annual meeting at Green Bank June 19 - 21, and enjoyed numerous programs at the Science Center. The *Quiet Skies Detector Teacher Workshop* was held at Green Bank June 28 - 30.

Visitor Centers

Table 1 lists the visitation figures for the Green Bank Science Center and the VLA Visitors Center for April – June 2005. Compared to the same months in 2004, visitation at the Green Bank Science Center increased by 9.0% (973 persons). Visitation at the VLA Visitor Center for these three months, however, decreased by 5.0% (352 persons).

Table 1. Green Bank Science Center and VLA Visitor Center visitation, April – June 2005.

Site	Mar 05	Apr 05	Jun 05	Total
Green Bank	1,983	3,997	5,770	11,750
VLA	2,122	2,049	2,449	6,620

A new exhibit was installed in April 2005 at the VLA Visitor Center that explains the major hardware and software modifications that are currently converting the VLA into the Expanded Very Large Array (EVLA). This new four-panel EVLA exhibit features a spectacular background image of the radio source Fornax-A with its twin radio lobes extending ~ 500,000 light-years on opposite sides of the elliptical galaxy, NGC 1316. The individual exhibit panels explain, e.g., the benefits of replacing the old stainless steel waveguide with a new fiber optic system that digitizes signals at the antenna. The expanded capabilities of the new correlator are described in graphics designed by Bill Saxton (NRAO – Green Bank) that explain recombination lines. The display was fabricated by Exhib-it! of Albuquerque.

Robyn Harrison, Dave Finley, Rick Perley, Walter Brisken, Kerry Shores, and Mike Revnell all assisted with the design and text.

Figure 5. The new EVLA exhibit is installed at the VLA Visitor Center.

EPO Support Committee

An EPO Support Committee has been formed to provide advice, input, and feedback to the Public Information Offices. Current members of the committee are Tim Bastian, Chris Casilli, Dale Frail, Harvey Liszt, and Juan Uson (chair). The committee does its work exclusively by e-mail and receives input regularly from the NRAO Site Directors.

Environment, Safety and Security

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

This quarter, ALMA management provided an additional ¼ FTE for support at the ALMA Test Facility located at the VLA. The ES&S manager made preparations for the development of the global ALMA Safety Program. In New Mexico, the VLA Emergency Medical Services group was reorganized this quarter and a new medical director was selected. A surplus fire engine was obtained and outfitting efforts were initiated. This quarter, development of the VLA Rope Rescue Team was initiated. In Green Bank, ES&S efforts were directed to evaluation of the 140-Foot Telescope for fire safety and start up activities later this summer. ES&S also worked on preparation of a sewer line project including safety issues such as confined spaces, excavation-trenching, and access-egress. Additionally, the Green Bank annual fire alarm system preventive maintenance check was completed, and a site wide compliance inspection documenting various safety concerns was completed. In Charlottesville, the NTC facility was inspected to determine areas where personnel hazards could exist. In the next quarter, ES&S will begin development of the ALMA Safety Program. In Socorro, efforts will be directed toward redevelopment of the EMS group, while efforts in Green Bank will be focused on prevention and training programs.

ALMA

This quarter, ALMA management agreed to provide an additional ¼ FTE for support at the ALMA Test Facility located at the VLA. An individual was hired to support this effort and resources adjusted to provide coverage at the site. Additionally, the ES&S manager spent the period making preparations to relocate to Santiago, Chile for the development of the global ALMA Safety Program.

New Mexico

In New Mexico, the VLA Emergency Medical Services group was reorganized this quarter and a new medical director was selected. A significant effort was put forth to obtain a surplus fire engine for the fire brigade use and outfitting efforts were initiated for both the fire engine and the site ambulance. The departure of a key member of the EMT group and the transfer of the EMT chief to a VLBA post will require additional effort the next quarter to rebuild the team.

This quarter, efforts were initiated to begin development of the VLA Rope Rescue Team. The group met with training providers from the New Mexico Fire Academy to determine the training requirements for the team. Additionally, the team initiated efforts for outfitting the group with appropriate man-rated rescue gear.

Environment, Safety and Security

This quarter, the NM Fire Marshall visited the AOC with a NM Tech representative. As a result of this inspection, NM Tech has initiated repairs on several life safety systems including emergency lighting and exit signage

Green Bank

This quarter, ES&S efforts were directed to evaluation of the 140-Foot Telescope for additional fire extinguishers in preparation for start up activities later this summer. Work issues presently being addressed include painting, security system, CO2 system, and other safety-related items. The Air Gas Fire Protection Division has been contacted in reference to bringing the CO2 fire suppression system back on-line. Additionally, safety briefing was conducted for MIT/LL personnel in preparation for their visit to the 140-Foot Telescope.

The High Angle Rescue Team continues to meet monthly. A professional High Angle Rescue trainer provided valuable training and practical experience scenarios to the team in both April and June.

ES&S worked with the Crafts group in preparation for a sewer line project. The issues included confined spaces, excavation-trenching (sloping/stepping,) and access-egress.

Additionally, this quarter the annual fire alarm system preventive maintenance check was completed. The inspection included system batteries, alarms, strobes, and other warning devices. Additionally, a general fire alarm evacuation drill was conducted for the Jansky Lab. An inspection of the sites emergency exits/lights was also performed to assure life safety measures are in place and functional.

The Green Bank Safety Committee performed a site-wide compliance inspection documenting various safety concerns and passing the concerns on to the appropriate Division Manager for resolution.

The video surveillance company representative completed repairs and updates to the site's 14 video surveillance cameras. One unit is still experiencing interference issues and work continues to solve the problem

Charlottesville

This quarter, ES&S inspected the NTC facility to determine areas where personnel hazards could exist. This inspection resulted in the identification of several restricted areas including the machine shop and the chemistry lab. These spaces have been designated for authorized personnel only. Additionally, the compressor room was identified as a potential hearing protection area. In the future, careful attention will be needed for the setup of the Photonics Lab where fiber optic lasers are planned for deployment.

Future Efforts

In the next quarter, ES&S will begin year of service to the Joint ALMA Office to develop the ALMA Safety Program. The resources for the ES&S office have been reallocated to cover this need and to address the needs of the remainder of the Observatory. Safety administrative responsibilities have been shifted to Dale Webb while ES&S program priorities will be defined by Jody Bolyard. Local support safety officers will remain in Socorro and Green Bank with local priorities defined by Mark McKinnon and Bob Anderson, respectively.

In Socorro, efforts will be directed toward redevelopment of the EMS group, while efforts in Green Bank will be focused on prevention and training programs. It is also anticipated that a level of effort will be initiated to the inspection and training of VLBA sites and staff.

The ES&S Division replaced the open position with support in Green Bank. The current ES&S staffing level is as follows:

Location	Position	FTEs
Green Bank	ES&S Manager	1
Green Bank	Administrative, Safety Officer	1 ½
Socorro, VLA	Safety Officer	1
Tucson	Deputy Safety Officer	0
Charlottesville	Deputy Safety Officer	0
ALMA Project, VLA Site	Safety Officer	¼
NRAO ES&S Total		3 ¾

Telescope Usage

The NRAO telescopes were scheduled for research and maintenance during the second quarter of 2005 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.

Beginning with 2005 antennas being modified for EVLA are now accounted as downtime for individual projects.

Telescope Usage			
Activity	**VLA** (hrs)	**VLBA** (hrs)	**GBT** (hrs)
Scheduled Observing	1654.00	1194.00	1488.00
Scheduled Maintenance and Equipment Changes	194.50	213.60	353.00
Scheduled Tests and Calibration	335.00	337.50	343.00
Time Lost	214.94	58.10	66.00
Actual Observing	1440.00	1135.90	1422.00

GBT Observing Programs

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

No.	Observer(s)	Programs
BB196	Bartel, N. (York) Bietenholz, M. (York) Rupen, M.	Resolving the pulsar/black-hole nebula in the center of SN 1986J's shell. 1.3 cm
BB202	Bower, G. (UC, Berkeley) Anderson, J. (Rice)	Trigonometric parallax of a radio star in the pleiades. 3.5 cm
BB204	Biggs, A. (JIVE) Porcas, R. (MPIfR) Rusin, D. (Pennsylvania)	Imaging of the radio jets in the siximage lens system, CLASS B1359+154. 21 cm
BB209	Boyce, E. (MIT) Hewitt, J. (MIT) Myers, S.	Observations of gravitational lens central images. 3.5, 6 cm
BF083	Forbrich, J. (MPIfR) Massi, M. (MPIfR) Ros, E. (MPIfR) Menten, K. (MPIfR)	Protostar VLBI. 3.5 cm
BK114	Kondratko, P. (CfA) Greenhill, L. (CfA) Moran, J. (CfA) Reid, M. (CfA)	Followup imaging of three NGC4258like water megamasers discovered with the GBT. 1.3 cm
BK119	Kemball, A. (Illinois) Diamond, P. (Jodrell Bank Obs.)	New constraints on Sio maser physics and Agb models using the high sensitivity array.
BM223	Maccarone, T. (Amsterdam) Brisken, W. Miller-Jones, J. (Amsterdam) Jonker, P. (CfA)	High sensitvity array observations of M 15: searching for emission from intermediate mass black hole candidates. 6 cm
BN031	Nakashima, J. (Illinois) Kemball, A. (Illinois) Deguchi, S. (NRO)	Maser spot distribution in the molecular envelope of an unusual SiO maser source IRAS 19312+1950.

