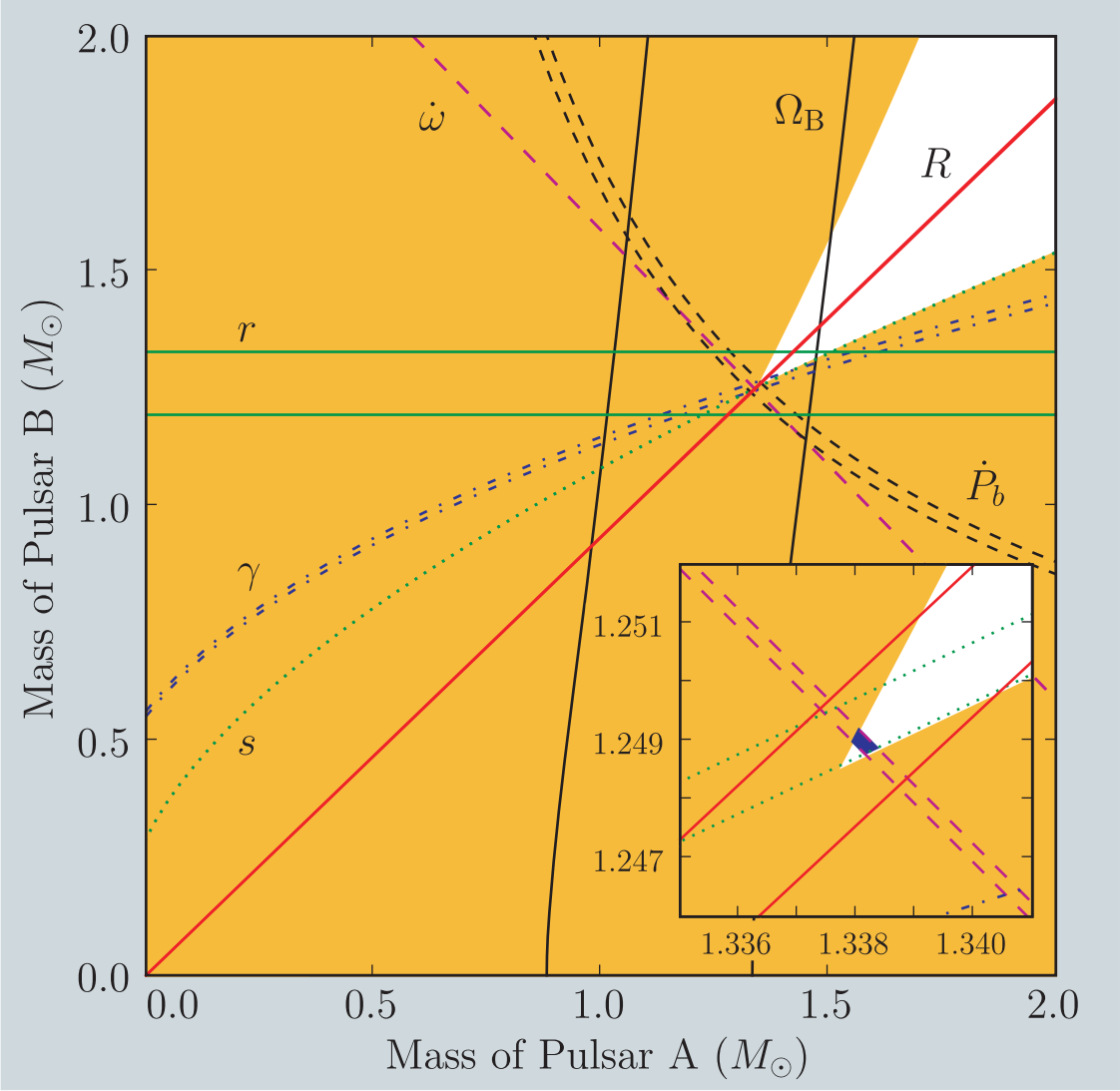
National Radio Astronomy Observatory



Quarterly Report

April – June 2008

NATIONAL RADIO ASTRONOMY OBSERVATORY

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Cover Image: GBT observations of the eclipsing binary pulsar J0737–3039A/B revealed relativistic precession consistent with General Relativity and tightened mass constraints on the two neutron stars (Breton et al. 2008, Science, 321, 104).

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EXECUTIVE SUMMARY

The VLA and the Chandra X-Ray Observatory found the youngest known (140 years) supernova remnant in our Galaxy. A systematic HI study of nearby Seyfert galaxies revealed that most are interacting tidally with gravitationally bound neighboring galaxies, while a control sample of inactive galaxies showed few interactions. GBT HI data suggest that the high-velocity Smith's Cloud is on track to collide with the Milky Way disk in 20–40 million years, bringing fresh gas to the star-forming regions of the Galaxy. The VLBA demonstrated its capabilities for precision spacecraft tracking (30 m at 1.9 AU) by following NASA's Phoenix spacecraft during insertion for its May 25 landing in the North Polar region of Mars.

During the past quarter the Observatory participated in a large number of reviews and management meetings, including the AUI Visiting Committee meeting and the Users Committee Meeting, and NRAO Scientific Staff Retreat, the second meeting of the AUI Committee to Assess NRAO Operations (the "Milkey Committee"), the NSF/LMI Cost Review (in Charlottesville, Green Bank, and Socorro), an AUI Executive Committee Meeting and an AUI Board Meeting. The AUI Cooperative Agreement renewal proposal was also prepared.

Sixteen EVLA antennas have been retrofitted and restored to routine service. The prototype WIDAR correlator was installed at the VLA site and "on-the-sky" tests began. Bob Dickman met with the Vice President of UPC Systems and the New Mexico State Land Office (SLO) commissioner. The SLO and the power-line developer are now seriously considering alternative routes that will not interfere with array operations. The Array Operations Center (AOC) was rededicated on May 30 and renamed the Pete V. Domenici Science Operations Center in recognition of the Senator's longstanding critical support for NRAO's radio astronomical mission in New Mexico.

Carol Lonsdale accepted the position of Assistant Director of the NAASC. The NAASC tested CASA in preparation of Beta patch 2 and led CASA tutorials for 50 participants at the NRAO Synthesis Summer School. NAASC staff traveled to Santiago for a meeting of the Science Operations Working Group, to work with recent JAO hires, and to discuss science support with ESO. The science program for the third NAASC science workshop was set. The NSF approved a sub-award request for the University of Virginia Microfabrication Laboratory to manufacture and supply replacement SIS mixer chips for ALMA.

The international SKA Science and Engineering Committee held its first meeting, and the U.S. SKA Consortium elected officers and representatives for the next three years. The FASR Mid-Size Infrastructure proposal was submitted to the NSF Atmospheric Sciences Division. The NASA Mission of Opportunity proposal for VLBA operations support of VSOP-2 was not funded.

Noise temperatures of 22 K from 83–87 GHz and < 30 K from 78–85 GHz with 30 dB gain were achieved with a new 35nm InP HEMT MMIC LNA, the lowest ever reported at these frequencies. The Central Development Lab is experimenting with integrated analog/digital/photonic receiver architectures to improve performance and better enable large-format focal plane arrays. Construction of EVLA amplifiers remains on schedule. Electroforming processes in the chemistry lab made a fresh start with great success.

The summer maintenance season for the GBT included holography tests, servo replacement tests, active-surface analysis, and painting. Dynamic Scheduling began and was well received by observers.

EXECUTIVE SUMMARY

The Proposal Submission Tool (PST) sponsored by the Office of End to End Operations now accepts electronic proposals for all NRAO telescopes plus the HSA. New archive interfaces let users retrieve data, observations, pipeline images, and proposal cover-sheet information in one search. A prototype NRAO Showcase in Google Sky was completed. The US Virtual Astronomical Observatory proposal was submitted in April by AUI and AURA; NRAO participated in the development of the proposal.

EPO organized and led the NRAO exhibition at the joint AAS/ASP meeting in St. Louis. The NRAO co-sponsored the ASP meeting, which focused on U.S. planning for the International Year of Astronomy 2009. The NRAO electronic Newsletter (eNews) published its debut issue in June. A very successful CV Open House hosted 920 guests from the CV community. National Geographic TV filmed at the VLA in April for "The Known Universe."

SCIENCE

SCIENCE HIGHLIGHTS

Very Large Array and Very Long Baseline Array (VLBA)

Youngest Galactic Supernova Remnant Discovered: The VLA and the Chandra X-Ray Observatory found the youngest known supernova remnant (SNR) in our Galaxy. Chandra observations of G1.9+0.3 in 2007 showed a significantly larger SNR shell than the VLA had observed in 1985. New VLA observations in 2008 confirmed that the shell had expanded by about 16 percent since 1985. The high expansion rate indicates the SNR is only about 140 years old, making it the first example of a long-sought "missing population" of young SNRs in the Galaxy.

The VLA observers were led by D.A. Green (Cavendish Laboratory) and the Chandra observers by S.P. Reynolds (NC State).

HI Images Indicate Tidal Interactions Trigger Seyfert Activity: A systematic HI study of nearby Seyfert galaxies revealed that the vast majority are interacting tidally with gravitationally bound neighboring galaxies, while a matched control sample of inactive galaxies showed few interactions. At optical wavelengths these Seyferts show no sign of interaction. This is the first strong evidence for the long-suspected link between tidal interactions and luminous Seyfert activity. The study clearly demonstrates the power of HI imaging to reveal tidal interactions that otherwise would remain undetected.

C.Y. Kuo (ASIAA and U. Va.), J. Lim (ASIAA), Y.W. Tang (ASIAA and National Taiwan University), and P.T.P. Ho (ASIAA and CfA).

Green Bank Telescope (GBT)

The Parsec-Scale Accretion Disk in NGC 3393: The spiral galaxy NGC 3393 has an active galactic nucleus (AGN) that has outflows and an almost edge-on obscuring structure containing clumps of H_2O maser emission. Using the VLBA, VLA, and GBT to make VLBI observations of this AGN, Kondratko, Greenhill, & Moran mapped the maser emission and interpreted it in the context of a parsec-scale nearly edge-on molecular disk perpendicular to the radio jets. From the angular extent of the maser disk they estimate an inner disk radius of 0.36 pc enclosing a central object of 3×10^7 solar masses. However, by using the GBT to monitor the H_2O spectra at six epochs between January 2005 and May 2006, they measured a centripetal acceleration within the disk of 5±1 km/s/yr for the maser spots directly on the line of sight to the dynamical center of the system. From this acceleration they derive an inner disk radius of only 0.17±0.02 pc and deduce that the accretion disk must extend from 0.17 to 1.5 pc.

Kondratko, P.T., Greenhill, L.J., and Moran, J.M. (Harvard-Smithsonian, CfA) 2008, ApJ, 678, 87.

SCIENCE

1. SCIENCE HIGHLIGHTS

The Smith Cloud: A High-Velocity Cloud Colliding with the Milky Way: Galaxies are not closed systems; they continue to grow by capturing their smaller satellites and accreting material remaining from the initial collapse. The high-velocity HI clouds seen around the Milky Way and nearby galaxies are thought to be part of this process, though direct evidence for their interaction with the Galactic disk has been lacking. New GBT observations of the high-velocity cloud known as Smith's Cloud now clearly show that this object, which contains about a million solar masses of gas, is already interacting with the Galaxy's gaseous halo and likely being disrupted by tidal forces. The GBT data determine all components of its space velocity and thus its complete trajectory. They suggest that Smith's Cloud is on track to collide with the Milky Way disk in 20–40 million years, bringing fresh gas to the star-forming regions of the Galaxy.

Lockman (NRAO), Benjamin (U. of Wisconsin-Whitewater), Heroux, (U. of Wisconsin-Whitewater), & Langston (NRAO) 2008, ApJ, 679, L21.

SCIENCE AND ACADEMIC AFFAIRS

Office of Science and Academic Affairs (OSAA)

The OSAA conducted research appraisals in conjunction with the annual Observatory Performance Evaluation Program (PEP). The Observatory continues to improve the evaluation process for both the functional and research components of the research staff. The goal is a merit-based system that is open and transparent, with consistent criteria for career advancement. We completed the evaluation of all 75 NRAO permanent research staff utilizing the new Research Staff Performance Appraisal forms.

SAA organized the NRAO Scientific Staff Retreat on April 10-11, 2008. The topic of the retreat was "Future Prospects and Developments at NRAO and in the U.S. Radio Community."

The 2008 Karl G. Jansky Lectureship was awarded to Dr. Arthur M. Wolfe of the University of California, San Diego (UCSD). Dr. Wolfe's Jansky Lecture will be entitled, "Finding the Gas that Makes Galaxies." The fall schedule for his presentations is online at http://www.nrao.edu/jansky/wolfe.shtml. The Karl G. Jansky Lectureship is an honor established by the trustees of Associated Universities, Inc., to recognize outstanding contributions to the advancement of radio astronomy.

Historical Archives

Digitization of Grote Reber's papers and letters was completed, and the images were linked from the finding aid and the Archives online catalog. Digitized items include all correspondence and papers, photographs, and materials related to design and construction of his 1937 Wheaton antenna and his antennas in Tasmania. It is unusual for any archives to have such complete digitized holdings of a collection. Processing continues on post-1979 NRAO materials and on the papers of John D. Kraus, and we continue to digitize photographs for public access via the online catalog.

The entire historical image file from Green Bank, including 26,000 black and white negatives, several thousand un-indexed 35 mm slides, and three large boxes of unindexed photos and slides from Tucson, have now been transferred to Archives for future identification, organization, and processing.

Archives assisted in providing images for posters and slide shows for the recent memorial services of NRAO retirees Barry E. Turner and Hein Hvatum.

The family of Ronald N. Bracewell designated the NRAO Archives as the repository for Bracewell's radio astronomy papers, and we have received the first shipment (approximately 70 linear feet) of what should be a very large collection. Preliminary examination and sorting of the received materials has begun with assistance from Scientist Emeritus A. Richard Thompson, who worked with Bracewell at Stanford before coming to the NRAO in 1973.

Finding aids to the collection and the Archives online catalog are linked from the NRAO Archives home page, http://www.nrao.edu/archives/.

Library Program

The NRAOPapers database system is operational on the Library staff side. This allowed the Library to renegotiate the EOS International contract, which resulted in a large cost savings. We expect the NRAOPapers user interface to be operational by the end of August.

The Library is working with the E2E team to identify methods of locating Project Codes/Proposal Numbers for papers entered into NRAOPapers. When an accurate and efficient method is found, the Library Staff will begin entering Project Codes/Proposal Numbers for older papers. In addition, there will be a link between the NRAO Data Vault and NRAOPapers to allow scientists to move from data to resultant papers or from papers to data. The link between the two will be the Project Codes/Proposal Numbers added to NRAOPapers by the Library.

Charlottesville Library staff began cataloguing the Exchange Collection (materials donated by observatories around the world) that will make some of the unique and uncommon materials *findable* by Libraries around the world as all cataloguing records are entered on OCLC.

The NRAO Library has also accepted the responsibility of cataloguing all ASP Conference Proceedings as soon as they are issued electronically so that other astronomy libraries can copy the record.

Scientific Appointments

Arrivals/Promotions

- Dr. Anthony Remijan, Research Associate, began a NAASC appointment as Assistant Scientist/A, participating in ALMA Commissioning and Science Verification, June 1.
- Dr. Rob Reid, Research Associate, began a project appointment with the ALMA CIPT as an Assistant Scientist/CS working on CASA efforts effective June 1.
- Rachel Rosen, UNC, Chapel Hill, started her Research Associate appointment in May working in Green Bank as the Project Director for the Pulsar Search Collaboratory project.
- Jim Ulvestad, Scientist/A (Tenure) and Assistant Director for the NIO, agreed to serve as Principal Scientist for the VLBA during this quarter.

Departures/Extensions

- James Aguirre completed his Jansky Fellowship on June 30. He has accepted a position as Assistant Professor at the University of Pennsylvania.
- Neal Miller completed his Jansky Fellowship April 30. He is on staff at Johns Hopkins University.

Student (Graduate and Co-op) and Visiting-Scientist Programs

Pre-docs

- Urvashi Rao-Venkata (New Mexico Tech) continued working with Frazer Owen in Socorro and Tim Cornwell at the Australia Telescope National Facility. She is investigating parameterized deconvolution in radio synthesis imaging, specifically for high-dynamic-range and multi-frequency imaging with the EVLA, co-supervised by Prof. Jean Eilek at New Mexico Tech.
- Chataili Parashare (University of Virginia) continued working with Richard Bradley at the NRAO Technology Center (NTC) on instrumentation for low-frequency radio astronomy arrays.
- Rohit Gawande (University of Virginia) also continued working with Richard Bradley at the NTC on development and fabrication of ultra-wide-band feeds for radio astronomy applications.

Graduate Interns

- Ryan Lynch (University of Virginia) began a graduate internship working with Scott Ransom in Charlottesville on searches for new globular-cluster millisecond pulsars with the GBT.
- Cheng-Yu Kuo (University of Virginia) began a graduate internship working with Jim Braatz in Charlottesville on reducing and analyzing spectral-line VLBI observations of the water-maser emission from the nucleus of NGC 6323.
- Katharine Johnston (University of St. Andrews, Scotland) worked with Debra Shepherd in Socorro on disk-outflow interactions in massive protostars.
- Katie Mae Chynoweth (Vanderbilt University) worked with Glen Langston in Green Bank on HI observations of interacting galaxies with the GBT and VLA.
- Nimish Sane (University of Maryland) was awarded a graduate internship to work with John Ford in Green Bank on digital processing for radio spectroscopy.
- Alyson Ford (Swinburne University) again worked with Jay Lockman in Green Bank on analysis of the distribution, structure, and properties of HI clouds above the Galactic plane.

Co-op Students and Engineering Interns

- Colin Frentzel, an electrical engineering major at Missouri University of Science and Technology (formerly UM–Rolla), continued a co-op assignment in Socorro with Dan Merteley and the Interference Protection Group at the VLA site.

Visiting Scientists

- Malcolm Gray (University of Manchester, U.K.) is spending a sabbatical year in Socorro working on theory and computational models associated with astrophysical masers.
- Maura McLaughlin and Duncan Lorimer (WVU) began appointments at Green Bank to work on follow-up observations of rotating radio transients and new pulsars discovered in the 350 MHz drift-scan survey made with the GBT.
- Andrew Harris and Shuvra Battacharyya (University of Maryland) were awarded appointments at Green Bank to work with John Ford on digital processing for radio spectroscopy.
- Glen Morrison (CFHT) visited Socorro to work with Frazer Owen on the multi-frequency follow-up to the SWIRE deep radio survey and on the deep Abell 851 and GOODS-N radio surveys.
- Jose Afonso (Lisbon) visited Socorro to work with Nissim Kanekar on a project to obtain a deep 325 MHz image of the Chandra Deep Field (South).
- Patrick Palmer (University of Chicago) worked with Miller Goss in Socorro on parallax and proper-motion studies of excited-state OH masers in DR21.

Support Programs

Student Observing Support (SOS)

The NRAO Student Observing Support Committee met in April 2008 to discuss the twelve proposals that were submitted during the last trimester. The SOS committee (composed of five faculty from U.S. universities) discussed the science case and student-support application for each proposal and selected four to receive funding. The proposals are listed below.

2. Science and Academic Affairs (SAA)

- Julia Deneva (Cornell, Supervisor: J. Cordes) will receive $13,000 for work related to the GBT proposal 08B-017 "Uncovering the Galactic-Center Pulsar Population: Spectrum Estimation and Timing of Two New Pulsars."
- Kyle Willet (U. Colorado, Supervisor: J. Darling) will receive $35,000 for work related to the GBT proposal 08B-035 "A High-Redshift OH Megamaser Survey."
- Fonda Day (U. New Mexico, Supervisor: Y. Pihlstrom) will receive $32,200 for work related to the VLBA proposal BP150 "Parallax and OH and H_2O studies of Water Fountain PPNe."
- Steve Warren (U. Minnesota, Supervisor: E. Skillman) will receive $29,000 for work related to the VLA Large proposal AO215 "VLA and HST: Star Formation History and ISM Feedback in Nearby Galaxies."

Complete information on the Student Observing Support program is available on the NRAO web page http://wiki.gb.nrao.edu/bin/view/Observing/NRAOStudentSupportProgram.

TELESCOPE USAGE

The NRAO telescopes were scheduled for research and for maintenance during the second quarter of 2008 as described in the table below. 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 hours of array time lost, while losing one out of ten VLBA antennas for one hour counts as 0.1 hours of array time lost. Antennas being modified for the EVLA and therefore not available for astronomical observations are counted as lost for observing.

We now schedule approximately 40% of the VLA time dynamically, prototyping our dynamic scheduling process for the EVLA. There are voids in this process creating unscheduled periods because we do not always have programs of the right length in the right range of sidereal times to fill in the gaps in the schedule. This is particularly true during the 6–8 weeks each year when antennas are being moved because the mixed VLA configurations are not useful for the majority of our astronomical observations. In addition, EVLA testing and commissioning now takes priority for dynamic time, especially at short notice. The EVLA testing sometimes fills part of a dynamic scheduling slot in such a way that there is no corresponding astronomical observation available to fill the rest of the slot.

There are three primary factors that create unscheduled periods for the VLBA.

(1) Both dynamically scheduled and fixed-schedule VLBA projects are typically 10–16 hours in length; with only 10 antennas, the VLBA cannot effectively take snapshots. The lack of scientifically compelling proposals that last for only 2–4 hours means that gaps of this length usually cannot be filled by dynamically scheduled programs, so the VLBA is idle for such periods.

(2) The VLBA observing rate is limited by the disk module supply, which is sufficient only for a 128 Mbps sustained recording rate with a module turnaround time of about 30 days. Because the best science typically requires more sensitivity, as many as 70% of the VLBA proposals now request 256 Mbps or 512 Mbps data rates; these proposals can be accommodated (and the correlator can keep up!) only if we leave gaps in the schedule.

(3) We have at least three scheduled 1–2 week maintenance visits per year to a VLBA station. There are significant gaps in the schedule during those periods because most programs require at least nine working antennas to have effective imaging capability. We have neither the personnel nor the hardware available to visit multiple antennas during the same week.

Telescope Usage (hours)			
Activity	**VLA**	**VLBA**	**GBT**
Scheduled Observing	1585.15	1042.00	1816.00
Scheduled Maintenance and Equipment Changes	223.00	229.15	293.00
Scheduled Tests and Calibrations	375.85	324.25	75.00
Time Lost	204.33	43.80	68.00
Unscheduled	117.75	588.60	—
Actual Observing	1380.82	998.20	1748.00

PROJECTS

EXPANDED VERY LARGE ARRAY (EVLA)

EVLA highlights include:

- Sixteen antennas have been retrofitted to the EVLA design and account for 55.2% of all antenna hours in scientific observations.
- A prototype of the WIDAR correlator and the first set of racks for the full WIDAR correlator were installed at the VLA site.
- The fiberglass lamination of all 28 L-band feed horns was completed.
- The first Ka-band receiver was installed on an EVLA antenna.
- The S-band orthomode transducer was shown to meet project specifications.

EVLA Milestones

Milestones	Original Date	Revised Date	Date Completed
1. C-band OMT: broadband test in receiver	08/31/06	04/04/08	04/11/08
2. Calibration Data Model, v 1.00 published	12/31/07	04/14/08	04/14/08
3. L-band receiver OMT design completed	04/15/08		04/15/08
4. Complete hardware acceptance tests on antenna 5	04/10/08		04/18/08
5. Complete production design of C-band OMT	03/14/08	04/11/08	04/18/08
6. Antenna 5 turnover to Operations	04/11/08		04/21/08
7. Shut down MODCOMPS	04/21/08		04/25/08
8. OPT outputs an EVLA observe script	10/25/06	03/13/08	05/05/08
9. Begin production of C-band OMT	02/28/07	05/01/08	05/08/08
10. EVLA correlator VCI document drafted	05/15/08		05/15/08
11. Start EVLA conversion of antenna 3	05/15/08		05/15/08
12. 1st production Ka-band receiver installed	03/03/08	04/03/08	05/22/08
13. Install wideband C-band receiver on antenna	11/02/06	04/17/08	05/22/08
14. Correlator baseline board (production) signed off	05/28/08		05/28/08
15. Implement correlator-room cleanliness procedures	05/29/08		05/29/08
16. Delivery of correlator racks from Penticton	03/18/08	05/15/08	06/02/08
17. Start correlator rack and cable installation at VLA site	05/30/08		06/04/08
18. 4-station-board correlator rack delivered to VLA site	06/09/08		06/04/08
19. T301 solar attenuators tested on one antenna	02/29/08	04/17/08	06/12/08
20. Ku-band feed horn pattern measurements completed	06/13/08		06/13/08
21. Complete hardware acceptance tests on antenna 2	06/10/08		06/19/08

PROJECTS

1. Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
22. Circuit-board design review for new DDS	06/16/08		06/19/08
23. Antenna 2 turnover to Operations	06/11/08		06/20/08
24. 2-station-board correlator installed	06/09/08		06/30/08
25. Start on-the-sky testing w/ 2-station prototype correlator	07/02/08	07/07/08	
26. Successful conversion of SDM+BDF to FITS	07/07/08		
27. First article 3-bit sampler chip on-board test completed	06/30/08	07/10/08	
28. OPT readiness review for Ka band	07/14/08		
29. Start EVLA conversion of antenna 28	07/15/08		
30. Second Ka-band receiver ready to install	07/15/08		
31. Circuit board design & prototype for new DDS completed	07/15/08		
32. 4-station board correlator installed	07/15/08		
33. S-band receiver OMT tests completed	05/13/08	07/21/08	
34. Begin lab tests of 3-bit sampler in DTS module	07/28/08		
35. All 16 WIDAR correlator racks delivered	07/30/08		
36. L-band receiver OMT tests completed	11/15/07	07/31/08	
37. Complete hardware acceptance tests on antenna 3	08/04/08		
38. Antenna 3 turnover to Operations	08/08/08		
39. Science Data Model, v 1.00 published	12/31/07	08/08/08	
40. WIDAR correlator room fire-suppression system activated	08/11/08		
41. 10-station correlator boards delivered	08/15/08		
42. Assemble four DTS modules with 3-bit samplers	08/18/08		
43. Correlator racks & cable installation completed	08/29/08		
44. Stringent cleaning of new correlator room completed	09/03/08		
45. Correlator room access control implemented	12/05/07	09/09/08	
46. Final training & correlator room access control implemented	09/09/08		
47. On-the-sky testing of 4-station prototype correlator completed	09/23/08		
48. Start limited observing w/ 10-station board correlator	09/23/08		
49. Design waveguide-style X-band receiver	01/15/08	10/08/08	
50. WIDAR correlator CDR	06/10/08	10/21/08	
51. Science Support System software PDR	11/13/07	11/14/08	

1. Expanded Very Large Array

EVLA Management

The AUI Visiting Committee met on April 8–9, 2008. The committee was impressed with the steady progress of bringing the EVLA to completion and noted that nearly all recommendations from its previous report had been addressed. One of the more project-specific recommendations listed in the committee's report this year is to find and assign resources to the integrated schedule that ties together the software and hardware deliverables for the commissioning and early operations of the telescope. The schedule was developed in advance of the Visiting Committee meeting.

On June 2 the EVLA change control board approved a request to supplement the front-end portion of the project's work breakdown structure (WBS) with additional funds to support the production of machined components for EVLA receivers. The original budget for the work in this part of the WBS, in particular for outsourcing to commercial fabricators, was underestimated. The request included hiring a machinist for the VLA machine shop. The machine-shop work was the most significant technical risk to the project, as noted on the project's risk register. The request totaled $400K, and its approval retired over $700K in estimated risk to the project.

The remaining project contingency funds are estimated at $3.04M, or about 18.2% of the cost to complete the project. The estimate includes the supplement mentioned above. The percentage contingency remains at historically high levels. The semiannual update of the WBS cost data sheets and risk register for the EVLA project is underway. The contingency will be re-estimated when the updates are complete.

Systems Integration

The electronics outfitting of the 16th EVLA antenna was completed. All 16 antennas are used in routine observations. In June 2008 they accounted for 55.2% of all antenna hours in scientific observations.

We continued work on the unexplained change in the phase of the antenna signal with antenna elevation. Tests conducted earlier in the year confirmed that the problem is in the antenna portion of the LO/IF electronics. Recent tests have focused on the L300 Synthesizer Reference Generator, which produces each antenna's local oscillator signals. Phase-lock loops were added to the L300 module, one for each extracted comb line. In the laboratory this technique provided more stable 128 MHz and 512 MHz LO signals. However, field tests showed no improvement in the phase stability as the antenna was tilted.

An Analog Devices field-programmable gate array (FPGA) used in the direct digital synthesizer (DDS) for the L302 frequency synthesizers was found to dissipate too much heat, causing reliability problems with the DDS. To solve this problem, the FPGA was replaced with a lower-power Altera Cyclone device. The firmware for the new device is currently under development.

A review of the status of the module documentation determined that about 60% of the EVLA electronics modules have adequate documentation. The importance of documentation was restated, and an effort to complete the documentation by January 2009 was initiated.

Civil Construction

The civil-construction group assisted Electronics Division personnel with the installation of the equipment racks for the WIDAR correlator. The first set of eight racks has been installed. Electricians are in the process of installing the cable tray and 48 V power cables to these racks. The installation of tray and cables will be completed after the second set of racks is installed in early August.

1. Expanded Very Large Array

The civil construction WBS element of the EVLA project is basically complete. The only work remaining for civil construction is to install control and alarm wiring for the air-conditioning equipment in the shielded room and activate the FM200 gas cylinders in the fire-suppression system of the shielded room once correlator installation is complete.

Antennas

The mechanical overhaul of the 16th EVLA antenna was completed. The mechanical overhaul of the 17th antenna is nearly complete.

A major milestone in the EVLA program plan was to start the production of the S-band (2–4 GHz) feed horns. The horn production is well underway. The assembly and fiberglass lamination of the second S-band feed horn was completed. The horn was installed on antenna 3 after antenna pattern measurements on June 9 showed that it met design specifications. Lamination of the third S-band horn is underway. The remaining horns will be assembled at the rate of two every seven weeks. A second fixture for assembling the horns was built in the VLA welding shop. Fabrication of the aluminum rings for the S-band horns continues at the VLA site.

Antenna pattern measurements were made of the two prototype Ku-band (12–18 GHz) feed horns on June 10–13 at an antenna test range on the New Mexico Tech campus. The measurements showed that the horns meet design specifications.

The assembly and fiberglass lamination of all 28 L-band (1–2 GHz) feed horns are complete.

Front End

During the past quarter, the 16th EVLA antenna was outfitted with interim L-, C-, and X-band receivers as well as fully EVLA-compliant K-band and Q-band systems. The current status of each receiver band is summarized below.

L band: Bids have been solicited for the manufacture of the quad-ridge section of the L-band (1–2 GHz) orthomode transducer (OMT). Production of the OMT will proceed once laboratory tests show that it meets performance specifications.

S band: The second, and final, version of the S-band (2–4 GHz) OMT was fabricated and tested (Figure EVLA-1). Tests of the OMT show that it exceeds design specifications (Figure EVLA-2). The design of this OMT implemented the design philosophy and lessons learned from improvements to the C-band OMT.

C band: The first full-bandwidth C-band (4–8 GHz) OMT was installed in the receiver on antenna 2. The wideband receiver is performing well. The second wideband OMT will be installed in a fully EVLA-compliant receiver destined for antenna 3. Parts are in house to permit a high production rate for these receivers. The plan is to build and deploy one receiver a month.

X band: The design of a planar-style OMT for the X-band (8–12 GHz) receiver is nearly complete, and its Dewar assembly is being prepared to facilitate laboratory testing at Green Bank.

Ku band: The RF and mechanical designs of the Ku-band (12–18 GHz) receiver are complete. The OMT, phase shifter, and square-to-rectangular waveguide transition were scaled from the design of the K-band receiver. Full production of the Ku-band receivers will start in late 2009.

Ka band: The prototype Ka-band (26–40 GHz) receiver meets specifications and was installed on antenna 4 for test and checkout. The receiver is providing good performance parameters to date. Fringes were recorded with this receiver by tuning it to frequencies on the band edges that overlapped with K- and Q-band frequencies on other antennas in the array. Field and laboratory tests showed that local-oscillator power provided by the antenna is marginal for this receiver. An upgraded limiting LO amplifier will remedy this problem. It is on order and will be installed in all Ka-band receivers. The second Ka-band receiver will be installed on antenna 5 in July.

K band and Q band: The installation of EVLA-compliant K-band (18–22 GHz) and Q-band (40–50 GHz) receivers continues to keep pace with the antenna retrofitting schedule.