GBT Observing Programs

No.	Observer(s)	Programs
BN032	Nakai, N. (Tsukuba) Yamauchi, A. (NRO) Sato, N. (NRO) Diamond, P. (Jodrell Bank Obs.)	Watervapor megamaser in the LINER IC1481. 1.3 cm
BW080	Wrobel, J. Ulvestad, J. Ho, L. (Carnegie Institution)	Radio emission from the candidate IMBH in NGC 4395. 21 cm
BW084	Winn, J. (CfA) Rusin, D. (Pennsylvania) Keeton, C. (Rutgers)	A search for central images in two gravitational lenses. 6 cm
GB049	Bartel, N. (York) Rupen, M. Bietenholz, M. (York) Beasley, A.J. Graham, D. (MPIfR) Altunin, V. (JPL) Venturi, T. (IRA, Bologna) Umana, G. (IRA, Cagliari) Cannon, W. (York) Conway, J. (Onsala Space Obs.)	SN1993J: the center of the shell and its structural and spectral evolution. 6, 21 cm
GBT01A-020	Hollis, J. (GSFC) Jewell, P. Snyder, L. (Illinois) Lovas, F. (NIST)	A GBT Q-Band search strategy for interstellar glycine.
GBT01A-034	Combes, F. (Observatorie de Paris) Despois, D. (Bordeaux) Wlodarczak, G. (Lille, France) Wootten, H. A. Guelin, M. (Institute de Radio Astronomique Millmetrique)	Search for glycine and precursors.

GBT Observing Programs

No.	Observer(s)	Programs
GBT02A-066	Hughes, D. (INAOE) Aretxaga, I. (INAOE) Gaztanaga, E. (INAOE) Chapin, E. (INAOE) Dunlop, J. (Royal Obs.) Devlin, M. (Pennsylvania) Wagg, J. (CfA)	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-005	Yusef-Zadeh, F. (Northwestern) Roberts, D. (Northwestern) Maddalena, R.	Search for positronium recombination maser line emission toward the Galactic Center. 3.5, 21 cm
GBT02B-020	Benford, D. (Goddard) Hunter, T. (CfA) Staguhn, J (Goddard)	Search for low excitation molecular gas in high redshift Quasars (CO). 1.3 cm
GBT03B-011	Widicus, S. (Caltech) Blake, G. (Caltech) Braakman, R. (Caltech)	A search for sugars in hot cores. 1.3 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-033	Roberts, D. (Northwestern) Yusef-Zadeh, F. (Northwestern) Maddalena, R.	A 7 mm recombination line search for high velocity ionized gas toward Sgr A west and Sgr A* 7 mm.
GBT04B-011	Rickett, B. (UC, San Diego) McLaughlin, M. (Manchester) Coles, W. (UC, San Diego) Lyne, A. (Jodrell Bank Obs.) Stairs, I. (British Columbia) Camilo, F. (Columbia) Freire, P. (Arecibo)	Scintillation studies of the J0737-3039 binary system. 6, 11 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT04B-026	Kramer, M. (Jodrell Bank Obs.) Stairs, I. (British Columbia) Camilo, F. (Columbia) McLaughlin, M. (Manchester) Lorimer, D. (Manchester) Lyne, A. (Jodrell Bank Obs.) Manchester, D. (ATNF) Possenti, A. (Osservatorio di Cagliari) D'Amico, N. (Osservatorio di Cagliari) Burgay, M. (Osservatorio di Bologna) Freire, P. (Arecibo) Joshi, B. (Tata Institute) 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
GBT04B-029	Stairs, I. (British Columbia) Camilo, F. (Columbia) Kramer, M. (Jodrell Bank Obs.) Faulkner, A. (Jodrell Bank Obs.) McLaughlin, M. (Manchester) Lorimer, D. (Manchester) Lyne, A. (Jodrell Bank Obs.) Hobbs, G. (ATNF) Manchester, D. (ATNF) 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

GBT Observing Programs

No.	Observer(s)	Programs
GBT04C-011	Yun, M. (Massachusetts)	Hydrogen recombination lines in Starburst+AGN systems. 2 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-031	Kondratko, P. (CfA) Greenhill, L. (CfA) Moran, J. (CfA) Lovell, J. (ATNF) Kuiper, T. (JPL) Jauncey, D. (ATNF)	Monitoring of five NGC4258-like water megamasers discovered with the GBT and the DSN. 1.3 cm
GBT04C-041	Braatz, J. Henkel, C. (MPIfR)	Monitoring extragalactic H_2O masers discovered with the GBT. 1.3 cm
GBT04C-043	Ransom, S. Freire, P (Arecibo) Gupta, Y. (NCRA)	Timing the eccentric millisecond pulsar binary in globular cluster NGC 1851. 90 cm
GBT05A-001	Kanekar, N. Ellison, S. (Victoria)	A search for 21cm absorption in a high metallicity DLA at z = 2.193. 70 cm
GBT05A-003	Campbell, B. (CfA) Carter, L. (CfA) Campbell, D. (Cornell)	Radar mapping of the Moon at 70-cm wavelength using Arecibo and the GBT. 70 cm
GBT05A-007	Widicus, S. (Caltech) Blake, G. (Caltech)	A Ka- and Q-Band complex molecule survey of Orion and Sagittarius B2(N-LMH).
GBT05A-009	Reach, W. (Caltech) Robishaw, T. (UC, Berkeley) Heiles, C. (UC, Berkeley)	Mapping a galactic "worm" from W43 to the halo. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT05A-011	Ransom, S. Camilo, F. (Columbia) Stairs, I. (British Columbia) Kaspi, V. (McGill) Hessels, J. (McGill) Freire, P. (Arecibo)	Timing of the binary and millisecond pulsars in Terzan5. 11 cm
GBT05A-013	Robishaw, T. (UC, Berkeley) Heiles, C. (UC, Berkeley)	Threading the magnetic slinky: mapping the Zeeman Effect in the Eridanus/Orion region. 21 cm
GBT05A-014	Bailes, M. (Swinburne) Ord, S. (Swinburne) Jacoby, B. (Caltech) Kulkarni, S. (Caltech) Camilo, F. (Columbia) Hotan, H. (Swinburne) Edwards, R. (ATNF)	A high sensitivity millisecond pulsar survey. 90 cm
GBT05A-017	Blain, A. (Caltech) Chapman, S. (Caltech) Ivison, R. (Royal Obs.) Smail, I. (Durham) Hainline, L. (Caltech)	Survey for CO(1-0) from dusty submillimeter galaxies at known redshifts.
GBT05A-024	Campbell, D. (Cornell) Campbell, B. (CfA) Carter, L. (CfA) Margot, J. (Cornell) Stacy, N. (Defence Science and Technology Organization, Australia)	S-Band radar mapping of the Lunar polar regions. 11 cm
GBT05A-030	Bania, T. (Boston) Rood, R. (Virginia) Balser, D. Quireza, C. (Universidade de Sao Paulo)	Stalking the cosmic 3-Helium abundance. 3.5 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT05A-032	Greve, T. (Caltech) Ivison, R. (Royal Obs.) Papadopoulos, P. (ETH Zurich Institute) Smail, I. (Durham) Blain, A. (Caltech)	Probing the dense, starforming gas in high-redshift starburst galaxies. 1.3 cm
GBT05A-036	Ransom, S. Hessels, J. (McGill) Kaspi, V. (McGill) Roberts, M. (McGill)	A 350-MHz survey of the Northern Galactic Plane for pulsars. 90 cm
GBT05A-037	Roberts, M. (McGill) Hessels, J. (McGill) Ransom, S. Kaspi, V. (McGill)	A pulsar survey of mid-galactic latitude EGRET eror boxes in the North Polar Cap. 90 cm
GBT05A-038	Stinebring, D. (Oberlin College) Minter, A. Ransom, S. Hill, A. (Oberlin College)	Pulsar scintillation arc time variations. 21, 38 cm
GBT05A-040	Baker, A. (Maryland) Harris, A. (Maryland) Genzel, R. (UC, Berkeley)	CO(1-0) Observations of four submillimeter galaxies.
GBT05A-041	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
GBT05A-042	Baker, A. (Maryland) Mulchaey, J. (Carnegie Institute) Zabludoff, A. (Arizona) O'Neil, K.	HI observations of isolated ellipticals. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT05A-048	Camilo, F. (Columbia) Ransom, S. Gaensler, B. (CfA) Lorimer, D. (Manchester) Manchester, D. (ATNF)	Exploratory time request: have we detected the very young pulsar in SNR G21.5-0.9? 11, 38 cm
GBT05A-051	Yun, M. (Massachusetts)	VLA HI observations of HCG~40. 21 cm
GBT05A-052	Lazio, T. (NRL) Jacoby, B. (Caltech) Brogan, C. (JCMT) Gaensler, B. (CfA) Gelfand, J. (CfA) Lazendic, J. (MIT) Kassim, N. (NRL) McClure-Griffiths, N. (Washington State)	Pulsar counterpart to the TeV source HESS J1813-178? 11 cm
GBT05A-053	Nolan, M (Arecibo) Howell, E. (Arecibo) Ostro, S. (JPL) Benner, L. (JPL) Margot, J. (Cornell)	Radar observations of near-earth asteroid 2005 ED318. 11 cm
GBT05B-004	Pandian, J. (Cornell) Goldsmith, P. (Cornell) Momjian, E. (Arecibo)	A search for recombination lines towards continuum sources associated with 6.7 GHz methanol masers. 6 cm
GBT05B-006	Camilo, F. (Columbia) Gotthelf, E. (Columbia) Halpern, J. (Columbia)	Detecting in radio the recently discovered X-ray pulsar in SNR G33.6+0.1. 11 cm
GBT05B-007	Minter, A.	Does pulsar scattering arise in photo-dissociation regions of molecular clouds? 21 cm
GBT05B-011	Minter, A.	Using pulsar HI absorption to determine the distance to the local spiral arm in the second quadrant of the galaxy. 21 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT05B-012	Darling, J. (Carnegie Institute) Kelson, D. (Carnegie Institute)	A search for OH megamasers in major mergers in the rich cluster MS 1054-03 at z = 0.83. 38 cm
GBT05B-016	Barvainis, R. (NSF) Antonucci, R. (UC, Santa Barbara)	Detection of a water maser at z = 0.66, and a search for more. 2 cm
GBT05B-018	Kanekar, N. Chengalur, J. (NCRA) Ellison, S. (Victoria)	Do the fundamental constants change with time ? 70 cm
GBT05B-019	Roberts, M. (McGill) Hessels, J. (McGill) Breton, R. (McGill) Ransom, S. Kaspi, V. (McGill)	Examining the intermittent emission of PSR J1744-3922. 11 cm
GBT05B-028	Freire, (Arecibo) Ransom, S. Hessels, J. (McGill) Stairs, I. (British Columbia) Begin, S. (British Columbia)	A GBT S-Band globular cluster survey: Phase A. 11 cm
GBT05B-032	Thorsett, S. (UC, Santa Cruz) Stairs, I. (British Columbia) Arzoumanian, Z. (GSFC)	Timing the millisecond pulsar B1620-26 with the GBT. 21 cm
GBT05B-038	Kondratiev, (Astro Space Center) Bartel, N. (York) Kovalev, Jr., Y. Popov, M. (Lebedev Physical Institute) Soglasnov, V. (Astro Space Center) Bietenholz, M. (York) Cannon, W. (York)	Mysterious giant pulses from the millisecond pulsar B1937+21. 11 cm
GBT05B-041	Greve, T. (Caltech) Borys, C. (Caltech) Farrah, P.(IPAC, Caltech) Pihlstroem, Y. (Caltech)	A search for OH gigamasers in two high-z HLIRGs. 38 cm