Local Oscillator (LO) and Intermediate Frequency (IF) Systems

Modules for the local oscillator (LO) and intermediate frequency (IF) systems of the EVLA are now being built on a slightly accelerated schedule to meet the goal of having all modules finished by the end of FY 2009. Some modules require retrofits for hardware upgrades and RFI considerations. The module retrofits will be made so as not to interrupt the antenna retrofitting schedule. Parts procurement for all LO/IF modules will be complete by the end of the 2008 calendar year.

The wideband upgrade of existing T304 baseband downconverter modules was started. Wideband filters, gain slope equalizers, and total power detectors will be installed in the T304 modules. Currently, the EVLA antennas in the array use the EVLA's narrowband (1 GHz) signal path. Exploiting the EVLA's wideband (2 GHz) signal path requires the WIDAR correlator. The wideband upgrade also requires the installation of an additional set of frequency synthesizers. These modules are currently being built, and their installation will begin later this year after the firmware for the new DDS is complete.

An attempt was made to accelerate the production of the L352 round-trip module so that L352 capability can be provided to the retrofitted antennas now in use. However, the production was delayed by a phase-wrap error discovered in the module. Potential solutions to this small error are being explored.

Some LO/IF modules have not met phase-stability requirements because of thermal effects in the modules. The phase stability of these modules is being improved by adding thermal mass to them and by replacing existing module cables with cables that are less sensitive to temperature variations. Investigations into module phase stability will continue in an attempt to identify any other problems, particularly in the course of testing the wideband signal path with the new correlator.

Fiber Optic System

Modules for the digital transmission system (DTS), formatter, and deformatter continue to be built to meet the antenna retrofitting schedule. The deformatters are actually being built ahead of the antenna retrofitting schedule to allow testing of the prototype WIDAR correlator. Engineering samples of the 3-bit, 4Gsps digitizer were received and are being tested in the laboratory. The assembly of the digitizer modules is planned to meet the testing of the WIDAR correlator once its installation is complete. All digitizer chips should be delivered from the vendor by October 2008. Retrofitting the DTS modules with the 4Gsps sampler will continue at the rate of one antenna per month.

1. Expanded Very Large Array

The fiber-optics group led the installation of the prototype correlator and the first set of eight equipment racks for the final correlator on June 5, 2008. Tests of the prototype will be conducted through September 2008. Data paths from the antennas are split between the prototype and VLA correlators so that test and scientific observations can be made with either correlator without re-cabling the signal path. The installation of cable trays and cables will be completed after the second set of correlator racks is installed in August. Limited observing with a 10-station correlator will begin in October. Access, cleanliness, and electrostatic-discharge procedures will be implemented in the correlator shielded room in early October.

Correlator

The first set of eight equipment racks for the WIDAR correlator was delivered in early June. The racks were bolted in place by NRAO staff. NRC/DRAO staff from Penticton arrived shortly thereafter to install half of the 500 high-speed data cables that connect all of the correlator boards. Each cable can support data rates of about 10 Gbps. All racks fit in place and the rack cabling proceeded smoothly, although the high density of cables in some racks demands care and time in the installation. The remaining racks are scheduled for delivery in late July, with installation and cabling complete by the end of August.

Testing of the station board was completed, and 14 pre-production boards were fabricated. These boards have been delivered and are undergoing tests in Penticton. Testing of and design changes to the baseline board were also completed. The manufacturing package for the baseline boards is currently undergoing design for manufacturing and test analysis. Bids have been solicited for pre-production boards, and six of these are scheduled for delivery in early October. If tests of these pre-production units proceed satisfactorily, eight more units will be fabricated and then delivered about a month later.

The test rack for the prototype correlator (PTC) was also installed in early June. Later in the month, two prototype station boards and one prototype baseline board were installed in the PTC rack by NRAO staff. A “first fringes” test observation on a single baseline will be made once tests with test vectors are complete. These tests help to ensure that the correlator is actually working as a correlator with all the necessary functions in place. NRC/DRAO personnel are making frequent long-term visits to Socorro over the summer to assist with testing and troubleshooting.

Significant development and testing of correlator software occurred over the quarter. Prototype hardware has been used for generating data to test and exercise the correlator backend code and to identify bugs in graphical user interfaces and the real-time control system. A protocol specification document for the Virtual Correlator Interface (VCI) was rewritten in preparation for a semi-formal review in early July. The protocol is the foundation for continued and final development of the correlator mapping software and EVLA control software. This software will enable the correlator's many operational features.

Monitor and Control (M&C)

Weekly meetings of the M&C group were held to coordinate activities in preparation for on-the-sky testing of the PTC. They covered a variety of issues including hardware and network needs, data flow through the system and database needs, and between software subsystems. Especially important is the transmission of the delay model from the Executor to the lowest levels of the correlator. Testing of this dataflow is ongoing. A meeting with users of the monitor database was held to gain insight into some of the problems in using the current system and on how different individuals actually use data retrieved from the database. A list of possible enhancements to the monitor database system is in preparation.

1. Expanded Very Large Array

Work continued on the WIDAR M&C system, especially to prepare for on-the-sky testing of the PTC. A special set of end-to-end hardware/software vector tests were conducted on the two-station boards and one-baseline board of the PTC prior to shipment to Socorro. These boards were received and installed at the VLA and testing continues. Problems with the proper receipt and propagation of timing pulses were found and are being investigated. They do not affect the vector tests but do impact on-the-sky testing.

A preliminary version of the Science Data Model (SDM) has been incorporated into the data capture and format (DCAF) module of the M&C system. This module captures science metadata as observing scripts are executed, reformats them, and stores them in a set of tables that is the SDM. These data are then written to a staging area where they are ingested into the next generation archiving system (NGAS) together with binary data from the correlator. At the present time, this is a preliminary system intended for on-the-sky testing of the PTC. However, it is now routinely being run on metadata from VLA observations. This SDM is currently being used by ALMA at the ALMA Test Facility (ATF). A compatible version of the Binary Data Format (BDF) is also supported and has been tested with simulated data from the correlator subsystem. This combination of the SDM metadata and binary data has been successfully loaded into CASA using the same software filler that is being used by ALMA at the ATF. In preparation for on-the-sky testing of the PTC, a new NGAS server has been installed at the VLA. This is a smaller archive system that is intended as a staging area for science datasets. The final version of the document defining the general SDM that has been in preparation by ALMA has been delivered to the EVLA and is currently under careful review. The EVLA project has prepared extensive comments on this document and further discussions are continuing with the active participation of the EVLA. The BDF, which is a subset of this general document, was crafted and agreed to by the correlator groups from both ALMA and EVLA.

Allen Farris joined the EVLA project as supervisor of the M&C group.

Science Support Systems (SSS)

Most of the effort of the SSS group was devoted to the web-based Observation Preparation Tool (OPT). The OPT needs to be able to support observatory staff in the configuration and testing of the ten-station prototype WIDAR correlator beginning in October. A decision will also be made in the middle of July on whether or not to use the OPT to support Ka-band observing with the current VLA correlator.

The OPT consists of three main components: one for configuring instrumentation, one for maintaining catalogs of target sources and calibrators, and one for putting together actual observing programs. NRAO staff scientists have been testing each of these components for the past few months. The instrument configuration component is ready for use with EVLA antennas and the VLA correlator. The source catalog component is also ready for use, though we do anticipate adding a number of features in the near future. More testing is required on the observation setup component before it is ready for use.

Some of the more visible changes made to the OPT are:

- The source catalog component includes two new catalogs: the SMA and ATCA catalogs.
- Users are able to create HTML links in the details section of their sources.
- The VLBA image links now point to GIF images, which are more convenient for display in a browser than the format previously used.
- The VLA catalog now preserves the calibrator quality table present in the text version.
- All three components now have much more validation of user input than they had previously.

A new version (1.7.5) of JObserve was released to help users with newer operating systems.

1. Expanded Very Large Array

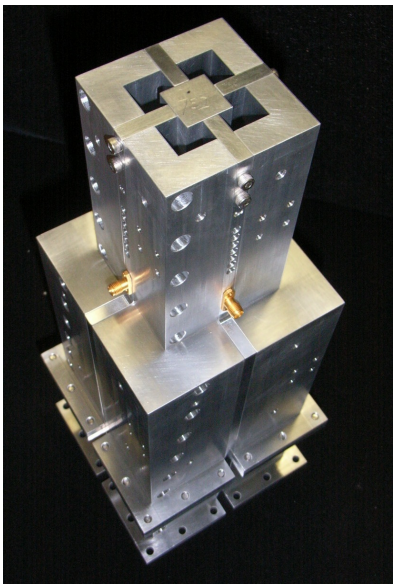

Figure 1. Fully assembled S-band OMT.

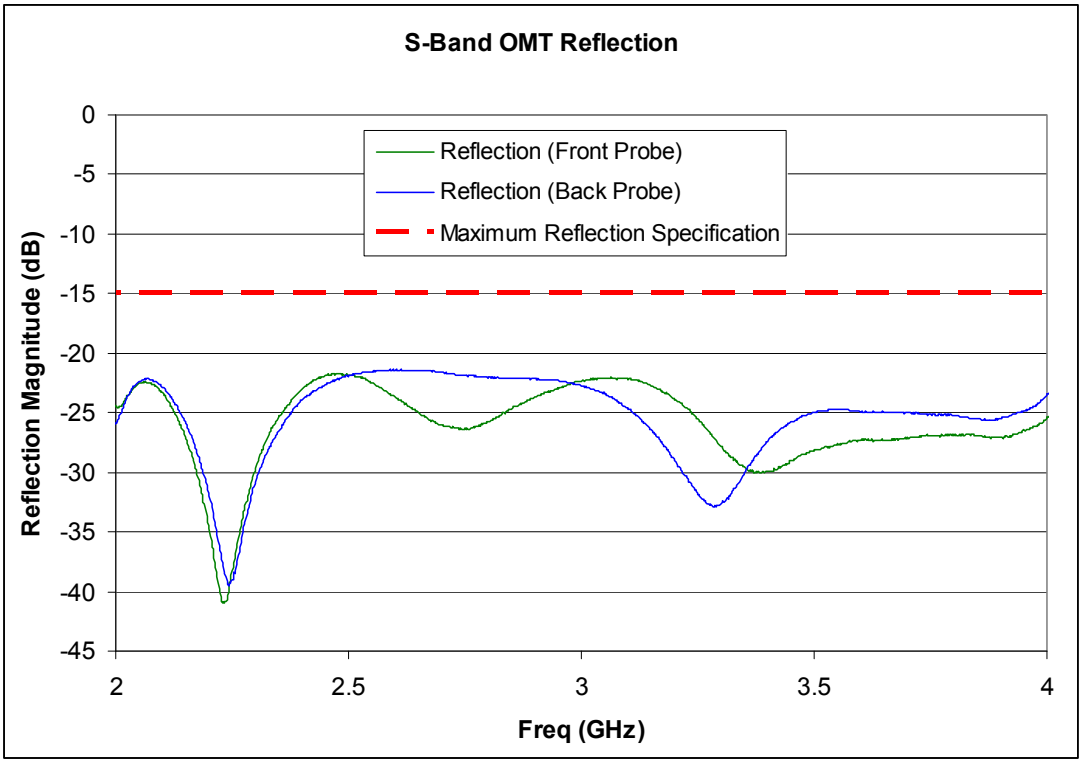

Figure 2. Test results from the S-band OMT show reflection performance exceeding specification by over 5 dB across the receiver band.

NEW INITIATIVES

Square Kilometer Array (SKA)

The first meeting of the newly formed SKA Science and Engineering Committee (SSEC) took place in Perth, Australia in April. This meeting was held in conjunction with a scientific conference on SKA Pathfinders and other events such as the SKA Forum, meetings of various SKA working groups, and a meeting of the informal Funding Agencies Working Group for the SKA.

The U.S. SKA Consortium met near Washington, DC in May. Elections were held for various offices in the U.S. SKA Consortium, and two NRAO representatives were among the seven individuals elected to represent the U.S. on the SSEC. One of these two also began a term as chair of the SSEC. The primary topic of the U.S. Consortium meeting was discussion of the Consortium approach to the upcoming U.S. decadal survey. Current plans as envisioned by the U.S. SKA decadal-survey working group were presented and discussed. As expected, two key issues are (1) the disconnect between the timeline being carried by the international SKA Program Development Office and that which the U.S. Consortium believes is achievable, and (2) the de-scope of the SKA specifications that has made some of the most marketable science goals unachievable. These and other issues continue under discussion as the actual formation of the decadal survey committee have been delayed.

VLBI Space Observatory Programme-2 (VSOP-2)

The first meeting of the VSOP-2 International Science Council (VISC-2) was held in May, in conjunction with a European meeting on VSOP-2 key science. VISC-2 has two NRAO members, one representing NRAO interests and one as the chair of the Global VLBI Working Group. A structure and charter were adopted for the VISC-2, and officers were elected. Discussions of scientific policies and the role of international partners were held (see next paragraph for discussion of the NRAO role.)

The NASA Mission of Opportunity proposal submitted in January was not selected. This proposal was for a U.S.-led key science program associated with the VSOP-2 spacecraft, which is scheduled for launch in 2012. The review panel found only strengths in the science part of the proposal and only minor weaknesses in the Technical, Management, and Cost portion; thus it was rated as a "Category I" proposal, the highest category eligible for funding. Unfortunately, the Selection Committee chose other proposals instead. The proposal requested funding for VLBA participation in VSOP-2, both for mission preparation and for operations of the telescope and correlator. Since the NASA proposal was rejected, the NRAO will be unable to participate in VSOP-2 without an additional source of outside funding.

External Partnerships

The final report on the VLBA 22 GHz sensitivity upgrade funded by the Max Planck Institut für Radioastronomie was completed and submitted to the MPIfR.

The GLAST (Gamma-ray Large Area Space Telescope) was launched in early June. We expect the first NRAO observing time allocated in a joint NRAO-GLAST program to be used during the third quarter.

The VLBA successfully observed the Phoenix spacecraft en route to Mars on nine occasions in May, determining the position of the spacecraft relative to background quasars and to multiple Mars-orbiting spacecraft. Position accuracy was derived as a function of the separation between Phoenix and the reference source, with a best accuracy of under 25 microarcsec when Phoenix and a Mars orbiter were in

the same antenna beam just before Phoenix reached Mars in late May. We hope to improve the accuracy by a factor of 2–3 with a better understanding of systematic errors. The 25 microarcsec accuracy corresponds to about 30 meters at a Mars distance of 1.9 Astronomical Units. Preliminary results were presented to the head of the NASA Planetary Science Division at a meeting in late June.

Frequency Agile Solar Radiotelescope (FASR)

The final teaming agreement was signed by the various FASR university and institutional partners, and a proposal requesting $25M in funds for FASR construction was submitted to the National Science Foundation Mid-Size Infrastructure Opportunity in June 2008. If the proposal is successful, first funding is expected as early as the first quarter of FY 2009. FASR design and development activities continue under a separate NSF award. These activities include designing and prototyping analog subsystems—including the ultra-broadband feed and first-stage amplifier—and designing and prototyping the station-based digital filter bank. These activities will enable the rapid deployment of prototype FASR stations by mid-2009 for evaluation and testing.

New Initiatives Office Milestones

Milestones	Original Date	Revised Date	Date Completed
1. FASR teaming agreement signed by partners	04/01/08		04/01/08
2. SKA Science and Engineering Committee meeting	04/08/08		04/08/08
3. First meeting of VSOP-2 International Steering group	05/13/08		05/13/08
4. U.S. SKA Consortium meeting and elections	05/22/08		05/22/08
5. Complete VLBA observations of Phoenix	05/26/08		05/26/08
6. FASR proposal submitted to MSI Opportunity	06/01/08		06/02/08
7. Phase A downselection for VSOP-2 MoO proposal	09/15/08		06/23/08
8. First NRAO observing in NRAO/GLAST program	08/15/08		
9. Draft “Return on Investment”—NASA use of VLBA	08/31/08		
10. Submit final report on VLBA Phoenix results	10/15/08		
11. U.S. SKA Consortium meeting	11/30/08		

OPERATIONS

GREEN BANK OPERATIONS

Green Bank Operations highlights for this quarter include:

- Successful launch of the Green Bank Telescope (GBT) Dynamic Scheduling beta test.
- Shared-risk call for MUSTANG proposals yielding six proposals.
- Completed acceptance testing of the GBT PLC antenna controllers.
- Successful test of applied thermal Zernike coefficients to shape the active surface of the GBT.
- Correction of long-standing GBT active-surface actuator error.
- Measured magnitude and direction of the local deflection of gravity at Green Bank, validating the GBT pointing model and re-confirming the azimuth-track refurbishment accuracy.
- Mars Phoenix Lander entry, descent, and landing phases successfully tracked by the GBT.
- Long-term funding and agreement for Green Bank Solar Radio Burst Spectrometer.

The first schedule from the GBT's prototype Dynamic Scheduling System (DSS) was created June 1. The scheduling process went extremely smoothly. The total time from initial release of the system to publication of the schedule was less than 1.5 hours. GBT telescope schedules are built daily and weather checks of the schedule are made throughout the day. The GBT will be scheduled using the DSS for the 08B trimester (June 1–Sept 30), after which the telescope will revert to its previous scheduling system until the full release of the DSS (currently planned for summer 2009). User feedback from the beta test will allow the DSS team to ensure that the system, especially its user interface, is simple to use.

The goal of the DSS is to maximize observing efficiency while ensuring that none of the flexibility and ease-of-use of the GBT is harmed and the data quality is not adversely affected. The DSS provides all observers at least 24 hours notice of their upcoming observing. In the uncommon event that the observing weather is significantly worse than predicted, a backup project in the database will be run instead. Details of the DSS and access to the system are available on-line at http://www.gb.nrao.edu/dss

The MUSTANG 90 GHz bolometer array, a collaborative effort of the NRAO, the University of Pennsylvania, NASA, and NIST, was taken off the GBT and transported to the University of Pennsylvania for planned enhancements that might include a new, more sensitive, array. Data obtained over the winter are being analyzed to characterize the performance of MUSTANG and of the GBT, with work continuing to filter pulse-tube noise from the data and refine the data-analysis algorithms. Cryogenic M&C capabilities have been added, and the user interfaces are being prepared for the high-frequency observing season. With policies and procedures for shared-risk observing in place, a call for proposals was issued for scientists to use MUSTANG during the 2008/2009 winter observing season. Six proposals requesting a total of 179 observing hours were received.

The Precision Telescope Control System (PTCS) group continued working on the GBT surface and servo control system. A series of observations yielded extremely encouraging results reaffirming that the combination of Out of Focus (OOF) and traditional holography can accurately and repeatably characterize the active antenna surface. We found and corrected a bookkeeping error in the original photogrammetry measurements that prevented the central column of 45 actuators from being loaded into the actuator offset table. An initial, staff-operable deployment of OOF that acquires a set of OOF holography maps, launches an analysis, and allows the resulting Zernike terms (the so-called "thermal" terms) to be quickly applied as an offset to the gravitational model was successful and reinforces its viability as a user tool allowing

observers to do active-surface corrections quickly over the course of an observing session. Work continues on using MUSTANG to make OOF maps for faster surface corrections. The pointing team determined that the discrepancy between the small global tilt of the new track (only a fraction of an arcsec) and the 4 arcsec tilt in the radio pointing data agrees in magnitude and direction with the local deflection of gravity at Green Bank. This result confirms the accuracy of the refurbished azimuth track.

The final portion of the PLC Interlock project was completed and accepted. Prototype Laser Range Finder (LRF) electronics testing was completed and specifications were established for measuring ranges with about 10 μm accuracy. Excessive coupling loss of light from the retro reflector with single-mode fiber and sensitivity of multimode fiber to movement led us to design of an optical system with a larger receive lens and free-space PIN-diode photodetector. Fabrication of the revised prototype is underway. LRF work has been placed on a lower priority since ongoing excellent results favor holography for surface measurement. The servo-oscillation problem was identified, and corrective hardware filters have been designed and turned over to the Electronics Division for fabrication. Small teams are moving in a parallel effort on servo-system modeling, servo hardware design, and control software design, including developing a comprehensive test bed. Improved sampling capabilities of the various encoders and samplers on the GBT were implemented to collect more detailed data for structural modeling, simulations, and meeting the stringent requirements for pointing and tracking at higher frequencies.

K-band Focal Plane Array (KFPA) efforts were directed toward designing and fabricating components for the Dewar, integrated downconverter, LO module, M&C module, and the noise-calibration module. The test Dewar was constructed along with the phase shifters, 45 degree twist, and circular-to-square transitions. A sliding waveguide prototype was constructed, three OMT's were built, and a device for reducing the heat load employing a thermal transition was modeled and constructed. All electromagnetic components necessary for August testing of a single pixel are now complete and being individually tested. All components external to the Dewar are also on schedule for August testing. The kick-off meeting for the associated data pipeline software established a set of basic observing modes for the instrument and started discussions between the NRAO and the University of Calgary regarding collaboration on the KFPA data pipeline. This pipeline will leverage knowledge from two existing multi-pixel receiver pipelines—the pipeline in place at the JCMT and the GALFACTS pipeline for ALFA.

Configurable Instrument Collection for Agile Data Acquisition (CICADA) work concentrated on development of the Green Bank Ultimate Pulsar Processing Instrument (GUPPI). Work continued on the first version of the machine, in spite of challenging timing problems in the synchronization of the various discrete boards in the system. Control and data-acquisition software has been written for the machine and is being used to collect test data. A paper on this work was presented at the SPIE Astronomical Telescopes conference held this summer. The instrument has been used to collect pulsar data on both the GBT and the 43m telescope. Release for expert-user first science should occur in the next quarter.

NASA contacted the NRAO with a request to use the GBT to track the entry, descent, and landing of the Mars Phoenix Lander. The sensitivity and mobility of the GBT made it the ideal candidate to receive the signal from the Lander during this critical phase, and the GBT provided confirmation on the spacecraft's health until communications could be established via the Mars orbiters. During the March 13 Operational Readiness Test for this project, a strong interfering signal was detected that would obliterate the Lander's signal for most of the critical phase. By observing the Doppler shift of the interfering signal, the Green Bank interference protection group determined that Low Earth Orbiting satellites were the cause. Through an exhaustive effort utilizing their industry contacts and additional measurements, often at odd hours, the group located the interfering sources and the managing parties and was able to coordinate the interference, clearing the way for the GBT to detect the first indications of a successful Mars landing.

OPERATIONS

1. Green Bank Operations

While the GBT's role in successfully tracking the Mars Phoenix Lander received the most public attention, outside-funded activities continue to expand. In addition to the MIT/Lincoln Labs' spacecraft tracking using the 43m telescope, the Solar Radio Burst Spectrometer (SRBS) project on the 45 foot telescope was funded and extended through FY 2012, and plans are underway to add a magnetometer at Green Bank for UCLA/IGPP's MEASURE (Magnetometers along the Eastern Atlantic Seaboard for Undergraduate Research and Education), a network of sensors operating throughout the southeastern U.S.

GBT Site Milestones for FY 2008

Milestones	Original Date	Revised Date	Date Completed
Dynamic Scheduling System[1]			
1. Stage II tests begin	08/15/07	06/01/08	06/01/08
2. Stage II tests complete	09/30/07	09/30/08	
3. Design Review	12/01/07	12/01/08	
4. Release Stage III software for general use	06/01/08	10/01/09	
CICADA[2]			
1. GUPPI Phase 1 (Spigot Replacement)	01/01/08	08/30/08	
2. GUPPI Phase 2 (Coherent Machine)	06/30/08	03/30/09	
3. GUPPI Phase 3 (Common User Machine)	06/30/08	08/30/09	
4. Design Study for Array Spectrometer	09/30/08		
K-BAND FOCAL PLANE ARRAY			
1. M&C hardware with support software complete	05/13/08	08/01/08	
2. Single-pixel construction complete	05/08/08	08/01/08	
3. Single-pixel tests complete, with CDR acceptance	08/08/08	11/01/08	
MUSTANG[3]			
1. MUSTANG open for shared-risk proposals (new)	10/01/08		
2. MUSTANG available as a GBT instrument (new)	10/01/08		
PTCS[4]			
1. PLC interlock system main servo complete	08/31/07	05/16/08	5/16/08
2. PLC interlock system complete	08/31/07	08/31/08	
3. Laser rangefinder V2 development complete	09/31/07	09/30/08	
4. Recommission the traditional holography receiver	04/01/08	09/01/08	
Zpectrometer[5]			
1. Science validation complete	06/01/08		06/01/08

Notes:

1. Dynamic-scheduling work was delayed by work on the high-frequency receivers.
2. CICADA (FPGA Development Project) is a University Collaboration with the University of Cincinnati and West Virginia University. Deployment delayed by ongoing timing problems within computer used for the Phase #1 Pulsar Machine. Work is not yet started on Phase #2.
3. MUSTANG (Penn Array Receiver) is a University Collaboration with the University of Pennsylvania.
4. Deployment of the traditional holography receiver was delayed by the discovery of thermal instability of the first LO that requires device replacement and re-testing. Laser-rangefinder work was reprioritized to reflect the expected capabilities of holography for surface characterization.
5. The Zpectrometer is a University Collaboration with Andy Harris at the University of Maryland.

NEW MEXICO OPERATIONS

New Mexico Operations Management highlights for this quarter include:

- In January, NM Operations management was alerted to a proposal made to the State of New Mexico to construct a high voltage power line across the East and West arms of the VLA. A letter objecting to the proposed route was submitted to the State Land Office (SLO) Commissioner. The NSF was also notified, and contact was made with management of the power-line development company. Bob Dickman met in early April with the Vice President of the power-line development company and later that month met with the New Mexico SLO Commissioner. These meetings provided an opportunity to describe the extremely negative impacts that the proposed power line would have on VLA operations, to emphasize the scientific heritage of the VLA, and to specifically describe the broad array of Federal and State stakeholders in the array. It now appears that the SLO and the power-line developer are seriously considering alternative routes, with the SLO currently favoring a path for the power line that would not interfere with array operations.
- The VLA/VLBA Proposal Scheduling Committee (Chaired by Prof. Alex Brown, University of Colorado) met in Socorro April 3–5, 2008.
- The NRAO Visiting Committee met in Socorro on April 8–9.
- The NRAO Array Operations Center (AOC) on the New Mexico Tech campus was rededicated on May 30, 2008. At a ceremony attended by the Senator and other dignitaries, the AOC was renamed the Pete V. Domenici Science Operations Center. The rededication recognized the Senator's critical support for NRAO's radio astronomical mission in New Mexico, which has spanned more than three decades.
- The 11th NRAO Synthesis Imaging School was held in Socorro from June 10 through June 17. Nearly 150 students and scientists attended the school on the New Mexico Tech campus.
- The NSF and its contractor, LMI, conducted a review of New Mexico Operations business and administrative costs from June 23 through June 25.

VLA highlights for this quarter include:

- Array reconfigurations from C to DnC and from DnC to D were completed on or ahead of schedule, on May 29 and June 24, respectively.
- Sixteen VLA antennas have now been retrofitted to EVLA specifications and account for 55.2% of all antenna hours in scientific observations.
- The prototype WIDAR correlator was installed at the VLA site, and "on-the-sky" tests of the hardware have begun.

VLBA highlights for this quarter include:

- The VLBA successfully demonstrated its capabilities for precision spacecraft tracking when it followed NASA's Phoenix spacecraft during landing insertion for its May 25, 2008 touchdown in the North Polar Region of Mars. The demonstration is ultimately aimed at promoting a partnership between the NASA Deep Space Network and the NRAO (through the New Initiatives Office) in order to satisfy the recommendations for the VLBA made by the NSF Senior Review.

New Mexico Operations Management and Scientific Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Proposal Scheduling Committee meeting	04/03/08		04/05/08
2. Return EVLA antenna 5 to array	04/11/08		04/21/08
3. VLBA tracks Phoenix landing on Mars	05/26/08		05/26/08
4. Complete reconfiguration to DnC array	06/06/08		05/29/08
5. VLA/VLBA proposal deadline	06/01/08		06/01/08
6. 4-station board correlator delivered to VLA site	06/09/08		06/04/08
7. Return EVLA antenna 2 to array	06/11/08		06/20/08
8. Complete reconfiguration to C array	06/27/08		06/24/08
9. Proposal Scheduling Committee meeting begins	08/11/08		
10. Antenna 3 turnover to operations	08/08/08		
11. Proposal deadline	10/01/08		
12. Complete reconfiguration move from D to A	10/03/08		
13. Antenna 28 turnover to operations	10/08/08		

Computer Infrastructure Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Complete EVLA correlator network design	01/31/08	04/30/08	04/11/08
2. Bring up EVLA antenna-2 network	05/15/08		05/15/08
3. Establish network tunnel to DRAO	08/31/06		06/18/08
4. Install 4-station correlator computers and network.	05/30/08		06/25/08
5. Bring up EVLA antenna-3 network	07/15/08		
6. Assist with ETK rollout	07/20/08		
7. Assist with Data Security Plan rollout	07/30/08		
8. Bring up EVLA antenna-28 network	10/15/08		
9. Establish EVLA/AOC fiber plan	11/30/07	09/30/08	
10. Install EVLA correlator network	10/30/08	08/31/08	
11. Redhat EL5 upgrade	10/30/08		

Notes:
1. Final draft is done. Design changes will be made as we gain experience with the test correlator.
4. Delayed by correlator delivery schedule.
11. Upgrades will progress from present through October.

Electronics Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Install a new IF cable wrap at SC-VLBA	04/15/08		04/15/08
2. Build a VLBA software correlator computer cluster using dual-quad processors installed in commercial stand-alone computers.	04/21/08		04/21/08
3. Scheduled Maintenance Visit at NL-VLBA	05/30/08		05/07/08
4. Design and install an EVLA-compatible API	07/30/08		
5. Complete a VLA prototype ACU system design	08/01/08		
6. Scheduled Maintenance Visit at OV-VLBA	05/15/08	08/25/08	
7. Install an EVLA compatible API at the VLA	08/27/08		
8. Install the FRM brake power supply and new interface board for testing in a single VLA antenna.	09/19/08		
9. Delivery of the Mark5C recorders	06/25/08	09/23/08	
10. Install Mark5 pressure enclosure at MK-VLBA	05/09/08	09/30/08	
11. Develop a Digital Back End (DBE) for the VLBA	03/15/08	10/23/08	
12. Scheduled Maintenance Visit at SC-VLBA	11/20/08		
13. Perform development testing of the DBE1 and the MARK VB+ at six VLBA sites	11/21/08		Canceled

Notes:
6. The Tiger team visit is now scheduled for August 18–25, 2008.
9. Conduant Inc. delivered the three Mark5C chassis in June. The 10GE daughter cards will be delivered in September.
10. This is a low-priority task and will be completed as time permits.
11. Revisions to the Berkeley ROACH computer card delayed board manufacturing. Version 1 hardware was tested in June. Version 2 hardware will be delivered in August for testing. Complete DBE testing will start in September when the Mark5C recorders are 100% functional.

Engineering Services Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Repair Pie Town broken AZ #2 axle	06/06/08		06/06/08
2. Complete DnC array reconfiguration	06/06/08		05/29/08
3. Complete D array reconfiguration	06/27/08		06/24/08
4. Antenna 28 AZ bearing replacement	08/12/08		
5. Complete A array reconfiguration	10/03/08		
6. St. Croix Visit: subreflector, paint, EL brg., AZ wheel assy. replacement, general mech. maint.	10/30/08		
7. St. Croix Antenna Painting	12/15/07	10/30/08	
8. Replace 4,000 Ties	11/30/08		

Notes:
7. Antenna painting is 99% complete; the area inside the truss structure just below the dish needs its final topcoat. Painting will be completed during the Major Mechanical Maintenance Visit in the fall.

NORTH AMERICAN ALMA SCIENCE CENTER (NAASC)

NAASC highlights for the quarter include:

- NAASC Assistant Director hired.
- Extensive testing of CASA in preparation for beta release, patch 2.
- Scripts were written and CASA tutorials were given to ~50 participants of the NRAO Synthesis Summer School in June.
- The science program for the third NAASC Science Workshop "Transformational Science with ALMA: The Birth and Feedback of Massive Stars, within and Beyond the Galaxy" was set. The workshop will be September 25–27, 2008 in Charlottesville.
- The NSF approved a subaward request for the University of Virginia Microfabrication Laboratory (headed by Dr. Arthur Lichtenburger) to manufacture and supply replacement SIS mixer chips for ALMA.