GBT Observing Programs

No.	Observer(s)	Programs
GBT05B-044	McLaughlin, M. (Manchester) Possenti, A. (Osservatorio di Cagliari) Stairs, I. (British Columbia) Kramer, M. (Jodrell Bank Obs.) Lyne, A. (Jodrell Bank Obs.) Lyutikov, M. (McGill) Burgay, M. (Osservatorio di Bologna) Manchester, D. (ATNF) Freire, P.(Arecibo) Camilo, F. (Columbia)	Studying the interactions in the J0737-3039 System. 90 cm
GBT05B-047	Mangum, J. G.	NRAO CV summer student projects. 1.3, 3.5, 6, 21 cm
GT006	Taylor, G. Philstrom, Y. (CalTech) Granot, J. (Kavli Institute) Doeleman, S. (Haystack/NEROC)	Observations of GRB 030329 at t+2 years. 6 cm

VLA Observing Programs

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

No.	Observer(s)	Programs
AA298	Araya, E. (NMIMT) Hofner, P. (NMIMT) Goss, W.M. Kurtz, S. (Mexico/UNAM) Olmi, L. (CNR) Linz, H. (MPIA)	Continuum toward 6 cm formaldehyde maser in IRAS 18566+0408. 3.6, 6 cm
AB1140	Buckalew, B. (Wyoming) Kobulnicky, H. (Wyoming)	Continuum search for young star clusters in NGC 450. 2 cm
AB1150	Birzan, L. (Ohio) McNamara, B. (Ohio) Carilli, C. Rafferty, D. (Ohio) Nulsen, P. (CfA) Wise, M. (MIT)	Interactions between radio sources and the intra-cluster medium: X-ray cavities. 3.6, 6 cm
AB1159	Van Breugel, W. (LLNL) Van Gorkom, J. (Columbia) Morganti, R. (ASTRON) Oosterloo, T. (ASTRON) Croft, S. (LLNL) deVries, W. (LLNL)	HI Imaging of Minkowski's object. 20 cm
AB1161	Bohringer, H. (MPE) Feretti, L. (Bologna) Giovannini, G. (Bologna) Sarazin, C. (Virginia) Schuecker, P. (MPE) Zhang, Y. (MPIE)	Imaging a cluster with a luminous cooling core. 3.6, 6, 20 cm
AB1162	Boone, F. (MPIR, Bonn) Brouillet, N. (Bordeaux) Braine, J. (Bordeaux) Kording, E. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Jimenez-Garate, M. (MIT) Rupen, M.	Nature of the ultra luminous X-ray source M81 X-9. 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AB1179	Bower, G. (UC, Berkeley) Bolatto, A. (UC, Berkeley) Kalas, P. (UC, Berkeley) Matthews, B. (UC, Berkeley) Wright, J. (UC, Berkeley) Graham, J. (UC, Berkeley) Marcy, G. (UC, Berkeley)	Astrometric detection of planets around nearby stars. 3.6, 20 cm
AB1181	Beasley, A. Claussen, M. Healy, K. (Arizona)	Water masers around low-mass stars in the environment of Orion Nebula. 1.3 cm
AB1182	Brunthaler, A. (JIVE) Falcke, H. (ASTRON) Reid, M. (CfA) Greenhill, L. (CfA) Henkel, C. (MPIR, Bonn)	Second maser in IC 10. 1.3 cm.
AC711	Clarke, T. (Virginia) Sarazin, C. (Virginia) Blanton, E. (Virginia)	Studying the cooling flow disruption in the merging cluster Abell 115. 90 cm
AC759	Cohen, A. (NRL) Israel, F. (Leiden) Kassim, N. (NRL)	Investigating the nature of low-frequency spectral flattening in spiral galaxy NGC 891. 400 cm
AC765	Cesaroni, R. (Arcetri) Beltran, M. (Arcetri) Codella, C. (CNR) Furuya, R. (Caltech) Olmi, L. (CNR) Testi, L. (Arcetri)	Searching for infall in a high mass circumstellar disk. 1.3 cm
AC768	Curiel, S. (CfA) Girart, J. (IEEC) Raga, A. (Mexico/UNAM)	Proper motions of SiO emission in the L1448 outflow. 0.7 cm

VLA Observing Programs

No.	Observer(s)	Programs
AC773	Cohen, A. (NRL) Lane, W. (NRL) Kassim, N. (NRL) Lazio, T. (NRL)	Structure of ultra-steep spectrum sources in the VLSS. 20 cm
AC775	Curiel, S. (CfA) Ho, P. (CfA) Hirano, N. (ASIAA) Zhang, Q. (CfA) Girart, J. (IEEE)	Physical properties of highly collimated SiO outflow in HH211. 0.7 cm
AC776	Clarke, T. (Virginia) Sarazin, C. (Virginia) Markevitch, M. (CfA)	Particle acceleration in the merger shock of Abell 520. 90 cm
AC779	Cheung, C. (MIT) Siemiginowska, A. (CfA) Harris, D. (CfA)	Deep imaging of the 300 kpc X-ray jet in PKS 1127-145. 3.6 cm
AC781	Cannon, J. (MPIA) Skillman, E. (Minnesota) Walter, F. (MPIA)	HI Imaging of starbursts with Ly-alpha in emission and absorption. 20 cm
AC788	Curiel, S. (CfA) Girart, J. (Barcelona) Rodriguez, L. (Mexico/UNAM)	Toward the true nature of YLW 15 binary system. 0.7 cm
AD498	DeLaney, T. (Minnesota) Rudnick, L. (Minnesota) Sankrit, R. (Johns Hopkins) Blair, W. (Johns Hopkins) Petre, R. (NASA) Harrus, I. (NASA)	Probing the dynamics of Kepler's supernova remnant. 6, 20 cm
AD500	DeLaney, T. (Minnesota) Rudnick, L. (Minnesota)	Spectral-index imaging of Cassiopeia A. 6, 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AD507	Decin, L. (Katholieke) Blommaert, J. (Katholieke) Groenewegen, M. (Katholieke) Butler, B.	Normal late-type stars. 0.7 cm
AD509	DeLain, K. (Minnesota) Rudnick, L. (Minnesota)	Structure and spectra of diffuse sources not in rich clusters. 90 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. 0.7, 3.6, 6 cm
AF414	Frail, D. Soderberg, A. (Caltech) Kulkarni, S. (Caltech)	Continued monitoring of bright GRB 030329. 3.6, 6, 20 cm
AF415	Furuya, R. (Caltech) Cesaroni, R. (Arcetri) Shinnaga, H. (CfA)	Continuum emission toward a cluster of high-mass proto stars. 1.3 cm
AF420	Faber, S. (UC, Santa Cruz) Chapman, S. (Caltech) Davis, M. (UC, Davis) Ivision, R. (ROE) Steidel, C. (Caltech) Reddy, N. (Caltech) Smail, I. (Durham)	Deep imaging of the DEEP EGS region. 20 cm
AF425	Fish, V. Reid, M. (CfA)	New velocity feature in W3 (OH). 6, 20 cm
AG678	Garay, G. (Chile) Rodriguez, L. (Mexico/UNAM)	Search for gyro-synchrotron sources toward cold massive cores. 3.6 cm