Staffing remains a high priority for North American ALMA operations. Dr. Carol J. Lonsdale will replace Chris Carilli as Assistant Director for the North American ALMA Science Center (NAASC) effective October 1, 2008. Dr. Lonsdale brings a strong background of project leadership from more than 20 years at IPAC, where she has led various teams, including science user support, user software development, archive development and proposal reviews, and also headed the Science Staff for many years. She served as Science Operations Manager for the NASA Wide-area Infrared Explorer (WIRE) and was the principal investigator for the Spitzer Legacy project SWIRE, a wide-field extragalactic survey that produced a catalog containing data from over one million galaxies. She is a member of the science team of NASA's Midex mission WISE, the Wide-Field Infrared Survey Explorer, set to launch in late 2009. In other staffing news, a scientist to serve as the second commissioning liaison is still being recruited.

NAASC support and testing of ALMA offline software continued, coordinated by ALMA CASA Subsystem Scientist Crystal Brogan. The major activities during this quarter were (1) testing and preparing for the Beta Patch 2 release (scheduled for the beginning of next quarter) and (2) developing scripts and organizing the CASA tutorials at the NRAO Synthesis Imaging Summer School in Socorro in June. At the workshop ~50 participants took part in CASA tutorials on data types ranging from VLA HI spectral line, VLA continuum polarization, and BIMA millimeter CO line. This quarter saw significant improvements to the CASA ALMA Simulator *almasimos,* in preparation for Patch 2 (work overseen by Remy Indebetouw). Patch 2 will be the first fully open release of the CASA software. Brogan also took part in meetings to set development targets for Patch 3 of the Beta release (scheduled for 2008Q4), and strategies for filling the Head of CASA Development position. In other ALMA software areas, NAASC staff participated in User Test 5.0 of the ALMA Observing Tool.

The NAASC-developed spectral-line database *Splatalogue* (www.splatalogue.net) continues to be updated under the guidance of Anthony Remijan. This quarter, the ability to search on multiple species simultaneously was implemented, and a new fit to and improved spectroscopic data for acetic acid (CH_3COOH) and transitions of methyl mercaptan (CH_3SH) and new data from methylamine (CH_3NH_2) were added.

The NA ARC Manager traveled to Santiago in May for a meeting of the Science Operations Working Group and to work with recent JAO hires (budget manager and head of technical services) to understand the reasoning, justification, and methodologies behind the ALMA operations plan and to work towards

developing the 2009 Chilean operations plan and budget. In June the ARC Manager traveled to ESO to discuss archive operations, helpdesk workflow, and user support with ESO and EU ARC staff.

The NAASC staff continues to provide support at the ALMA Test Facility (ATF) in Socorro. This activity involves prototype antenna and software testing and debugging, to gain familiarity with the system and train for eventual work in Chile and at the NAASC, and testing the functionality of CASA to import and analyze real ALMA data. Since ATF operations have been extended until at least September, this support will continue into the next quarter.

The final science program for the 3rd NAASC Science Workshop *"Transformational Science with ALMA: The Birth and Feedback of Massive Stars Within and Beyond the Galaxy"* was posted and registration was opened. The response to the first announcement was so strong that the meeting venue was changed to accommodate ~130 participants (compared to ~85 that can be accommodated in the NAASC). The meeting will be held in Charlottesville on September 25–27, 2008.

In June the NSF approved a subaward request for the University of Virginia Microfabrication Laboratory (headed by Dr. Arthur Lichtenburger) to manufacture and supply replacement SIS mixer chips for ALMA. The subaward is for five years and is funded through the NAASC work element "ALMA Special Projects." An MOU between the NRAO and UVa is close to being signed, and the accompanying contractual structure between the parties is currently being solidified. Summaries of the work under this contract will appear in future ALMA operations quarterly and annual reports.

The Herzberg Institute of Astrophysics (HIA) sent a revised "Memorandum of Understanding" for Canadian participation in ALMA Operations, which was iterated with AUI/NRAO. The final version will be ready for signature in the next quarter.

The ALMA North American Scientific Advisory Committee (ANASAC) has been considering an interim charge on pre-ALMA scientific programs in North America. Planning has begun for the face-to-face meeting in September, and the NRAO has drafted charges that will be forwarded to the ANASAC in time for their July telecon.

Reporting continues to take up a considerable amount of time. Material and presentations were given to the NRAO Visiting Committee (April, in Socorro), the Users Committee (May, in Green Bank), and the AUI/Milkey Committee (Feb in Socorro, May in Charlottesville). A memo was written describing the effect of a Continuing Resolution on the NAASC in the coming fiscal year.

This quarter included the NRAO annual review cycle, with all NAASC staff completing self-appraisals for their work over the past year and setting goals for the coming year As part of this process, functional assignments for the coming year were made for all current NAASC staff, and plans were made to move two NRAO staff (in part or in whole) into the NAASC in the coming year: Todd Hunter, who is currently working in GB operations, and Harvey Liszt, who is working in Spectrum Management.

NAASC staff attended a number of meetings and gave science talks, including discussion of the potential for ALMA, at the Naval Research Lab (Carilli), the Harvard Sackler Cosmology symposium (Carilli), an ESO workshop on 3D Visualization (Hibbard), a CCAT workshop "Spectrometry with CCAT: Science and Instrumentation Opportunities" (Brogan), Peking University (Evans), and the "63rd International Symposium on Molecular Spectroscopy" (Remijan). Two NAASC staff (Brogan & Evans) participated in and gave talks at the Bilateral China-U.S. Workshop on Radio Astronomy held in Beijing. Carilli and Brogan gave lectures at the NRAO Synthesis Imaging Summer School in Socorro.

3. North American ALMA Science Center(NAASC)

NAASC Milestones April to June 2008

Milestones	Original Date	Revised Date	Date Completed
1. Two new hires for commissioning	12/30/07	02/08	1st: 3/30/08 2nd: pending
2. New MOU with Canada for ALMA operations	09/01/07	08/08	
3. Presentation to Visiting Committee meeting	04/09/08		04/09/08
4. NRAO Staff Retreat	04/10/08		04/10/08
5. Coordinate "Integrated NRAO Operations" vision with NM Ops, GB Ops, E2E, DO, and OSAA. Presentation to Milkey committee.	05/01/08		05/09/08
6. Presentation to Users Committee meeting	05/20/08		05/20/08
7. FY 2009 budget planning	05/08		06/14/08
8. NAASC Science Workshop III: science program	05/22/08		06/14/08
9. Set NAASC functional assignments for FY 2009	05/08		05/07/08
10. SciOps IPT face-to-face meeting in Santiago	05/15/08		05/15/08
11. Complete employee yearly evaluations	06/08		06/05/08
12. Recruit NAASC AD	07/08		05/29/08
13. Software testing: CASA, Pipeline, Simulator, Obstool (CASA beta patch 2)	Ongoing		05/08
14. Software testing: CASA, Pipeline, Simulator, Obstool (Simulator)	Ongoing		05/08
15. Software testing: CASA, Pipeline, Simulator, Obstool (Obstool Test 5)	Ongoing		06/08
16. Offline software cookbook	Ongoing		06/30/08
17. CASA tutorials	Ongoing		06/17/08

NAASC Milestones beyond July 2008

Milestones	Original Date	Revised Date	Date Completed
1. Complete Canadian MOU	09/01/07	08/08	
2. Write FY 2008 Project Summary	07/28/08		
3. Budget face-to-face planning with JAO in Charlottesville	08/6–08/08		
4. Revise NAASC FY 2009 budget using revised JAO CY 2009 budget	08/10/08		
5. ALMA EPO Working Group face-to-face meeting in Charlottesville	08/11–12/08		
6. Write FY 2009 Program Plan	08/20/08		
7. Participate in ALMA Simulator Meeting in Grenoble	09/08/08		
8. ANASAC face-to-face meeting in Charlottesville	09/12/08		
9. SciOps IPT face-to-face meeting in Mitaka	09/18–20/08		

3. North American ALMA Science Center(NAASC)

Milestones	Original Date	Revised Date	Date Completed
10. NAASC Science Workshop III	09/25–27/08		
11. ASAC face-to-face meeting in Charlottesville	09/27–29/08		
12. CASA testing for Beta Patch 3 Release	09/30/08		
13. Talks on ALMA science and status at NA institutions	Ongoing		
14. Software testing: CASA, Pipeline, Simulator, Obstool	Ongoing		
15. Testing at ATF	Ongoing		
16. Spectral-line catalogue—resolve species	Ongoing		
17. Participation in SciOps IPT, ARC managers meetings	Ongoing		
18. Resolve CASA helpdesk tickets	Ongoing		

CENTRAL DEVELOPMENT LAB (CDL)

CDL highlights for the quarter include:

- A single-downconversion mixer with digitally enhanced sideband separation has been demonstrated.
- New high-frequency MMIC power amplifiers using a short-gate-length (70 nm) GaAs MMIC process have been fabricated and characterized on-wafer. First-pass success was achieved for at least one design for each targeted band.
- A wideband transition from high-impedance twin-wire (for log-periodic feeds) to microstrip with minimal electrical path-length using ground-aperture shaping was designed.
- A cryogenic MMIC noise-calibration coupler was fabricated for the K band (18–26.5 GHz) focal plane array feed for the GBT.
- Record low noise of 22 K from 83 to 87 GHz and <30 K from 78 to 95 GHz with 30dB gain was obtained from a packaged 35nm InP HEMT MMIC LNA designed by the CDL.
- The EVLA Ku band (12–18 GHz) feed was prototyped and measured.
- Using the measured patterns of an ALMA Band 3 cartridge, the telescope beam and efficiency were calculated.

Amplifier Design and Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Develop prototype ALMA Band 1 and Band 2 amplifiers	06/30/07	09/30/08	
2. Redesign VLBA 12–18 GHz amplifier (waveguide instead of K-connector input)	06/30/08	06/30/08	07/10/08

Notes:

1. Demonstration amplifiers for ALMA Band 1 (31–45 GHz) and Band 2 (67–90 GHz) receivers have been designed. Experimental evaluation awaits the availability of technician time.
2. A WR62–K-connector transition was designed, manufactured, and tested. This transition can be integrated with the existing design of the 8–18 GHz amplifier. A photograph of the 12–18 GHz amplifier with WR62 waveguide input is shown in Figure 1 below.

Other Projects: Research on noise properties of heterostructure bipolar transistors (HBTs) and CMOS MOSFETs continues.

Amplifier Production Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Build/upgrade/repair cryogenic amplifiers using Cryo-3 TRW devices for the EVLA covering the frequency range from 1 to 50 GHz	12/31/15		ongoing activity
2. Build/upgrade/repair cryogenic amplifiers using Cryo-3 TRW devices for the VLBA and the GBT covering the frequency range from 1 to 95 GHz	ongoing		ongoing activity
3. Improve existing noise-measurements systems	ongoing		ongoing activity

Notes:

1 and 2. New amplifier production included two 1–2 GHz low-noise, two 1–2 GHz high-dynamic-range, four 2–4 GHz, eight 4–8 GHz, four 18–26 GHz and six 26–40 GHz units. Repair, upgrade, and retest amplifiers, included four 1–2 GHz low-noise amplifiers. In total, 30 amplifiers were shipped. Deliveries needed for EVLA construction are on schedule.

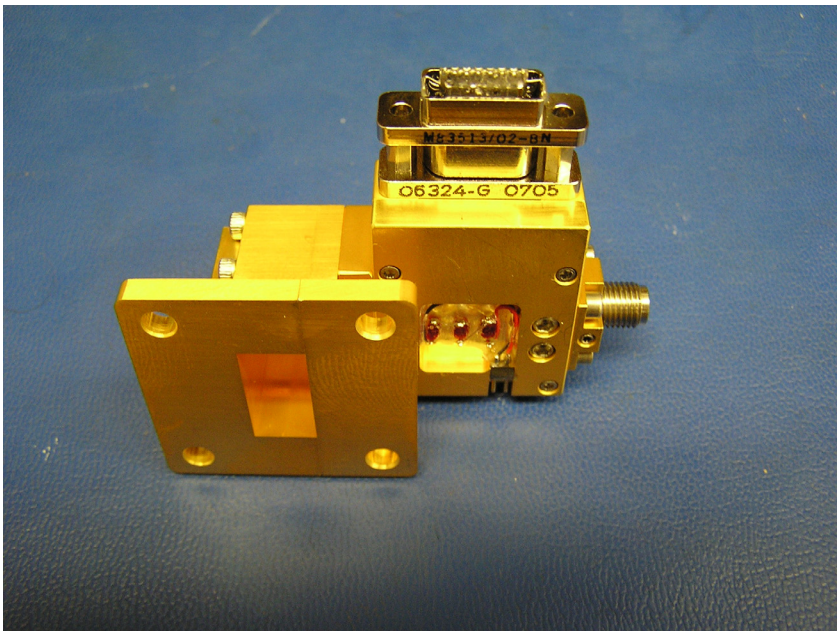

Figure 1. 12–18 GHz amplifier with WR62 waveguide input.

MMIC Design and Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Develop differential LNA for balanced feeds	12/01/06	12/01/08	
2. Develop integrated wideband LNA-feed package	12/01/06	12/01/08	
3. Design and test GaAs W band (75–110 GHz) power amplifiers to improve reliability of millimeter-wave local oscillators	03/01/07	12/01/08	
4. Demonstrate wideband digitally enhanced sideband-separation receiver at L band in an integrated package.	12/01/08		
5. Demonstrate digitally enhanced polarization-isolation receiver at X band in an integrated package.	12/01/08		
6. Integrate analog and digital components for digitally enhanced receivers in a single compact housing.	06/01/09		
7. Evaluate InP HBTs for use in cryogenic amplifiers.	06/01/08		06/30/08
8. Test 67–95 GHz 35nm InP MMIC LNA	10/31/07	08/15/08	
9. Develop cryogenic noise-calibration modules	03/31/08	09/30/08	

Notes:

1. Extensive effort has been put into designing this MMIC. Some progress has been made, but meeting all specifications on input impedance, noise temperature, and dynamic range is most challenging. A serious design will have to wait for the appropriate MMIC wafer run. Funding for experimental wafer runs such as these may become available through the newly founded Keck Institute for Space Studies at Caltech. We plan to pursue this development with them at a workshop in July.
2. Optimization studies have been performed on the high-impedance transition between log-periodic feed antennas above a ground plane and the microstrip circuitry of the active balun. Simulated results show that a decade-bandwidth transition can be made with minimal electrical path length and more than 30 dB return loss by appropriate shaping of the ground-plane aperture.
3. Fabrication was completed in June 2008, and on-wafer small-signal testing showed that several of the new 70 nm MMIC designs were successful, including at least one first-pass success from each targeted band. Chips are currently being diced and will be delivered in August for output-power characterization packaged in ALMA modules.
4. A breadboard single-downconversion analog/digital sideband-separating mixer with >55 dB of image isolation has already been demonstrated. The next step is to implement this in a more integrated package for long-term stability testing.
5. Front-end digitally enhanced OMT package design is underway.
6. Preliminary studies lead us to believe that it is possible to integrate analog and digital components in a common housing with sufficient isolation for radio astronomy work.
7. Several different sizes of InP HBTs from NGST have been measured at temperatures down to 12 K. These devices will work in cryogenic amplifiers; however, they are not competitive with HEMTs in terms of noise temperature. They may still prove useful in later stages of cryogenic amplifiers, where they can lower 1/f noise over all-HEMT amplifiers. Recently reported results with SiGe HBTs indicate noise performance competitive with InP HEMTs up to about 20 GHz. Future research projects may concentrate on investigating the use of SiGe HBTs for radiometric receivers.
8. The 67–95 GHz MMIC LNA, using the new NGST 35nm InP HEMT process, was packaged and tested at the CDL. Measured noise temperature at cryogenic temperatures was less than 30 K from 78 to 95 GHz, with a minimum of 22 K from 83 to 87 GHz. Measured gain cold is 27–31 dB for the designed band. This is the lowest noise temperature for an amplifier ever reported at these frequencies. Analysis is ongoing to tune the lowest-noise band to cover ALMA Band 2 (67–90 GHz) as well as to design a new amplifier to cover 84–116 GHz. Also, two more packaged amplifiers are currently being assembled using the current MMIC design. Funding for future wafer runs in this process may also become available through the Keck Institute for Space Studies (see note #1).
9. Performance of the prototype cryogenic noise source was presented at the K-band Focal Plane Array (KFPA) Conceptual Design Review. An integrated calibration source and coupler for the single-pixel KFPA prototype was designed and fabricated based on the approved design using a commercial MMIC LNA as the noise source. It is currently being assembled and will be tested on the GBT with the rest of the single-pixel prototype receiver module in September 2008.

4. Central Development Lab

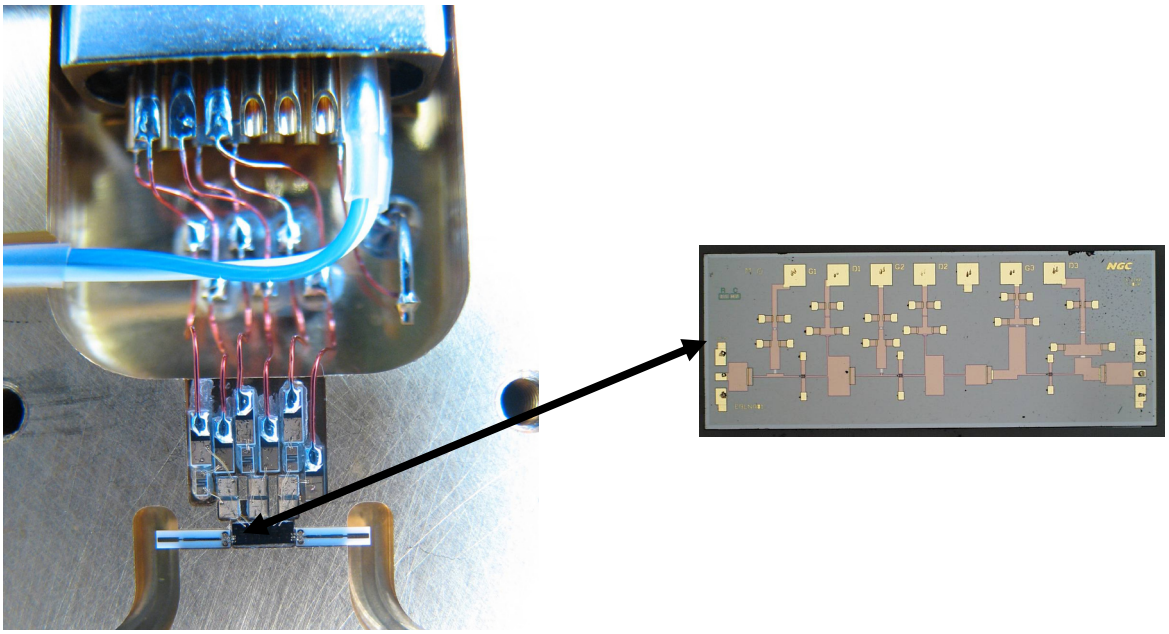

Figure 2. Packaged 35 nm InP HEMT MMIC LNA. The measured noise temperature at cryogenic temperatures is < 30 K from 78 to 95 GHz with a record-low minimum of 22 K from 83 to 87 GHz.

Electromagnetic Support Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Develop dual-band 342/800 MHz feed for the GBT	09/30/05	11/30/08	
2. Measure EVLA 12–18 GHz feed	12/31/07		06/30/08
3. Design and prototype EVLA X-band OMT	09/30/08	01/31/09	
4. Design and prototype EVLA X-band phase shifter	09/30/08	03/31/09	
5. Measure and complete design of Ku-band polarizer	09/30/08		

Notes:

2. The patterns of the Ku-band feed were measured at the outdoor antenna range in Socorro, and the patterns match the predictions. The feed input match is better than –30 dB.
3. The turnstile junction of the OMT (orthomode transducer) has been designed and has return loss better than –23 dB.

Other Projects:

Impedance-match measurements were done on an EVLA S-band feed and on three production EVLA C-band feeds.

Efficiency calculations of ALMA Band 3 were completed using measured patterns from the ALMA near-field scanner at the NTC.

Superconducting Millimeter-Wave Receiver Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Complete 500 GHz mixer test set	12/31/08		
2. Measure new orthomode transducer	10/31/08		
3. Measure drop-in hybrid at 500 GHz	01/31/09		
4. First measurements of 500 GHz SIS mixer	01/31/07	03/31/09	
5. Design 350 μm optics	04/30/09		
6. Complete initial design for 900 GHz mixer	04/30/09		
7. Complete 900 GHz mixer test set	06/30/09		
8. Measure first 900 GHz receiver	09/30/09		

Notes:
2. The new OMT is scalable to ~1 THz. The design is being verified at ~100 GHz, at which frequency a vector network analyzer is available.
3. Drop-in hybrids will be crucial parts of the 500 GHz and 900 GHz balanced and sideband-separating SIS mixers.
4. The masks for the 500 GHz SIS circuits are currently being laid out. This project is an essential step on the way to a 900 GHz SIS mixer (item 8). Items 3 and 4 are being supported in part by the Arizona Radio Observatory.
6. The 900 GHz SIS mixer will be based largely on the 500 GHz design.
7. This is an extension of 1, with different optics and LO and signal sources.

Other:
The work on microwave loss reduction in cryogenically cooled conductors by copper or gold plating has been completed, and a paper has been submitted for publication.

Green Bank Solar Radio Burst Spectrometer (GB/SRBS) Milestones

Milestones	Original Date	Revised Date	Date Completed
GB/SRBS Phase III:			
1. 10–80 MHz, dual polarization, four crossed dipoles, new digital spectrometer	09/30/05	TBD	

Note:
1. The low-frequency antenna work has been delayed until summer 2008, pending funding.

The Precision Array to Probe the Epoch of Reionization (PAPER) Milestones

Milestones	Original Date	Revised Date	Date Completed
1. 16-element prototype array, operating in the 100–200 MHz band in Green Bank	12/31/06	07/15/08	
2. 32-element array in Western Australia	12/15/06	11/30/08	

Notes:
1. Delay continued by the shop fabrication schedule and correlator delivery.
2. Delayed by the extended period required to explore outsourcing options.

Electrochemistry Laboratory

The Chemistry Lab's gold-plating output this quarter, at estimated commercial prices, exceeded $60,000. With increasing production demands from both ALMA and EVLA, monthly production is expected to remain above $20,000 for the foreseeable future.

Production copper electroforming resumed during the second quarter, with results that are now exceeding our expectations in terms of product quality and production rate. The additive system we chose for copper plating was previously untested in electroforming applications, but it may in fact be uniquely well suited for this use. It allows us to plate bright, perfectly filled (free from voids) electroforms at a rate two to three times higher than the old system allowed. The existing two-station (two pieces simultaneously) tank configuration is allowing us to produce four to six finished pieces per month. We anticipate tank modifications will increase that capacity by up to 100%.

We have also investigated and implemented changes in the mandrel (the "foundation" for an electroform) design that reduce production time and improve quality, and we will experiment with a "Siamese twins" mandrel design that can again double productivity. Each finished electroform piece represents an average commercial cost savings of at least $500, with a cost input of typically $20 based on the commodity price of copper.

During the third quarter we will make electroforming tank modifications to facilitate production and increase productivity, and as time permits we will implement a second tank incorporating these modifications.

Figure 3. Recently plated copper electroformed phase shifters.

CHILE OPERATIONS

Chile Operations highlights for the quarter include:

- Activities in support of local labor
- Site-related business actions
- Site security
- Implementing EPO activities with the local community

Local Labor Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Signature of Control Document with ESO to formalize the reconciliation of costs of LSMs			06/19/08
2. Approval of the HR Recovery Fee by ALMA/ESO/NAOJ/NRAO			06/02/08

Business/Contracting/Security Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Assume responsibilities for sewage-plant maintenance			04/01/08
2. Catering, cleaning, and maintenance: startup			05/01/08
3. Implementation by AUI of garbage removal from OSF			05/01/08
4. Risk analysis and Security Plan, Phase 1 (diagnosis) commissioned.			05/09/08
5. Addition of nightly patrol in support of Security at Chajnantor			05/21/08

EPO Milestones

Milestones	Original Date	Revised Date	Date Completed
1. First video class between Magdalena and San Pedro School districts			05/03/08

END TO END (E2E) OPERATIONS

End-to-End Operations highlights for this quarter include:

- New Data Vault interfaces rolled out to http://archive.nrao.edu with expanded data, images, observations, and proposal cover-sheet information in May 2008.
- Proposal software with first electronic submissions for VLBA/HSA released in June 2008.
- The US Virtual Astronomical Observatory proposal was submitted in April by AUI and AURA; NRAO participated in the development of the proposal.
- Common Astronomy Software Applications (CASA) Beta Patch 2, the first publicly available release, used at the synthesis imaging summer school in June 2008.
- Prototype for NRAO Showcase in Google Sky completed in June 2008.

Other incremental accomplishments include the following:

Archive and Pipeline Operations

Work progressed on the archive infrastructure build-out in Socorro, enhancing the accessibility of archived information and providing upgraded equipment to resume pipeline processing of historical VLA data. The ESO/ALMA NGAS archive system was installed on three servers at the AOC and at the VLA site. This makes it possible to begin migrating current VLA/VLBA archive data (35 TB) into the NGAS systems and internally connecting to the existing Archive Query Tool. 6.5 TB of VLA data are now in the NGAS system and available to users. The users do not see a difference between data stored in the old system and data stored in the NGAS system. Software for EVLA operations that reads ASDM (ALMA Science Data Model, used for ALMA and EVLA) data files produced by the EVLA and loads appropriate metadata into the archive is also being developed.

Last quarter a new Data Vault framework was developed for ongoing integration of new services such as Google Sky, the Spectral Line Search Engine (SLiSE), and other add-ons in order to provide a fully featured archive user experience. This major advance was projected to facilitate rapid development, and in Q2 we began to deliver on this promise. Services to access recent GBT scheduling blocks, recent proposal cover sheets, and pipeline-produced images were added and released to http://archive.nrao.edu. Summer students started working on two services requiring this framework: a prototype service to access historical VLA cover sheets back to 1982 was developed, and a semantic search service was launched to tag NRAO archive data based on the taxonomy used for SIMBAD/VO. Both services are planned for installation to the archive in Q4 2008 after rigorous testing. Substantial progress was also made on ingesting data from the 140 ft and 12 m telescopes into the archive and accessing them from the archive interfaces. With good continued progress this should be released to users by the end of the calendar year.

Progress in VLA pipeline imaging was stalled in 2008 at 72,839 images (with calibrated data files) of 15,590 unique sky positions. Equipment has been upgraded to handle additional array configurations, and processing of data taken prior to 1991 will commence during Q3 2008. Once we have imaged VLA continuum data, we will turn to spectral-line data. Automated VLA spectral-line processing will be initiated by the end of the calendar year. Further processing steps (additional editing, self-calibration and polarization calibration) will be initiated as needed by the astronomers when accessing the data and images through the archive; a lightweight service-oriented programming framework will be prototyped in Q4 to explore this.

Proposal Operations

The proposal submission tool (PST) successfully handled 223 VLA, VLBA/HAS, and GBT proposals for the June 2, 2008 deadline. This was the first time that VLBA/HSA proposals were submitted electronically; overall the feedback was positive. Several enhancements were added during this cycle, including: author and institution lists were made available to all astronomers to help alleviate problems adding authors to proposals, and minor changes to the sources/resources/sessions pages were made to improve editing capabilities. There were a handful of serious incidents where a user temporarily was able to view other users' pages. An immediate investigation revealed bugs in third-party software integrated into the PST that resulted in these cross-talk/caching problems. They have been fully resolved.

Virtual Astronomical Observatory (VAO) Operations

The facility proposal for the National Virtual Observatory—now known as the Virtual Astronomical Observatory or USVAO—was submitted by AUI and AURA to NASA/NSF in April. NRAO participated in the development of the proposal and continues to participate in planning for the operational phase of the USVAO. The next phase of planning cannot go forward in earnest until the VAO operations contract has been awarded and the VAO begins to function, which is expected this fall.

NRAO participation in VO standards development this past quarter has focused on the new table access protocol, the second-generation image access protocol, and specification of an applications framework for processing and analysis of astronomical data, to provide advanced capabilities and help integrate the next generation of observatory data processing with the VO.

A draft specification for the table access protocol and a conceptual design for the new image access protocol were released in early May, and they were discussed at the IVOA interoperability workshop in Trieste later that month. A draft conceptual design for the applications framework system interfaces is in preparation and was discussed in several meetings. D. Tody participated in an AURA science software workshop held in Hilo in May, representing NRAO as well the NVO/OPTICON collaboration. W. Cotton and W. Young also contributed to this effort on the NRAO side, helping to ensure that the applications framework will be suitable for longer-term NRAO and ALMA data processing with CASA as well as AIPS if desired. J. Crossley is nearing completion of a first version of a load-testing Web application to be used to help test and verify NVO services as we transition to the operations phase.

Data Processing Development/CASA

CASA Beta Patch 2 was completed in June 2008 and used in tutorials for the synthesis imaging summer school held in Socorro in June. This patch includes:

- Improved flexibility in calibration solutions (crossing or not crossing spectral-window, scan, and field boundaries).
- Additional Linux distributions (including Debian, SuSE, and Ubuntu) and some 64-bit distributions.
- Improvements to task parameter scoping.
- Several plotxy improvements (velocity plotting, vector averaging, bugs).
- Major reworking of imaging tasks (combined in new “clean” task).
- New image-analysis tasks, including a first Gaussian-fitting task.
- Polarization support in the single-dish tasks.
- Improvements to the ALMA simulator *almasimmos* (better display, noise generation), and
- 64-bit distributions for Linux RHEL 4 and 5.

6. END TO END Operations

With some improvements identified during the summer school, the CASA Beta Release is now available for public testing. Members of the user community who log in to NRAO Interactive Services at http://my.nrao.edu will see an option for the CASA Beta Release. A CASA Advisory Group is being formed to facilitate close and productive relationships between the CASA scientists and the development team, and several members of the user community have already registered to join this group. The short-term goals for fall and winter 2008 are to develop Beta Patch 3, tentatively scheduled for October 15.

Other Developments

OEO also supported progress on the next-generation GBT instrumentation. GUPPI saw first light with the GBT on 17 April 2008, observing the pulsar B1824–24 (also known as J1824–2452A or M28A). The time resolution of GUPPI was shown to be twice that available with the GBT's previous instrumentation. Also, the GUPPI team was able to easily reuse their software with instruments developed independently by collaborators and, as a result, the NRAO and West Virginia University were able to quickly start up another instrument for the 140 foot telescope at Green Bank.