VLA Observing Programs

No.	Observer(s)	Programs
AG696	Greve, T. (Caltech) Knudsen, K. (MPIA) Borys, C. (Caltech) Vander Werf, P. (Leiden) Kneib, J. (Toulouse) Blain, A. (Caltech) Ivison, R. (ROE)	Deep observations of three massive clusters of galaxies. 6 cm
AG698	Gomez, J. (LAEFF) deGregorio-Monsalvo (LAEFF) Suarez, O. (LAEFF)	Re-appearance of water maser in L1448C. 1.3 cm
AH810	Hoare, M. (Leeds) Lumsden, S. (Leeds) Oudmaijer, R. (Leeds) Busfield, A. (Leeds) Diamond, P. (Manchester) Garrington, S. (Manchester) Muxlow, T. (Manchester) Gunn, A. (Manchester) Spencer, R. (Manchester) Cotton, W. Churchwell, E. (Wisconsin) Kurtz, S. (Mexico/UNAM) Shepherd, D. Chandler, C. Mundy, L. (Maryland) Gibb, A. (Maryland) Ridge, N. (FCRAO) Gledhill, T. (Hertfordshire) Zijlstra, A. (Manchester) Fender, R. (Amsterdam)	Coordinated radio and infrared survey for high mass star formation. 6 cm
AH847	Humphreys, E. (CfA) 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

VLA Observing Programs

No.	Observer(s)	Programs
AH856	Hofstadter, M. (JPL) Butler, B.	Seasonal variations and depth probing of the atmosphere of Uranus. 1.3 cm
AH858	Hardcastle, M. (Bristol) Harris, D. (CfA) Worrall, D. (Bristol) Birkinshaw, M. (Bristol)	Hotspots of FRII sources. 0.7, 1.3 cm
AH862	Harris, D. (CfA) Junor, W. (Los Alamos) Cheung, C. (MIT)	Monitoring knot HST-1 in the M87 jet. 1.3, 2, 3.6 cm
AH866	Hunter, D. (Lowell Obs) Elmegreen, B. (IBM) Brinks, E. (Guanajuato) Westpfahl, D. (NMIMT) Nordgren, T. (Redlands) Wilcots, E. (Wisconsin) McIntyre, V. (Sydney) Ostlin, G. (Upsala)	Structure of HI in dwarf galaxies. 20 cm
AH869	Hoare, M. (Leeds) Urquart, J. (Leeds) Lumsden, S. (Leeds) Oudmaijer, R. (Leeds) Busfield, A. (Leeds)	Continuum toward red MSX sources. 6 cm
AH871	Hamidouche, M. (Illinois) Looney, L. (Maryland) Kuo, H. (Illinois) Shaw, Y. (Illinois)	Circumstellar structures of Herbig Ae/Be stars. 0.7 cm
AH875	Hamidouche, M. (Illinois) Looney, L. (Illinois) Shaw, Y. (Illinois)	Resolving circumstellar structures of Herbig Ae/Be stars. 0.7 cm
AH879	Healy, K. (Arizona) Claussen, M. Hester, J. (Arizona)	Survey for water masers in nearby molecular clouds. 1.3 cm

VLA Observing Programs

No.	Observer(s)	Programs
AJ313	Johnson, K. (Virginia) Plante, S. (Laval)	Structure and spectra of low-metallicity starburst. 0.7, 1.3, 2, 3.6, 6 cm
AJ316	Jimenez-Serra, I. (CSIC) Martin-Pintado, J. (IEM) Rodriguez-Franco, A. (CSIC) Chandler, C. DePree, C. (Agnes Scott)	Hot spot near Cephus HW2: sulfur dioxide emission. 0.7 cm
AJ319	Jarvis, M. (Oxford) McLure, R. (Oxford) Cotter, G. (Oxford) Miller, L. (Oxford)	Deeper imaging of radio quiet quasars. 6 cm
AK579	Kondratko, P. (Harvard) Greenhill, L. (CfA) Moran, J. (CfA)	Water maser emission in 5 distant AGN. 1.3 cm
AK583	Kulkarni, S. (Caltech) Soderberg, A. (Caltech) Cenko, S. (Caltech) Frail, D. Harrison, F. (Caltech) Fox, D. (Caltech) Gal-Yam, A. (Tel Aviv Univ.) Moon, D. (Caltech) Cameron, B. (Caltech)	Gamma ray bursts, X-ray flashes, and core collapse SNe. 0.7, 1.3, 2, 3.6, 6, 20 cm
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. (UNAM) Hofner, P. (NMIMT) Araya, E. (NMIMT)	Continuing imaging of DR 21 (OH). 1.3 cm
AK594	Keto, E. (CfA) Zhang, Q. (CfA)	Structure of ammonia and H53alpha in star-forming region NGC 7538. 0.7, 1.3 cm

VLA Observing Programs

No.	Observer(s)	Programs
AK601	Kouveliotou, C. (NASA) Gelfand, J. (CfA) Gaensler, B. (CFA) Wijers, R. (SUNY) Taylor, G. Eichler, D. (Ben Gurion) Fender, R. (Amsterdam) Garrett, M. (JIVE)	SGR 1806-20. 1.3, 3.6, 6, 20 cm
AK607	Keto, E. (CfA) Zhang, Q. (CfA)	Kinematics of RRLs toward HI regions with molecular flows. 1.3 cm
AK610	Kulkarni, S. (Caltech) Cameron, P. (Caltech) Frail, D.	Radio afterglow following giant flare from SGR 1806-20. 90 cm
AL625	Lang, C. (Iowa) Figer, D. (STScI) Najarro, F. (CSIC)	Structure and spectra of luminous blue variable stars. 0.7, 1.3 cm
AL637	Laing, R. (ESO) Hardcastle, M. (Bristol) Bridle, A.	Deep polarimetry of jets in FRI radio galaxy 3C 296. 3.6 cm
AL646	Liszt, H. Pety, J. (IRAM) Lucas, R. (IRAM)	HI absorption toward extragalactic continuum sources. 20 cm
AL647	Lang, C. (Iowa) Figer, D. (STScI) Najarro, F. (CSIC)	Structure and spectra of luminous blue variables. 1.3, 3.6 cm
AL649	Leon, S. (IAA) SabaterMontes, J. (IAA) Verdes-Montenegro, L. (IAA) Verley, S. (IAA) Lisenfeld, U. (IAA) Perez-Ramirez, D. (JAEN) Bergond G. (Michigan) Lim, J. (Academia Sinica)	Census and morphology of radio core of a well defined sample of isolated galaxies. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AL654	Lim, J. (Academia Sinica) Hirano, N. (ASIAA) Ohashi, N. (ASIAA) Takakuwa, S. (CfA)	Imaging binary/multiple proto stellar systems. 0.7 cm
AM793	Monnier, J. (Michigan) Greenhill, L. (CfA) Tuthill, P. (Sydney) Danchi, W. (NASA)	Continuum monitoring of colliding wind binary WR 112. 3.6 cm
AM818	Marti, J. (Jaen) Perez, D. (Jaen) Luque-Escamilla, P. (Jaen) Garrido, J. (Jaen) Paredes, J. (Barcelona)	Distant hot spot candidates toward Cygnus X-3. 3.6, 6 cm
AM821	Marecki, A. (Torun) Mack, K. (ASTRON)	Structure of potentially restarted sources. 3.6, 6 cm
AM825	Morrison, G. (IPAC) Dickinson, M. (NOAO) Owen, F. Bauer, F. (Cambridge) Koekemoer, A. (Mt. Stromlo) Mobasher, B. (STScI) Chary, R. (Caltech) Frayer, D. (Caltech)	Deep imaging of the GOODS northern field. 20 cm
AM827	Maia, M. (Valongo, Brazil) Schmiit, H. (NRL)	Imaging an optically-selected Seyfert sample. 3.6 cm.
AM828	Ma, C. (Hawaii) Lim, J. (Academia Sinica)	HI Absorption toward sources in galaxy clusters. 20 cm
AN124	Neff, S. (NASA) Owen, F. Eilek, J. (NMIMT) Morganti, R. (ASTRON)	Intermediate scale structure of Centaurus A. 90 cm

VLA Observing Programs

No.	Observer(s)	Programs
AO191	Osorio, M. (IAA) Anglada, G. (IAA) Rodriguez, L. (Mexico/UNAM) Lizano, S. (Mexico/UNAM)	Ammonia emission from candidate hot molecular cores. 1.3 cm
AO192	Osten, R. Jayawardhana, R. (Toronto)	Brown dwarf TWA 5B. 3.6 cm
AP452	Perley, R. Condon, J. Cotton, W. Lane, W. (NRL) Cohen, A. (NRL) Kassim, N. (NRL) Lazio, T. (NRL) Erickson, W. (Maryland)	VLA low-frequency sky survey. 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 cm
AP485	Pidopryhora, Y. (Ohio) Liszt, H. Lockman, F.J. Rupen, M.	HI and OH absorption in Galactic halo clouds. 20 cm
AP487	Pandian, J. (Cornell) Momjian, E. (Arecibo) Goldsmith, P. (Cornell)	HI Absorption to resolve the distance ambiguity of methanol masers. 20 cm
AP490	Pihlstrom, Y. (Caltech) Sjouwerman, L. Fish, V.	Excited OH masers toward supernova remnants. 1.3, 3.6, 6 cm
AR545	Rupen, M. Mioduszewski, A. Dhawan, V.	Monitoring of X-ray binaries, etc. 0.7, 1.3, 2, 3.6, 6, 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AR560	Rodriguez, L. (Mexico/UNAM) Loinard, L. (Mexico/UNAM) D'Alessio, P. (Mexico/UNAM))	Structure of proto planetary disk around HH24MMS. 0.7 cm
AR562	Ribo, M. (Saclay) Mirabel, I. (Saclay) Casares, J. (IAC) Combi, J. (Jaen)	Monitoring the spectrum of a new micro quasar candidate. 2, 3.6, 6, 20 cm
AR565	Remijan, A. (NASA) Hollis, J. (NASA)	Hot cores in proto stellar system IRAS16293-2422. 0.7 cm
AR568	Reviglio, P. (Columbia) Van Gorkom, J. (Columbia)	Imaging galaxies that deviate from FIR radio correlation. 20 cm
AR569	Reid, M. (CfA) Menten, K. (MPIR, Bonn)	Calibrator search for VY CMa. 0.7, 3.6 cm
AR570	Rupen, M. Mioduszewski, A. Dhawan, V.	Monitoring of and triggered response to X-ray transients. 0.7, 1.3, 2, 3.6, 6 and 20 cm
AS796	Soderberg, A. (Caltech) Kulkarni, S. (Caltech) Frail, D. 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. (NAOJ) Imai, H. (Kagoshima)	Monitoring circumstellar SiO masers near Sgr A*. 0.7 cm
AS812	Schinnerer, E. (MPIA) Rupen, M. Kennicutt, R. (Arizona) Mason, B.	Deep imaging of M51. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AS826	Spangler, S. (Iowa) Ingleby, L. (Iowa)	Faraday rotation through the Solar corona. 20 cm
AS827	Sakelliou, I. (Birmingham) Jetha, N. (Birmingham) Ponman, T. (Birmingham) O'Sullivan, E. (CfA) Vrtilek, J. (CfA) Mulchaey, J. (Carnegie) Darling, J. (Carnegie)	Structure and spectra of sources in galaxy groups. 90 cm
AS829	Shirley, Y. Claussen, M.	Continuum source in Spitzer core L1014. 3.6, 20 cm
AS831	Shepherd, D. Testi, L. (Arcetri) DePree, C. (Agnes Scott College) Scoles, S. (Agnes Scott College)	Massive outflow sources observed with Spitzer. 3.6 cm
AS832	Skillman, E. (Minnesota)	HI structure and kinematics of ultra compact blue dwarfs. 20 cm
AS833	Schiminovich, D. (Columbia) Johnson, B. (Columbia) Hoopes, C. (Johns Hopkins) Heckman, T. (Johns Hopkins) Treyer, M. (Marseille)	Imaging ultraviolet luminous galaxies. 20 cm
AS838	Stocke, J. (Colorado) Keeney, B. (Colorado) Carilli, C.	HI imaging of host galaxies of damped Ly-alpha absorbers. 20 cm
AS844	Schinnerer, E. (MPIA) Carilli, C. Smolcic, V. (MPIA)	Spectral indices of COSMOS sources without optical counterparts. 6 cm
AT299	Terashima, Y. (ISAS) Ho, L. (Carnegie) Ulvestad, J.	Physics of accretion flows in ultra-low luminosity AGNs. 3.5 cm

VLA Observing Programs

No.	Observer(s)	Programs
AT300	Tao, A. (Shanghai) Goss, W. M. Morris, M. (UC, Los Angeles) Hong, X. (Shanghai) Zhao, J. (CfA)	Proper motions of radio components near Sgr A*. 1.3 cm
AT303	Tsai, C. (UC, Los Angeles) Turner, J. (UC, Los Angeles) Beck, S. (Tel Aviv) Ho, P. (CfA)	HII regions in M82 and NGC 253. 0.7, 1.3 cm
AT304	Turner, J. (UC, Los Agneles) Naiman, J. (UCLA) Bekc, S. (Tel Aviv) Ho, P. (CfA) Tsai, C. (UCLA)	Super star cluster nebula in NGC 660. 1.3 cm
AT309	Tsai, C. (UCLA) Turner, J. (UCLA) Beck, S. (Tel Aviv)	Imaging candidate super nebulae in starburst galaxies. 1.3 cm
AT310	Torrelles, J. (Barcelona) Dent, W. (ROE) Anglada, G. (IAA)	SED of Ae/Be star with CO. 3.6 cm
AU104	Umana, G. (Noto) Cerrigone, L. (Catania) Trigilio, C. (Noto)	Survey of very young PNe candidates. 3.6 cm
AV280	deVries, W. (LLNL) Xanthopoulos, E. (LLNL) Becker, R. (UC, Davis)	Structure of candidate FRII quasars from the SDSS. 20 cm
AW605	Walter, F. (MPIA) Brinks, E. (Guanajuato) deBlock, E. (Cardiff) Thornley, M. (Bucknell) Kennicutt, R. (Arizona)	HI structures of nearby galaxies. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AW641	Weiler, K. (NRL) Stockdale, C. (Marquette) Sramek, R. VanDyk, S. (Caltech) Panagia, N. (STScI) Marcaide, J. (Valencia) Lewin, W. (MIT) Pooley, D. (MIT) Immler, S. (NASA) Ryder, S. (AAO)	Triggered observations of type II SNe. 1.3, 2, 3.6, 6, 20, 90 cm
AW647	Weiler, K. (NRL) Stockdale, C. (Marquette) Sramek, R. VanDyk, S. (IPAC) Panagia, N. (STScI) Marcaide, J. (Valencia) Lewin, W. (MIT) Pooley, D. (MIT) Immler, S. (NASA)	Long term monitoring of radio supernovae. 1.3, 2, 3.6, 6, 20 cm
AW649	Wilcots, E. (Wisconsin) Doane, N. (Wisconsin) Sanders, W. (Wisconsin) Chomiuk, L. (Wisconsin) Zweibel, E. (Wisconsin)	Deep imaging of spiral galaxies with X-ray super bubbles. 20 cm
AW652	Walter, F. (MPIA) Carilli, C. Bertoldi, F. (MPIR,Bonn) Menten, K. (MPIR, Bonn) Cox, P. (IAP-Paris) Weiss, A. (Bonn) Lo, K.Y.	Structure of CO in QSO host galaxies beyond redshift four. 0.7 cm
AY155	Yun, M. (Massachusetts) Xu, K. (Caltech) Verdes-Montenegro, L. (IAA)	HI distribution and kinematics in Stephan's Quintet. 20 cm