Management & Administration Activities

Milestones	Original Date	Revised Date	Date Completed
1. Complete E2E strategic planning exercise	09/15/07	04/30/08	07/31/08
2. Complete specifications for Strategic Decision Support System (a management dashboard)	09/30/07	09/30/08	
3. Prepare Partnership in Astronomy & Astrophysics Research and Education (PAARE) diversity proposal with NC A&T University	08/01/08		
4. Prepare Education & Information Services proposal with NRAO library for scanning equipment to link older proposals, memos, and publications	09/26/08		
5. Create online, living design document for E2E systems	01/31/09		

Algorithm Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Create project charter for algorithm development	09/30/07	08/31/08	05/31/08
2. Hold first NRAO Algorithm R&D Symposium	11/30/07	11/30/08	Canceled
3. Host Spring 2009 SKA Algorithms conference in Socorro	06/30/08		

NRAO Participation in the National Virtual Observatory (NVO) Project

Milestones	Original Date	Revised Date	Date Completed
1. VAO Facility Proposal to NASA/NSF (Tody/Radziwill)	04/22/08		04/22/08

OPERATIONS

6. END TO END Operations

Milestones	Original Date	Revised Date	Date Completed
2. Initial draft TAP specification			05/12/08
3. SIA V2 design analysis and conceptual design			05/18/08
4. IVOA interoperability workshop (Trieste)	05/19/08		05/19/08
5. Draft Applications Messaging specification	10/25/07	04/30/08	06/27/08
6. First draft applications framework interfaces document	03/01/08	08/01/08	
7. Initial release of service load-testing framework	07/15/08	08/15/08	
8. DALServer updated for SSA standard (V1.02)	11/05/07	08/15/08	
9. VOClient with CLI, registry, SSA support	02/15/08	08/15/08	
10. Conduct sessions at 2008 NVO summer school	09/15/08		
11. Initial working draft and prototyping for SIA V2	09/15/07	10/01/08	
12. TAP prototype with SimpleQuery functionality	11/05/07	10/15/08	
13. Revised SIA V1.0 specification for PR	08/15/07	10/15/08	
14. IVOA interoperability workshop (Baltimore)	10/27/08		
15. Planning for NRAO VAO operations (Tody/Radziwill)	12/15/08		

NRAO Archive Infrastructure & Interfaces

Milestones	Original Date	Revised Date	Date Completed
1. Complete Data Vault (Archive v2.0) Beta, production release of Archive v2.0 (stable Google-like search query, results, and download of VLA, VLBA, and GBT data)	12/31/07	04/09/08	05/19/08
2. Receive cost estimates from NCSA for long-term hosting and data curation	03/31/08	04/08/08	04/08/08
3. Devise archive-index schema and replication scheme; resolve data integrity issues in current NRAO archive	04/30/07	05/16/08	05/19/08
4. Update http://archive.cv.nrao.edu with new interfaces, begin summer beta-test period	05/19/08		05/19/08
5. Develop pipeline to generate calibrated SDFITS data	12/31/07	06/30/08	Canceled; design chg from KFPA pipeline
6. Develop pipeline to generate preliminary calibrated, averaged dataset	12/31/07	06/30/08	06/30/08
7. Release new archive interfaces to http://archive.nrao.edu	08/31/08		05/19/08
8. Send invitation to scientists to contribute material for NRAO Showcase on Google Sky	05/19/08	08/15/08	
9. Document description and diagram of existing archive infrastructure	03/31/08	10/31/08	

6. END TO END Operations

Milestones	Original Date	Revised Date	Date Completed
10. Document database schema and diagrams (ERD) for the archive metadata/registry	06/31/07	10/31/08	
11. Install the Spectral Line Search Engine (SLiSE) to query the single-dish spectra database	12/31/07	12/31/08	
12. Include 12 m and 140 ft data in the production single-dish archive node (requires ability to reduce data)	12/31/08		

NRAO Proposal Infrastructure & Interfaces

Milestones	Original Date	Revised Date	Date Completed
1. Integrate VLBA/HSA into the PST	06/01/08		05/16/08
2. 08C revisions available for user-acceptance testing	08/08/08		
3. 08C PST release	08/16/08		
4. Enable export of GBT source catalogs	06/01/08	09/30/08	
5. Resolve author/institution duplicates	09/16/08		
6. Install prototype for online helpdesk	09/16/08		
7. 09A revisions available for user-acceptance testing	12/20/08		
8. Release data-transfer mechanism to support EVLA observing tool	12/31/08		
9. Release proposals.nrao.edu	12/31/08		
10. 09A PST release	01/14/09		
11. Move online helpdesk into production environment	01/14/09		

Data Processing (CASA) Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Complete memo detailing CASA efficiency and throughput ("Terabyte Initiative") and summarize resulting recommendations	04/30/08	06/01/08	06/01/08
2. Complete gap analysis to estimate when CASA will be "done"	04/30/08	7/31/08	05/15/08
3. Plan for first public release, including dates, complete	05/15/08	7/31/08	06/30/08
4. Complete Beta Update 2.0 (bug fixes + functionality) for Synthesis Summer School	06/01/08		06/30/08
5. Transition to new management structure for CASA	10/01/08		
6. Compete Beta Update 3.0	10/15/08		

6. END TO END Operations

NRAO Pipeline Infrastructure & Interfaces

Milestones	Original Date	Revised Date	Date Completed
1. Resume pipeline processing of historical VLA data after processing upgrades	08/01/08		
2. Expand AIPS VLA pipeline to Level 2 processing	12/31/08		
3. Implement common search for VLA/Chandra	12/31/08		
4. Implement common search for NRAO/HST	12/31/08		
5. Implement common search for NRAO/Spitzer	12/31/08		
6. Second half of VLA archive processed via pipeline	06/30/08	06/30/09	

COMPUTER AND INFORMATION SERVICES (CIS)

CIS highlights for this quarter include:

- LMI audit interviews and lines of inquiry were completed using an ITIL Service Management framework and Capability Maturity ranking system.
- All-employee CIS questionnaire was generated and issued, yielding over 200 valid responses.
- New central data-backup solution has dramatically reduced the time to back-up and restore data, enabling the consolidation of multiple manual systems onto a single automated service.
- PEPs were completed on time and included a "360 degree assessment" given to key users.
- Hosted System Administrator conference to set priorities and align Information Technology initiatives NRAO-wide.

Observatory-wide Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Upgrade link between UVa and NRAO-CV to 1 Gbps (d) [1]	01/31/07	On Hold	
2. Annual system administrator conference in CV (b)	04/30/08	05/14/08	05/14/08
3. Re-bid Wide Area Network contract (d) [2]	04/30/08	08/31/08	
4. Deploy Microsoft Office 2007 (b) [3]	05/31/08	08/15/08	
5. Begin deployment of new Linux (RHEL5) (b)	05/31/08		05/31/08
6. Data security plan roll-out to Tier 1 users	05/28/08		06/27/08
7. Data security plan roll-out to Tier 2 users	05/28/08	07/22/08	
8. Data security plan roll-out to all staff [4]	06/11/08	Ongoing	
9. Complete LMI Audit for CV, GB and NM sites	06/25/08		06/25/08
10. Survey NRAO for service priorities in the 5-year plan (b)	06/06/08		05/09/08
11. Develop and deploy NRAO paper bibliography service (c)	07/18/08		

Notes:
1. The contract has been formalized, but installation has been delayed by budget concerns.
2. Transition Manager has been established with GSA.
3. Deployment is pending distribution customization and user training.
4. Data security is being integrated into annual all-hands security awareness training.

(a) Security
(b) Common Computing Environments
(c) World-wide web infrastructure
(d) Telecommunications

Charlottesville Computing Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Upgrade Exchange Server*	03/31/08	07/31/08	
2. Integrate 20TB library to back up all critical platforms	05/16/08		05/16/08

Notes:* Exchange 2007 server has been configured, schema extension is being evaluated, and user mailbox migration process is being validated.

EDUCATION AND PUBLIC OUTREACH (EPO)

EPO highlights for this quarter include:

- Organized AAS/ASP/IYA 09 meeting exhibition and Astro-Zone public outreach event in St. Louis.
- ALMA EPO Program Officer hired.
- NRAO electronic Newsletter – NRAO eNews – debuted.
- EPO webcast produced for GBT – Phoenix Mars Lander mission.
- 3rd annual NRAO Community Open House held in Charlottesville.
- Four teachers accepted summer appointments to the Research Experiences for Teachers (RET) program.
- IYA 2009 *Quiet Skies*, Virtual Astronomy Observatory, and AUI Cooperative Agreement EPO proposals prepared and submitted.

Publications / Documentation Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Publish April 2008 NRAO Newsletter (hardcopy)	04/01/08		04/01/08
2. Complete NRAO eNews design	05/01/08		05/01/08
3. Publish debut NRAO eNews	06/18/08		06/18/08

Notes:
3. Each monthly issue of the NRAO eNews has a submission deadline on the first Friday in the month of publication; eNews issues are published two weeks following the submission deadline.

Online Outreach Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Implement web metrics	04/04/08		03/28/08
2. Improve on-line video delivery options	05/23/08		05/21/08
3. Implement VLBA web cams	06/20/08		05/07/08
4. Design experts database for News Center	06/27/08	10/10/08	

Notes:
3. The ten (10) VLBA web cams have been integrated into the new NRAO EPO website.
4. Completion of this task has been delayed by higher-priority work on the NRAO website.

Scientific Community Outreach Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Generate and submit AAAS science symposium proposal	04/28/08	04/29/08	04/29/08
2. Generate and submit proposal for January 2009 NRAO Town Hall (Long Beach, CA AAS meeting)	05/15/08		05/15/08
3. Organize AAS/ ASP exhibition (St. Louis)	05/31/08		05/31/08

8. Education and Public Outreach

Milestones	Original Date	Revised Date	Date Completed
4. Revise Feb 2009 AAAS science symposium proposal	08/15/08		

Notes:
1. A science symposium proposal for the February 2009 AAAS Annual Meeting in Chicago was written and submitted in collaboration with scientific staff.
2. The NRAO Town Hall at the Long Beach, CA meeting of the AAS is envisioned as an early evening event that begins with a reception.
3. The NRAO was a co-sponsor of the ASP/IYA 2009 meeting.

Education Program Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Review 2008 Research Experiences for Teachers (RET) applications	04/04/08		04/18/08
2. Annual Community Open House (CV)	04/27/08		04/27/08
3. Astronomy Day public exhibition (Science Museum of Virginia)	05/10/08		05/10/08
4. Dark Skies/Quiet Skies workshop (AAS/ASP/IYA09 education event, St Louis, MO)	06/01/08		06/01/08
5. Chautauqua Short Course (GB)	06/04–06/08		06/04–06/08
6. Contemporary Lab Experiences in Astronomy (GB)	06/12–13/08		06/12–13/08
7. Society of Amateur Radio Astronomers (GB)	06/28–30/08		06/28–30/08
8. Chautauqua Short Course (SOC)	07/09–11/08		
9. StarQuest V (GB)	07/02–05/08		
10. Pulsar Search Collaboratory Teacher Workshop (GB)	07/06–17/08		
11. Pulsar Search Collaboratory Student Workshop (GB)	07/21–25/08		
12. WV Governor's School for Math & Science, Teacher/Mentor Training (GB)	08/01–02/08		
13. WV Governor's School for Math & Science (GB)	08/03–15/08		

EPO Community & Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. ALMA EPO Program Officer selection complete	09/28/07	04/08	04/23/08
2. SKA Outreach Working Group kickoff telecon	04/02/08		
3. NRAO logo development (Creativeworks, round-1)	05/13/08		
4. NRAO logo development (Creativeworks, round-2)	06/23/08		

Notes:
1. John Stoke will begin work at the NRAO as the ALMA EPO Program Officer on 4 August 2008. John comes to the NRAO from the STScI Office of Public Outreach.
2. Future SKA Outreach Working Group telecons are scheduled to occur every 3 months.

8. Education and Public Outreach

Custom EPO Programs & Tours: GB Science Center & VLA Visitor Center

Milestones	Event Date
1. University High School (GB Sci Ctr)	04/02/08
2. Old Dominion University (GB Sci Ctr)	04/04–05/08
3. VLA guided tours & Open House (VLA Vis Ctr)	04/05/08
4. GW Community School (GB Sci Ctr)	04/06–07/08
5. Zuni School (VLA Vis Ctr)	04/10/08
6. Glenville State College (GB Sci Ctr)	04/10–12/08
7. University of Texas – El Paso (VLA Vis Ctr)	04/12/08
8. Seneca Trail Christian School (GB Sci Ctr)	04/15/08
9. RV seniors, Colorado (VLA Vis Ctr)	04/18/08
10. Las Cruces Middle School (VLA Vis Ctr)	04/18/08
11. James River High School (GB Sci Ctr)	04/20/08
12. Wakefield School (GB Sci Ctr)	04/21–24/08
13. Quemado High School (VLA Vis Ctr)	04/22/08
14. University of Texas – El Paso Chem Eng (VLA Vis Ctr)	04/24/08
15. Rutgers University (GB Sci Ctr)	04/25–26/08
16. University of Texas – El Paso Physics & Astro (VLA Vis Ctr)	04/26/08
17. Estencia High Scholl gifted physics & astro (VLA Vis Ctr)	04/28/08
18. Washington & Lee University (GB Sci Ctr)	04/29/08
19. Cattle Industry group (VLA Vis Ctr)	05/06/08
20. Roswell MESA students (VLA Vis Ctr)	05/09/08
21. Reinhardt College (GB Sci Ctr)	05/10–17/08
22. Sarracino Middle School (VLA Vis Ctr)	05/12/08
23. Bernalillo High School gifted science (VLA Vis Ctr)	05/13/08
24. Cross Lanes Christian School (GB Sci Ctr)	05/15/08
25. Chapel Hill High School (GB Sci Ctr)	05/25–27/08
26. Holden Elementary School (GB Sci Ctr)	05/28/08
27. Newburgh Free Academy (GB Sci Ctr)	05/29–31/08
28. Rivesville Elementary/Middle School (GB Sci Ctr)	06/02/08
29. WV Home School (GB Sci Ctr)	06/05/08
30. Summer Astro Course for Teachers (VLA Vis Ctr)	06/12/08
31. REU/RET training (VLA Vis Ctr)	06/14/08
32. Southeastern Coop Education Programs (GB Sci Ctr)	06/17/08
33. Boy Scout camp leaders (VLA Vis Ctr)	06/19/08
34. ABQ Girl Scouts (VLA Vis Ctr)	06/19/08
35. RET & REU-led guided tours (VLA Vis Ctr)	06/21/08–07/28/08
36. Glenville State College Summer Camp (GB Sci Ctr)	06/21–23/08
37. Goddard Space Center (GB Sci Ctr)	06/25–26/08
38. ABQ summer K-5 (VLA Vis Ctr)	06/27/08

8. Education and Public Outreach

Milestones	Event Date
39. YMCA (VLA Vis Ctr)	07/07/08
40. Boy Scouts, Wisconsin (VLA Vis Ctr)	07/08/08
41. NM Tech summer engineering (VLA Vis Ctr)	07/09/08
42. Univ of TX REU (VLA Vis Ctr)	07/10/08
43. Earthwatch (VLA Vis Ctr)	07/11/08
44. Washington State Univ astro grad students (VLA Vis Ctr)	07/14/08
45. Acama Pueblo Boys & Girls Club (VLA Vis Ctr)	08/01/08
46. Civil Air Patrol (GB Sci Ctr)	08/22–24/08
47. Balash Tours (VLA Vis Ctr)	09/12/08 & 09/14/08
48. UNM Continuing education (VLA Vis Ctr)	09/17/08
49. Porsche Club (VLA Vis Ctr)	09/20/08
50. Enchanted Skies Star Party (VLA Vis Ctr)	09/25/08

MANAGEMENT

OBSERVATORY MANAGEMENT

During the past quarter the Observatory participated in several reviews and management meetings. The AUI Visiting Committee meeting, chaired by Dr. Stefi Baum, met in Socorro on April 8-9, 2008. It was followed by the NRAO Scientific Staff Retreat on April 10-11. The topic of the retreat was "Future Prospects and Developments at NRAO and in the U.S. Radio Community." The AUI Committee to Assess NRAO Operations (the "Milkey Committee") held its second face-to-face meeting with NRAO staff, this time in Green Bank and Charlottesville on May 8-9. The annual NRAO Users Committee meeting was held in Green Bank on May 20-21. The NSF/LMI Cost Review was held in Charlottesville on May 27-28, and then moved to Green Bank on May 29-30. The review group met again in Socorro on June 23-24. The AUI Executive Committee Meeting met in Washington, DC on April 16, and the AUI Board met in Green Bank on June 18-19. The AUI Cooperative Agreement renewal proposal was submitted to the NSF on May 2.

ADMINISTRATION

Environment, Safety, and Security (ES&S)

ES&S work this quarter focused on completing the card-access efforts in Green Bank. The Green Bank and Charlottesville systems are compatible and are in use. All Green Bank employees have their identification cards, and Charlottesville employees requiring card access for travel to Green Bank have been identified. The next major effort was to determine a replacement for ES&S Manager, Jody Bolyard, who had resigned his position to take up another position; Robert Daniels was hired to start on August 18 in Charlottesville.

Milestones	Original Date	Revised Date	Date Completed
1. Implement card-access controls for Green Bank	12/01/07	06/01/08	06/16/08
2. Evacuation drill at the NTC	12/01/07		05/27/08
3. Business-continuity planning, pending Peoplesoft completion	FY 2007	Pending	
4. Fort Davis VLBA safety inspection/audit and corrective items	04/01/08		05/11/08
5. Green Bank water tower tank inspection	05/01/08		07/22/08
6. North Liberty VLBA safety inspection/audit and corrective items	05/07/08		06/04/08
7. ES&S manager replacement	06/13/08		07/18/08
8. Pie Town VLBA safety inspection/audit and corrective items	05/29/08		06/13/08
9. Socorro (formerly AOC) mechanical room refurbishing oversight	06/23/08		
10. NRAO New Mexico safety manual review & revision	06/16/08		

HUMAN RESOURCES (HR)

Human Resources highlights for this quarter include:

- Employment actions (new hires and promotions)
- Female (F) and Minority (M) staffing
- Appointed Interim Assistant Director (F)
- High School Intern from Western Albemarle, VA (F)
- Undergraduate Intern from MIT (F)
- Sister City Student Outreach program designed between the U.S. and Chile will start in August 2008
- Identified Recruitment/Performance Management web-based system
- Notified of 2008 Reader's Choice Award for Best Diversity Company in the Government Sector by its readers.
- Employee turnover remains stable at all Observatory sites

Cultural Exchange Between Continents

A unique Sister Cities High School Student Exchange Program is under development and negotiation between the Observatory and the Twin Cities of Magdalena, New Mexico, near the VLA (and the location of the ALMA Antenna Test Facility) and the town of San Pedro de Atacama, Chile, near the ALMA site. The program began exchanging students in August 2008. Eduardo Hardy, Mark Adams, Robyn Harrison, Sergio Cabezon, and Roy Norville have participated in the development and operation of the program.