VLA Observing Programs

No.	Observer(s)	Programs
AZ155	Zijlstra, A. (Manchester) Hajduk, M. (UMIST) Kerber, F. (ESO) vanHoof, P. (Queens) Pollacco, D. (Queens) Evans, A. (Keele) Eyres, S. (Lancashire) Kimeswenger, S. (Innsbruck)	Structure of Sakurai's object and similar candidates. 6 cm
AZ159	Zapata, L. (CfA) Ho, P. (CfA) Rodriguez, L. (Mexico/UNAM)	Spectral indices of embedded sources in NGC 63341(N). 0.7 cm
BB196	Bartel, N. (York) Bietenholz, M. (York) Rupen, M.	Central compact source in SN 1986J. 1.3 cm.
BB204	Biggs, A. (JIVE) Porcas, R. (MPIR, Bonn) Rusin, D. (Pennsylvania)	Jet structures in the six image lens system. 20 cm
BB209	Boyce, E. (MIT) Hewitt, J. (MIT) Myers, S.	Observations of gravitational lens central images. 3.6, 6 cm
BD109	Dougherty, S. (DRAO) Pittard, J. (Leeds) O'Connor, E. (NRC) Beasley, A.J. Claussen, M.	Structural monitoring of colliding wind binary WR140. 0.7, 1.3, 2, 3.6 cm
BF083	Forbrich, J. (MPIR, Bonn) Massi, M. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Menten, K. (MPIR, Bonn)	Structure of proto star YLW15-VLA2. 3.6 cm
BK113	Kemball, A. (Illinois) Diamond, P. (Manchester)	Monitoring SiO masers in two evolved stars. 0.7 cm

VLA Observing Programs

No.	Observer(s)	Programs
BK114	Kondratko, P. (Harvard) Greenhill, L.(CfA) Moran, J. (CfA) Reid, M. (CfA)	Imaging three NGC 4258-like water mega masers. 1.3 cm
BM223	Maccarone, T. (Amsterdam) Brisken, W. Miller-Jones, J. (Oxford) Jonker, P. (CfA)	Imaging faint sources toward the globular cluster M15. 6 cm
BN031	Nakashima, J. (Illinois) Kemball, A. (Illinois) Deguchi, S. (Nobeyama)	Structure of SiO masers in IRAS 19312+1950. 0.7 cm
BN032	Nakai, N. (Tsukuba) Yamauchi, A. (NAOJ) Sato, N. (NAOJ) Diamond, P. (Manchester)	Water masers in LINER galaxy IC 1481. 1.3 cm
BR102	Ratner, M. (CfA) Bartel, N. (York) Bietenholz, M. (York) Lebach, D. (CfA) Lederman, J. (York) Lestdrade, J-F. (Meudon) Ransom, R. (York) Shapiro, I.I. (CfA)	Astrometric monitoring of HR 8703 in 2005 for GPB Mission. 2, 3.6, 6 cm
BW080	Wrobel, J. Ulvestad, J. Ho, L. (Carnegie Institute)	Radio emission from the candidate IMBH in NGC 4395. 20 cm
BW084	Winn, J. (CfA) Rusin, D. (Pennsylvania) Keeton, C. (Rutgers)	Search for central images in two gravitational lenses. 6 cm

VLA Observing Programs

No.	Observer(s)	Programs
GB049	Bartel, N. (York) Bietenholz, M. (York) Beasley, A.J. Graham, D. (MPIR, Bonn) Altunin, V. (JPL) Venturi, T. (Bologna) Umana, G. (Noto) Cannon, W. (York) Conway, J. (Onsala)	SN1993J: structural and spectral evolution of shell. 6, 20 cm
S60643	Brown, A. (Colorado) Ayres, T. (Colorado) Osten, R. Harper, G.M. (Colorado) Linsky, J. (Colorado)	Chandra/VLA/VLBA observations of binary Sigma Gem. 0.7, 1.3, 2, 3.6, 6, 20 cm
S60849	Kellogg, E.M. (CfA) Nichols, J. (CfA) Pedelty, J.A. (NASA) Sokoloski, J.L. (CfA)	Chandra/VLA observations of symbiotic star R Aqr. 3.6 cm

VLBA Observing Programs

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

No.	Observer(s)	Programs
BA053	Attridge, J. (Haystack) Homan, D. (Brandeis) Phillips, R. (Haystack) Wardle, J. (Brandeis)	Linear polarization of five AGN with VLBA. 0.3, 0.7 cm
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)	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
BB182	Bach, U. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Middelberg, E. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn)	Finding the nucleus in Cygnus A. 1, 2 cm
BB196	Bartel, N. (York U) Bietenholz, M. (York U) Rupen, M.	Central compact source in SN 1986J. 1.3 cm
BB200	Brunthaler, A. (JIVE) Falcke, H. (ASTRON) Greenhill, L. (CfA) Henkel, C. (MPIR, Bonn) Reid, M. (CfA)	Geometric distance to M33. 1 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BB202	Bower, G.C. (Calif., Berkeley) Anderson, J. (Rice)	Trigonometric parallax of a star in the Pleiades cluster. 6 cm
BB204	Biggs, A. (JIVE) Porcas, R. (MPIR, Bonn) Rusin, D. (Pennsylvania)	Jet structure in six-image lens system CLASS B1359+154. 18 cm
BB209	Boyce, E. Hewitt, J. (MIT) Myers, S.	Observations of gravitational lens central images. 3.6, 6 cm
BC147	Cotton, W.D. Danchi, W. (NASA/GSFC) Lacasse, M. (CfA) Ragland, S. (CfA) Schloerb, F. (Calif., Berkeley) Townes, C. (Calif., Berkeley) Traub, W. (CfA)	VLBA/IOTA observations of Miras with photospheric asymmetrics. 0.7 cm
BC151	Cotter, G. (Oxford) Bolton, R. (Cambridge) Chandler, C. Lee, D. (Oxford) Pearson, T. (Caltech) Pooley, G. (Cambridge) Readhead, T. (Caltech) Riley, J. (Cambridge) Waldram, E. (Cambridge)	Mapping of compact radio sources selected at 15 GHz. 6 cm
BD105	Dhawan, V. Fomalont, E. Lestrade, J-F. (Obs. de Paris) Mioduszewski, A. Rupen, M.	Astrometry of X-ray binaries. 2 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BD106	Doi, A. (Univ. Tokyo) Asada, K. (NAOJ) Inoue, M. (NAOJ) Kameno, S. (NAOJ) Nagai, H. (Tokyo Univ. of Science) Wajima, K. (Korea)	Narrow line Seyfert 1 survey. 20 cm
BD109	Dougherty, S. (DRAO) Pittard, J. (Leeds) O'Connor, E. (NRC) Beasley, A.J. Claussen, M.	Structural monitoring of colliding wind binary WR140. 0.7, 1.3, 2, 3.6 cm
BE037	Edwards, P. (ISAS) Chaty, S. (Saclay) Fomalont, E. Grenier, I. (Saclay)	Phase referencing observations of nearby Seyfert. 4, 13 cm
BF080	Fomalont, E. Kopeikin, S. (Missouri) Lanyi, G. (JPL)	Measuring solar gravitational deflection: tests. 0.7, 1.3, 2 cm
BF083	Forbrich, J. (MPIR, Bonn) Massi, M. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Menten, K. (MPIR, Bonn)	Structure of protostar YLW15-VLA2. 3.6 cm
BF085	Fish, V. Menten, K. (MPIR, Bonn) Reid, M. (CfA)	Proper motions of OH masers in young massive star-forming regions. 20 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

VLBA Observing Programs

No.	Observer(s)	Programs
BG158	Giovannini, G. (Bologna) Cotton, W.D. Feretti, L. (Bologna) Giroletti, M. (Bologna) Taylor, G.	Observations of an unbiased sample of radio galaxies. 6 cm
BH107	Horiuchi, S. (JPL) Kameya, O. (NAOJ) Migenes, V. (Guanajuato	Highly polarized water masers in Orion KL. 1 cm
BH126	Harris, D. (SAO) Cheung, C. (Brandeis) Junor, W. (LANL)	Ongoing outburst of knot 'HST-1' in the M80 jet. 90 cm
BH127	Hough, D. (Trinity)	Innermost jet structure in the nuclei of the lobe-dominated quasars 3C207 and 3C245. 1, 2, 4 cm
BI030	Imai, H. (Kagoshima) Diamond, P. (Manchester)	Evolution on a water fountain in W43A. 1 cm
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
BJ045	Junor, B. (LANL)	Deep 3mm obs. of Virgo A Core. 0.3, 0.7 cm
BJ050	Jin, C. (NAOC) Garrett, M. (JIVE) Nair, S. (RRI) Nan, R. (NAOC) Porcas, R. (MPIR, Bonn)	3mm observations of gravitational lens system PKS 1830-211. 0.3, 0.7 cm
BK113	Kemball, A. (Illinois) Diamond, P. (Manchester)	New constraints on the near-circumstellar environment of late-type evolved stars. 20 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BK114	Kondatko, P. (Harvard) Greenhill, L. (CfA) Moran, J. (CfA) Reid, M. (CfA)	Imaging three NGC 4258-like water megamasers. 1.3 cm
BK119	Kemball, A. (Univ. Illinois) Diamond, P.J. (Manchester)	SiO maser survey of Mira-like variables in Hipparcos catalog. 0.7 cm
BL123	Lister, M. (Purdue) Aller, H. (Michigan) Aller, M. (Michigan) Arshakian, T. (MPIR, Bonn) Homan, D. (Denison) Kadler, M. (MPIR, Bonn) Kellermann, K. Kovalev, Y. Y. Lobanov, A. (MPIR, Bonn) Ros, E. (MPIR, Bonn) Vermeulen, R. (ASTRON) Zensus, J. (MPIR, Bonn)	MOJAVE Program. 2 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. 4 cm
BL128	Loinard, L. (Mexico/UNAM) Mioduszewski, A. Rodriguez, L. (Mexico/UNAM) Torres, R. (Mexico/UNAM	Distance to Taurus from multi epoch observations. 4 cm
BL129	Liu, C. (SHAO) Fletcher, A. (SHAO) Gurvits, L. (JIVE) Jiang, D. (SHAO)	Multi-frequency polarimetry of GPS quasar OQ172. 2, 6, 13 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BM208	Middelberg, E. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Roy, A. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn	Proper motions in NGC3079. 6 cm
BO020	Orienti, M. (Bologna) Dallacasa, D. (Bologna)	Multi-frequency observation of extremely young radio sources. 2, 4, 6, 20 cm
BP112	Piner, B.G. (Whittier) Edwards, P. (ISAS) Wiik, K. (ISAS)	Decelerating jets of Mkn 421 and Mkn 501. 0.3, 0.7cm
BP118	Petrov, L. (NASA) Fomalont, E. (Gordon, D. (NASA) Kovalev, Y.Y.	VCS4: Filling last remaining holes in calibrator coverage. 0.4, 13 cm
BP120	Piner, B. (Whittier) Edwards, P.G. (ISAS) Jones, D. (JPL)	Kinematics of the 26 c components in the blazar 0827+243. 2 cm
BR099	Ros, E. (MPIR, Bonn) Aller, H.D. (Michigan) Aller, M. (Michigan) Kadler, M. (MPIR, Bonn) Kerp, J. (Univ. Bonn) Kovalev, Y.Y. Marscher, A. (Boston) Weaver, K. (NASA)	NGC 1052, the key to explore the disk jet connection in AGN. 0.7, 1 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BR102	Ratner, M. (CfA) Bartel, N. (York) Bietenholz, M. (York) Lebach, D.E. (CfA) Lederman, J. (York) Lestrade, J.-F. (Meudon) Ransom, R.R. (York) Shapiro, I.I. (CfA)	Astrometric monitoring of HR 8703 in 2005 for GPB mission. 2, 3.6, 6 cm
BR104	Romani, R. (Stanford) Ros, E. (MPIR, Bonn) Aller, H. (Michigan) Aller, M. (Michigan) Kadler, M. (MPIR, Bonn) Kerp, J. (Bonn) Kovalev, Y.Y. Marscher, A. (Boston) Weaver, K. (NASA) Zensus, J.A. (MPIR, Bonn)	Student observations. 4 cm
BS144	Sudou, H. (Gifu Univ.) Iguchi, S. (NAO, Japan) Murata, Y. (JAXA/ISAS) Takaba, H. (Gifu) Taniguchi, Y. (Tohoku) Wakamatsu, K. (Gifu)	Astrometric monitoring of the radio galaxy 3C 66B. 0.4, 13 cm
BS150	Savolainen, T. (Tuorla) Rastorgueva, E. (Tuorla) Takalo, L. (Tuorla) Valtaoja, E. (Tuorla) Valtonen, M. (Tuorla) Wiik, K. (Tuorla)	Multi-frequency polarimetric VLBA monitoring of next predicted outburst in OJ287. 0.3, 0.7 cm

VLBA Observing Programs

No.	Observer(s)	Programs
BS151	Soderberg, A. (Caltech) Chevalier, R. (Virginia) Frail, D. Kulkarni, S. (Caltech) Walker, R.C.	Understanding peculiar nature of SN 2003 bg. 4 cm
BS157	Savolainen, T. (Tuorla) Pian, E. (INAF) Rastorgueva, E. (Tuorla) Valtaoja, E. (Tuorla) Wiik, K. (Tuorla)	Triggered polarimetric monitoring of a blazar in outburst. 0.3, 0.7, 1,2, 6 cm
BT070	Taylor, G. Peck, A. (CfA) Pollack, L. (Calif., Santa Barbara)	Investigating binary black hole system in 0402+379. 4, 90 cm
BT079	van der Tak, F. (MPIR, Bonn) Hachisuka, K. (MPIR, Bonn) Menten, K. (MPIR, Bonn)	Proper motions of H_2O. 1 cm
BU026	Ulvestad, J. S. Gehrels, N. (NASA) Macomb, D. (Boise) Michelson, P. (Stanford) Romani, R. (Stanford)	Multi-epoch imaging of recently identified EGRET blazars. 2 cm
BV055	Vlemmings, W. (Cornell) Diamond, P. (Manchester) Langevelde, H. (JIVE)	Monitoring the magnetic field on the water masers of U Ori. 1 cm
BW066	Wiik, K. (Tuorla) Collmar, W. (MPIE) Savolainen, T. (Tuorla) Valtaoja, E. (Tuorla)	Hard X-ray and multi-frequency properties of blazar 3C 279. 0.7, 1,2,6 cm

VLBA Observing Programs

No.	Observer(s)	Programs
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. 0.7, 2, 4, 6, 13 cm
BW080	Wrobel, J. Ulvestad, J. S. Ho, L.	Radio emission from candidate IMBH in NGC 4395. 18 cm
BW084	Winn, J. (CfA) Rusin, D. (Pennsylvania) Keeton, C. (Rutgers)	Search for central images in two gravitational lenses. 6 cm
BY019	Yuan, W. (IoA) Fabian, A. (IoA) Taylor, G.	Probing the nature of the soft X-ray spectral flattening in two high-redshift quasars. 2, 6 cm
BY020	Yang, J. (Urumqi) Liu, X. (Urumqi) Shen, Z.Q. (Shanghai)	Complimentary multi-frequency VLBA survey for GPS sources. 2,4,6, 13 cm
GA022	Agudo, I. (IAA) Krichbaum, T. (MPIR, Bonn) Gomez, J-L. (IEEC) Bach, U. (Torino) Bremer, M. (Bristol) Witzel, A. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn)	Polarimetric monitoring of NRAO 150. 0.3 cm

VLBA Observing Programs

No.	Observer(s)	Programs
GB049	Bartel, N. (York) Bietenholz, M. (York) Beasley, A.J. Graham, D. (MPIR, Bonn) Altunin, V. (JPL) Venturi, T. (Bologna) Umana, G. (Noto) Cannon, W. (York) Conway, J. (Onsala)	SN1993J: structural and spectral evolution of shell. 6, 18 cm
GK032	Krichbaum, T. (MPIR, Bonn) Bach, U. (Torino) Alef, W. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn)	Monitoring Cygnus A. 0.3 cm
GK033	Krichbaum, T. (MPIR, Bonn) Graham, D. (MPIR, Bonn) Alef, W. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn) Bremer, M. (Bristol) Grewing, M. (IRAM)	Structural monitoring of M87. 0.3 cm
GP041	Pagels, A. (MPIR, Bonn) Krichbaum, T. (MPIR, Bonn) Witzel, A. (MPIR, Bonn) Zensus, J.A. (MPIR, Bonn)	Structural monitoring of 3C84. 3 cm

Personnel

NEW HIRES

Allen, Cynthia	Assistant Vice President	06-06-05
Castro, Jason	Electronics Engineer III	08-06-05
Clark, George	Associate Director	12-04-05
Hill, Jeremy	Research Assistant	06-06-05
Juerges, Thomas	Software Engineer III	07-06-05
Locke, Lisa	Electronics Engineer II	02-05-05
Morris, Keith	Electronics Engineer III	02-05-05
Stuteville, Jimmie	Safety Officer	01-06-05

TERMINATIONS

Lauria, Eugene	Electronics Engineer I	11-04-05
Stauffer, Fritz	Software Engineer II	15-04-05
Lewis, Patrick	Supervisor, Site & Wye	31-05-05
Van Buskirk, Philip	Software Engineer II	03-05-05
Constantikes, Kim	Electronics Engineer I	13-05-05
Ramey, Kenneth	Software Engineer II	20-05-05

PROMOTIONS

Chavez, Charles	Supervisor, Site & Wye	01-06-05
Ghosh, Soumya	Research Assistant	06-06-05
Jewell, Philip	Deputy Director	20-06-05

TRANSFERS

Muehlberg, James	Electronics Engineer II	01-06-05

Publications

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

ANDERSON, J. M.; ULVESTAD, J. S. The Size of the Radio-Emitting Region in Low-Luminosity Active Galactic Nuclei.

ATTRIDGE, J.M.; WARDLE, J.F.C.; HOMAN, D.C. Concurrent 43 and 86 GHz Very Long Baseline Polarimetry of 3C273.

BERGER, E.; RUTLEDGE, R.E.; REID, I.N.; BILDSTEN, L.; GIZIS, J.E.; LIEBERT, J.; MARTIN, E.; BASRI, G.; JAYAWARDHANA, R.; BRANDEKER, A.; FLEMING, T.A.; JOHNS-KRULL, C.M.; GIAMPAPA, M.S.; HAWLEY, S.L.; SCHMITT, J.H.M.M. The Magnetic Properties of an L Dwarf Derived from Simultaneous Radio, X-ray, and Hα Observations.