Recruitment and Applicant-Tracking Selection

The Human Resources Division has identified PeopleAdmin as the appropriate supplier for the web-based Recruitment and application-tracking software system that will be activated in the first quarter of FY 2009. This software system is in use by over 420 major universities and colleges in the U.S. and it is the leader of recruitment solutions in the academic community. The system is being implemented to ensure security within the application process, to enhance the candidate and supervisor recruitment experience, and to allow accurate reporting of recruitment and selection statistics.

Observatory Recognized for Diversity

The Observatory was notified in June that it had again been recognized by the readers of Diversity/Careers in Engineering and Information Technology Journal as a Reader's Choice Government-Sector Employer and contributor to diversity. This honor has been received for the second year in a row. The Diversity/Careers journal is read by over 190,000 professional and student readers.

NRAO's Human Resources Manager contacted the president of Diversity/Careers in Engineering and Information Technology Journal about their interest in interviewing Dr. Lo for an upcoming edition. The president was so impressed with Dr. Lo's background and being a minority leading a world-class U.S. observatory that she not only wanted to interview Dr. Lo but wanted his story to appear as the feature story in their October/November 2008 anniversary issue. The Editor in Chief conducted the interview with Dr. Lo in June.

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June 25, 2008

National Radio Astronomy Observatory
Roy Norville
520 Edgemont Road
Charlottesville, VA 22903

Dear Roy,

I am delighted to enclose an official certificate recognizing your company as a 2008 Readers' Choice Best Diversity Company. The certificate clearly shows that the readers of *Diversity/Careers* recognize your commitment to diversity in all its aspects.

Congratulations on this honor, and I hope you'll display your certificate with pride.

Best regards,

Roberta Renard
Publisher
President, Renard Communications

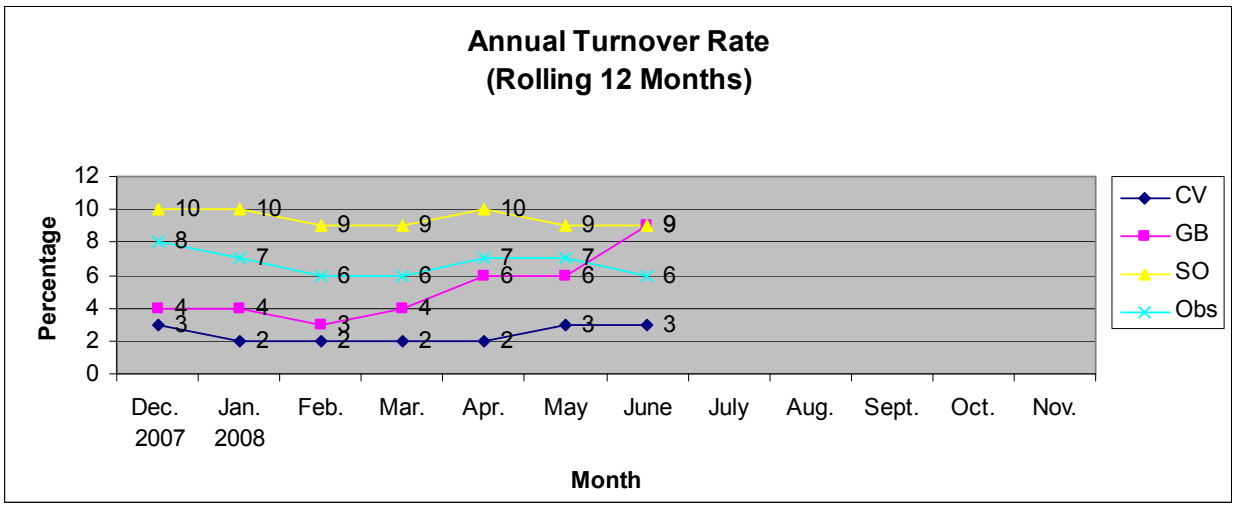
RR/er

Enclosures

Performance Evaluation Program (PEP)

The Observatory continued its redesign of the PEP within the Observatory. Along with major design changes that include a new scientific-staff evaluation form and procedure/redirection toward a performance-based/merit-driven evaluation for all regular full-time employees, all managers and those providing significant input into the Performance Evaluation of others were trained in "Effective Performance Evaluations." This training was presented by Jim Firmani, Shirley Franks, and Joyce Oliner (an outside consultant).

Employee Turnover Performance



The Observatory overall remains stable in its turnover trend. CV experienced a 1% increase in the month of May and Green Bank experienced an increase from 6 to 9% in June due to the expected loss of two postdocs. Socorro had no change in turnover.

Personnel

	New Hires	
Dutchess, Alan	Housekeeping/FS Supervisor	04/07/08
Rosen, Rachel	Research Associate	06/01/08
	Terminations	
Aguirre, James	Jansky Fellow	06/30/08
Albanna, Sarmad	Electronics Engineer II	04/15/08
Beasley, Anthony	Project Manager, Sr.	05/12/08
Bolyard, Jody	Safety & Environmental Protection Mgr.	06/20/08
Foley, Mary	Scientific Associate III	04/11/08
Grider, Ronald	Software Engineer I	04/04/08
Grider, Lihong	Scientific Associate III	04/07/08
Miller, Neal	Jansky Fellow	04/30/08
Morgan, Lawrence	NRAO Post Doc	06/27/08
Porter, William	ALMA Deputy Project Manager	05/30/08
Ruffle, Paul	Scientific Associate II	04/30/08
Thompson, Steven	Technical Specialist I	04/21/08
	Promotions	
Kern, Jeffrey	Software Engineer I	04/01/08
Ogle, Jim	to Telescope Ops Supervisor	05/01/08
Prestage, Richard	Head of Technical Services	05/12/08
Reid, Robert	Assistant Scientist	06/01/08
Remijan, Anthony	Assistant Scientist	06/01/08
O'Neil, Karen	Interim Assistant Director	05/12/08
	Transfers	
Farris, Allen	Software Engineer I (Group Lead)	04/15/08

BUDGET

New funding for NRAO Operations in FY 2008 is $52,740k. At the beginning of the fiscal year, the NRAO Operations budget included $7,644k for ALMA Operations and $6,010k for EVLA. Early in the first quarter, ALMA Operations was established as a separate Scientific Program Order under the AUI Cooperative Agreement. The NRAO Operations new funding was reduced by $7,644k from $52,740k to $45,096k, including EVLA. Excluding EVLA, the net new funding for NRAO Operations is $39,086k.

When combined with prior-year commitments and prior year carryover, the NRAO Operations total budget, less EVLA, is $47,075k. As of June 30, new funding in the amount of $32,322k was received for NRAO Operations and $5,733k was received for ALMA Operations. Fourth quarter new funding increments of $12,714k and $1,911k are anticipated for NRAO Operations and ALMA Operations, respectively. The NRAO Operations increment is $60k less than the expected $12,774k. These withheld funds are retained by the NSF to cover administration costs associated with overseeing the NRAO. Any remaining funds at year's end will be forwarded to the NRAO in a final funding increment. Overall, the NRAO Operations budget is approximately 7.5% below a linear spending rate through the third quarter. The following is a brief explanation of the WBS level 1 elements that are under/over spent in excess of 10% based on a linear projection rate:

- Observatory Management. Materials and Services expense continues significantly below a linear spend rate owing to the need to retain reserve as an offset to the expected FY 2009 and 2010 funding shortfalls.

4. Budget

NRAO Operations Expenses and Commitments FY 2008 Year to Date (October 1, 2007 to June 30, 2008) in $000							Percent of fiscal year	75.0%
WBS Level 1	Salaries & Benefits	Materials & Services	Travel	Revenue or Cost Recovery	Total	Linear Spending	Actual Exp + Comm	Actual Percent Expended & Committed
Observatory Management	6,124	2,676	354	-200	8,954	6,715	4,361	48.7%
Education and Public Outreach	582	244	21	-125	722	541	574	79.5%
Central Development Lab	1,491	216	23		1,730	1,298	1,235	71.4%
Green Bank Operations	8,901	2,766	145	-463	11,349	8,512	7,747	68.3%
New Mexico Operations	14,489	4,232	157	-80	18,798	14,098	13,975	74.3%
Computer and Information Services	1,066	737	25		1,829	1,371	1,371	75.0%
Science and Academic Affairs	1,795	1,519	385		3,699	2,775	2,516	68.0%
NRAO Operations total	34,448	12,390	1,110	-868	47,081	35,310	31,778	67.5%

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
AAAS	American Association for the Advancement of Science
AAS	American Astronomical Society
ACU	Antenna Control Unit
AGN	Active Galactic Nucleus
AIPS	Astronomical Image Processing System
ALFA	Arecibo L-band Feed Array
ALMA	Atacama Large Millimeter Array
ANASAC	ALMA North American Scientific Advisory Committee
AOC	Array Operations Center (Socorro, NM)
API	Atmospheric Phase Interferometer
ARC	ALMA Regional Center
ASAC	ALMA Scientific Advisory Committee
ASDM	ALMA Science Data Model
ASP	Astronomical Society of the Pacific
ATCA	Australia Telescope Compact Array
ATF	ALMA Test Facility
AUI	Associated Universities, Incorporated
AURA	Associated Universities for Research in Astronomy
BDF	Binary Data Format
BIMA	Berkeley Illinois Maryland Array
C band	4–8 GHz
CASA	Common Astronomy Software Applications
CCAT	Cornell-Caltech Atacama Telescope
CDL	Central Development Laboratory (Charlottesville, VA)
CDR	Critical Design Review
CICADA	Configurable Instrument Collaboration for Agile Data Acquisition
CIPT	Computing Integrated Product Team (ALMA)
CIS	Computer and Information Services
CLI	Command-Line Interface
CMOS	Complementary Metal-Oxide Semiconductor
CV	Charlottesville
DAL	Data Access Layer
DBE	Digital Back End
DDS	Direct Digital Synthesizer
DO	Director's Office
DRAO	Dominion Radio Astrophysical Observatory
DSS	Dynamic Scheduling System (GBT)
DTS	Digital Transmission System
EOS	EOS International Corporation (library automation software)
E2E	End-to-End
EPO	Education and Public Outreach
ERD	Entity Relationship Diagram
ES&S	Environment, Safety, and Security (NRAO)
ESO	European Southern Observatory
ETK	Electronic Time Keeping
EVLA	Expanded Very Large Array

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
FASR	Frequency-Agile Solar Radiotelescope
FITS	Flexible Image Transport Systerm
FPGA	Field-Programmable Gate Array
FRM	Focus/Rotation Mount
FY	Fiscal Year
GaAs	Gallium Arsenide
GALFACTS	G-ALFA Continuum Transit Survey (Arecibo)
GB	Green Bank
GB/SRBS	Green Bank Solar Radio Burst Spectrometer
Gbps	Giga bits per second
GBT	Green Bank Telescope
GHz	Gigahertz
GLAST	Gamma-ray Large-Area Space Telescope
GSA	General Services Administration
Gsps	Giga samples per second
GUPPI	Green Bank Ultimate Pulsar-Processing Instrument
HBT	Heterostructure Bipolar Transistor
HEMT	High-Electron-Mobility Transistor
HSA	High-Sensitivity Array
HI	Neutral Hydrogen
HIA	Herzberg Institute of Astrophysics
HR	Human Resources
HAS	High-Sensitivity Array
HST	Hubble Space Telescope
IF	Intermediate Frequency
InP	Indium Phosphide
IPT	Integrated Product Team
ITIL	Information Technology Infrastructure Library
IYA	International Year of Astronomy (2009)
IVOA	International Virtual Observatory Alliance
JAO	Joint ALMA Observatory
JCMT	James Clerk Maxwell Telescope
k	thousand
K	Kelvins (temperature)
K band	18–26.5 GHz
Ka band	26.5–40 GHz
KFPA	K-band Focal-Plane Array receiver (GBT)
Ku band	12–18 GHz
L band	1–2 GHz
LMI	Logistics Management, Inc.
LNA	Low-Noise Amplifier
LO	Local Oscillator
LRF	Laser Range Finder
LSM	Labor Supply Model
M&C	Monitor and Control
MEASURE	Magnetometers along the Eastern Atlantic Seaboard for Undergraduate

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
	Research and Education
MHz	Megahertz
MK	Mauna Kea (VLBA station)
mm	millimeter
MMIC	Monolithic Microwave Integrated Circuit
MoO	Mission of Opportunity (NASA)
MOSFET	Metal-Oxide Semiconductor Field-Effect Transistor
MOU	Memorandum of Understanding
MPIfR	Max Planck Institut fűr Radioastronomie
MSI	MidSized Infrastructure (NSF program)
μm	micrometer
MUSTANG	Multiplexed Squid TES Array at Ninety GHz (GBT "Penn Array" receiver)
NA	North American
NAASC	North American ALMA Science Center
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputing Applications
NGAS	Next Generation Archive System
NGST	Northrop Grumman Space Technology
NIO	New Initiatives Office
NIST	National Institute of Standards and Technology
NL	North Liberty (VLBA station)
nm	Nanometer
NRAO	National Radio Astronomy Observatory
NRC	National Research Council (Canada)
NSF	National Science Foundation
NTC	NRAO Technology Center (Charlottesville)
NVO	National Virtual Observatory (now VAO)
OCLC	Online Computer Library Center
OEO	Office of E2E Operations
OMT	Orthomode Transducer
OOF	Out Of Focus (holography)
OPT	Observation Preparation Tool
OPTICON	Optical–Infrared Coordination Network for Astronomy
OSAA	Office of Science and Academic Affairs (NRAO)
OSF	Operations Support Facility
OV	Owens Valley (VLBA station)
PAPER	Precision Array to Probe the Epoch of Reionization
PDR	Preliminary Design Review
PEP	Performance Evaluation Program
PLC	Programmable Logic Controller
PR	Proposed Recommendation
PST	Proposal Submission Tool
PTC	ProtoType Correlator (EVLA)
PTCS	Precision Telescope Control System (GBT)
Q	Quarter
Q band	40–50 GHz

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
R&D	Research and Development
RET	Research Experiences for Teaches (NSF program)
REU	Research Experiences for Undergraduates (NSF program)
RF	Radio Frequency
RFI	Radio-Frequency Interference
ROACH	Reconfigurable Open Architecture Computing Hardware
S band	2–4 GHz
SC	Saint Croix (VLBA station)
Sci Ctr	Science Center (Green Bank)
SDFITS	Single-Dish Flexible Image Transport System
SDM	Science Data Model
SIA	Simple Image Access
SIMBAD	SIMBAD astronomical database
SIS	Superconductor–Insulator–Superconductor
SKA	Square Kilometer Array
SLiSE	Spectral Line Search Engine
SMA	Sub-Millimeter Array
SOS	Student Observing Support (NRAO program)
SPIE	International Society for Optical Engineering
SRBS	Solar Radio-Burst Spectrometer (Green Bank)
SSA	Simple Spectral Access
SSEC	SKA Science and Engineering Committee
SSS	Science Support Systems
STScI	Space Telescope Science Institute
SWIRE	Spitzer Wide-area Infrared Extragalactic Survey
TAP	Table Access Protocol
TBD	To Be Determined
TRW	TRW Corporation
U band	12–18 GHz
UVa	University of Virginia
VAO	Virtual Astronomical Observatory
VCI	Virtual Correlator Interface (EVLA)
Vis Ctr	Visitor Center (VLA)
VISC-2	VSOP-2 International Science Council
VLA	Very Large Array
VLBA	Very Long Baseline Array
VLBI	Very Long Baseline Interferometry
VNA	Vector Network Analyzer
VO	Virtual Observatory
VSOP-2	VLBI Space Observatory Program successor
W band	68–117 GHz
WBS	Work Breakdown Structure
WIDAR	Wideband Digital Interferometric Architecture (EVLA correlator)
WISE	Widefield Infrared Survey Explorer
X band	8–12 GHz