BHAT, N.D.R.; CORDES, J.M.; CHATTERJEE, S.; LAZIO, T.J.W. RFI Identification and Mitigation Using Simultaneous Dual Station Observations.

BOBOLTZ, D.A.; DIAMOND, P.J. Axial Symmetry and Rotation in the SiO Maser Shell of IK Tauri.

BOBOLTZ, D.A.; MARVEL, K.B. OH 12.8-0.9: A New Water-Fountain Source.

BOETTCHER, M.; HARVEY, J.; JOSHI, M.; VILLATA, M.; RAITERI, C.M.; BRAMEL, D.; MUKHERJEE, R.; SAVOLAINEN, T.; CUI, W.; FOSSATI, G.; SMITH, I.A.; ABLE, D.; ALLER, H.D.; ALLER, M.F.; ARKHAROV, A.A.; BALIYAN, K.; BARNABY, D.; BERDYUGIN, A.; BENITEZ, E.; BOLTWOOD, P.; CARINI, M.; CAROSATI, D.; CIPRINI, S.; COLOMA, J.M.; CRAPANZANO, S.; DE DIEGO, J.A.; DI PAOLA, A.; DOLCI, M.; FAN, J.; FRASCA, A.; HAGEN-THORN, V.; HORAN, D.; IBRAHIMOV, M.; KIMERIDZE, G.N.; KOVALEV, Y.A.; KOVALEV, Y.Y.; KURTANIDZE, O.; LAEHTEENMAEKI, A.; LANTERI, L.; LARIONOV, V.M.; LARIONOVA, E.G.; LINDFORS, E.; MARILLI, E.; MIRABAL, N; NIKOLASHVILI, M.; NILSSON, K.; OHLERT, J.M.; OHNISHI, T.; OKSANEN, A.; OSTORERO, L.; OYE, G.; PAPADAKIS, I.; PASANEN, M.; POTEET, C.; PURSIMO, T.; SADAKANE, K.; SIGUA, L.A.; TAKALO, L.; TARTAR, J.B.; TERAESRANTA, H.; TOSTI, G.; WALTERS, R.; WIIK, K.; WILKING, B.A.; WILLS, W.; XILOURIS, E.; FLETCHER, A.B.; GU, M.; LEE, C.-U.; S. PAK, S.; YIM, H.-S. Coordinated Multiwavelength Observations of 3C 66A During the WEBT Campaign of 2003 - 2004.

BROGAN, C.L.; LAZIO, T.J.; KASSIM, N.E.; DYER, K.K. Spatially Resolved Low Frequency VLA Observations of the Supernova Remnant 3C 391.

BROGAN, C.L.; ZAUDERER, B.A.; LAZIO, T.J.; GOSS, W.M.; DE PREE, C.D.; FASION, M.D. Spatial and Temporal Variations in Small-Scale Galactic HI Structure Toward 3C~138.

CHANDLER, C.J.; BROGAN, C.L.; SHIRLEY, Y.L.; LOINARD, L. IRAS 16293-2422: Proper Motions, Jet Precession, the Hot Core, and the Unambiguous Detection of Infall.

CHEUNG, C.C.; WARDLE, J.F.C.; CHEN, T. Discovery of Optical Emission in the Hotspots of Three 3CR Quasars: High-Energy Particle Acceleration in Powerful Radio Hotspots.

Publications

CROWL, H.H.; KENNEY, J.D.P.; VAN GORKOM, J.H.; VOLLMER, B. Dense Cloud Ablation and Ram Pressure Stripping of the Virgo Spiral NGC 4402.

DE GREGORIO-MONSALVO, I.; CHANDLER, C.J.; GOMEZ, J.F.; KUIPER, T.B.H.; TORRELLES, J.M.; ANGLADA, G. High-Resolution Molecular Line Observations of the Environment of the Class 0 Source B1-IRS.

DENNISON, B.; TURNER, B.E.; MINTER, A.H. The Fine Structure Lines of Hydrogen in HII Regions.

EVANS, A.S.; MAZZARELLA, J.M.; SURACE, J.A.; FRAYER, D.T.; IWASAWA, K.; SANDERS, D.B. Molecular Gas and Nuclear Activity in Radio Galaxies Detected by IRAS.

FURUYA, R.S.; KITAMURA, Y.; WOOTTEN, A.; CLAUSSEN, M.J.; KAWABE, R. Proper Motion of H2O Masers in IRAS 20050+2720 MMS1: An AU Scale Jet Associated with An Intermediate-Mass Class 0 Source.

GELFAND, J.D.; LAZIO, T.J.W.; GAENSLER, B.M. A Wide Field, Low Frequency Radio Image of the Field of M31: II. -- Source Classification and Discussion.

GIROLETTI, M.; GIOVANNINI, G.; TAYLOR, G.B. Low Power Compact Radio Galaxies at High Angular Resolution.

KALBERLA, P.M.W.; BURTON, W.B.; HARTMANN, D.; ARNAL, E.M.; BAJAJA, E.; MORRAS, R.; POEPPEL, W.G.L. The Leiden/Argentine/Bonn (LAB) Survey of Galactic HI: Final Data Release of the Combined LDS and IAR Surveys With Improved
Stray-Radiation Corrections.

KAMOHARA, R.; DEGUCHI, S.; MIYOSHI, M.; SHEN, Z.-Q. Time Variation of SiO Masers in VX Sgr over an Optically Quiescent Phase.

KAPLAN, D.L.; ESCOFFIER, R.P.; LACASSE, R.J.; O'NEIL, K.; FORD, J.M.; RANSOM, S.M.; ANDERSON, S.B.; CORDES, J.M.; LAZIO, T.J.W.; KULKARNI, S. R. The Green Bank Telescope Pulsar Spigot.

KLOOSTERMAN, J.L.; DUNN, D.E.; DE PATER, I. Jupiter's Synchrotron Radiation Mapped with the VLA from 1981-1998.

LANE, W. M.; COHEN, A. S.; KASSIM, N. E.; LAZIO, T. J. W.; PERLEY, R. A.; COTTON, W. D.; GREISEN, E. W. Post-Correlation RFI Excision at Low Frequencies.

LAROSA, T.N.; BROGAN, C.L.; SHORE, S.N.; LAZIO, T.J.; KASSIM, N.E.; NORD, M.E. Evidence of a Weak Galactic Center Magnetic Field from Diffuse Low-Frequency Nonthermal Radio Emission.

LEDLOW, M.J.; OWEN, F.N.; MILLER, N.A. The Cluster of Galaxies Surrounding Cygnus A II: New Velocities and a Dynamical Model.

LEE, T.-H.; KWOK, S. Dust Extinction in Compact Planetary Nebulae.

Publications

LISTER, M.L.; HOMAN, D.C. MOJAVE: Monitoring of Jets in AGN with VLBA Experiments - I. First-Epoch 15 GHz Linear Polarization Images.

LUO, S.G.; CONDON, J.J.; YIN, Q.F. Radio Identifications of Recently Discovered Planetary Nebulae.

MUEHLE, S.; KLEIN, U.; WILCOTS, E.M.; HUETTEMEISTER, S. Triggering and Feedback: The Relation between the HI Gas and the Starburst in the Dwarf Galaxy NGC 1569.

NARAYANAN, D.; WALKER, C.K.; GROPPI, C.E. Warm-Dense Molecular Gas in the ISM of Starbursts, LIRGs and ULIRGs.

PALMER, P.; GOSS, W.M. VLA Observations of Broad 6-cm Excited State OH Lines in W49A.

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Budget

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

Available funds for NRAO Operations (without EVLA) total $45,214,705. This amount includes $47,021,802 in new NSF Funds (less $5,340k for EVLA Phase 1 construction), $1,726,156 in prior year commitments and $1,806,747 in prior year carryover

NRAO Operations Expenses and Commitments FY 2005 Year to Date (October 1, 2004 to July 31, 2005)

Work Breakdown Structure Element Level 1	Salaries & Benefits	Materials & Services	Travel	Revenue or Cost Recovery	Total
Observatory Management	$2,534,338	$5,425,206	$342,034	($247,074)	$8,054,504
Education and Public Outreach	$303,521	$165,984	$30,436	($113,777)	$386,164
Central Development Lab	$1,104,242	$72,790	$10,480	$0	$1,187,512
Green Bank Operations	$6,599,934	$2,175,441	$101,173	($469,973)	$8,406,575
New Mexico Operations	$9,930,859	$3,476,340	$132,461	($64,200)	$13,475,460
ALMA Operations	$297,021	$48,431	$15,205	$0	$360,657
Computer and Information Services	$787,897	$570,076	$15,026	$0	$1,372,999
Division of Science and Academic Affairs	$3,126,484	$433,428	$176,508	$0	$3,736,420
	$24,684,296	$12,367,696	$823,323	($895,024)	$36,980,291