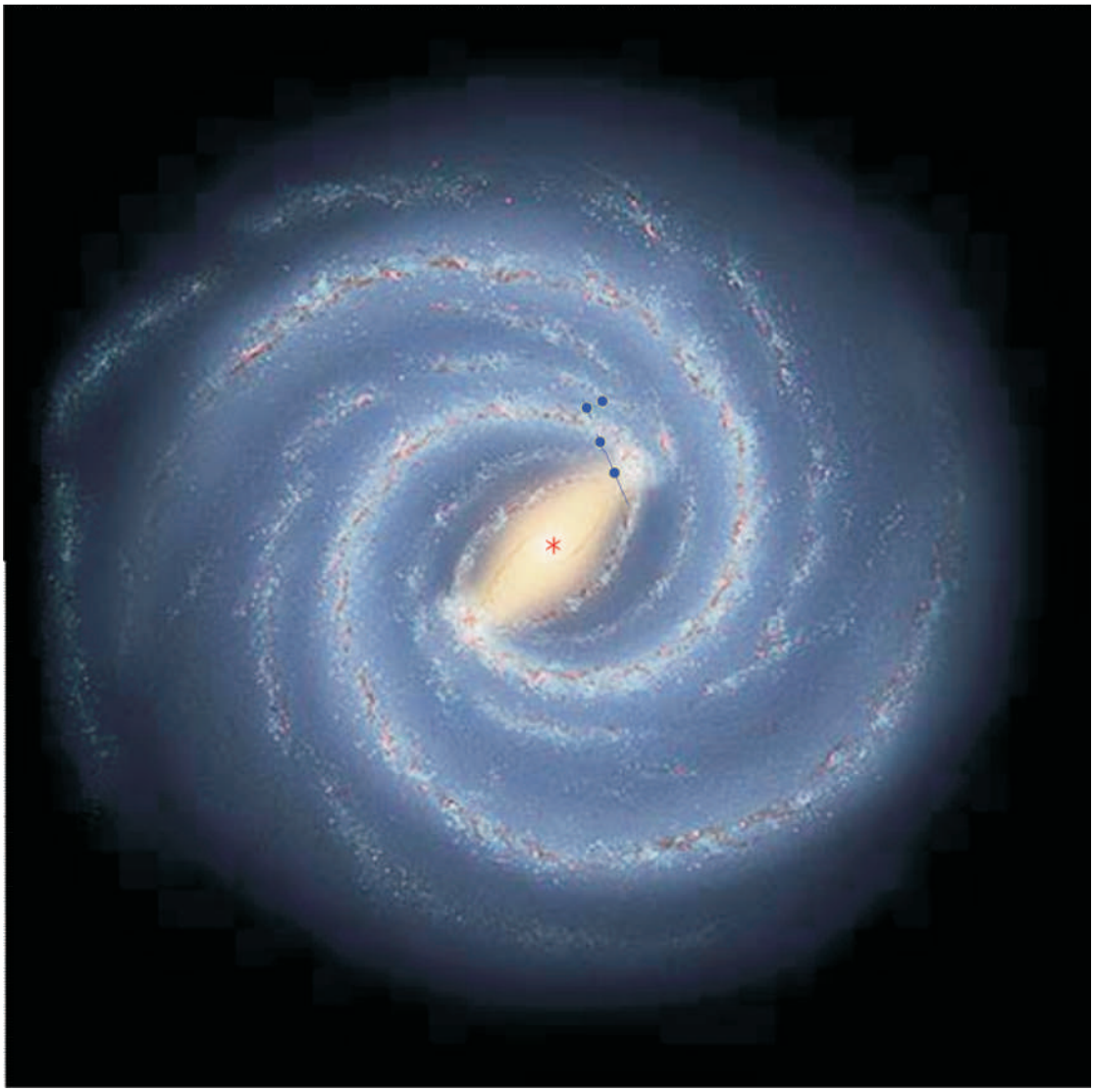
National Radio Astronomy Observatory



Quarterly Report

October – December 2008

NATIONAL RADIO ASTRONOMY OBSERVATORY

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Cover Image: A long-term VLBA project to map the Milky Way by measuring accurate positions of water masers in star-forming regions has shown that the Galaxy rotates 15 percent faster at the Solar circle than previously believed, and its mass is 50 percent greater.

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EXECUTIVE SUMMARY

A long-term VLBA project to map the Milky Way by observing water masers in star-forming regions showed that our Galaxy rotates 15% faster at the solar circle and is 50% more massive than previously believed.

Magnetic fields pervade the universe, and the leading theory of magnetic-field generation predicts that fields were weaker in the past. The average magnetic field strength in our Galaxy today is only 6 μG, but new GBT measurements measured 84 μG in a galaxy at redshift $z = 0.69$. These GBT data suggest that magnetic fields are generic features of galaxies at high redshifts and may be a bigger factor in galaxy formation and evolution than expected.

Eighteen EVLA antennas have been retrofitted and restored to routine service with the VLA. Tests of the prototype WIDAR correlator at the VLA site continued, and a pre-production Critical Design Review was successfully held. New Mexico operations management worked with the NSF Division of Astronomical Sciences and the NSF Office of General Counsel to consider legal bases for Federal action to challenge the routing of the UPC power line close to the VLA site. Discussions began with First Wind/UPC on a mutually satisfactory route for the proposed power line that would avoid producing RFI levels scientifically detrimental to VLA operations. An EVLA workshop *The EVLA Vision: Galaxies Through Cosmic Time* was held in Socorro and attended by nearly 100 participants. The VLBA tiger-team maintenance visit to the Saint Croix site was completed in mid-November 2008.

The National Astronomical Observatory of Japan submitted a preliminary proposal to their funding agency for a joint VLBA/VERA astrometry program that includes funding to support VLBA operations. Substantive discussions are under way with NASA and the Max Planck Institut für Radioastronomie regarding operations funding of the VLBA, with a goal of making partnership decisions by mid-2009. The possibility of doing SKA antenna verification testing at the VLA site was discussed with the SKA Program Development Office.

The traditional holography receiver was reinstalled on the GBT and used to make a high-resolution image of the GBT surface. Out-of-Focus Holography (OOF) became a regular Ka-Band and Q-Band observing tool for correcting thermal distortions of the GBT surface. The GBT Dynamic Scheduling System passed its critical design review. The Green Bank Ultimate Pulsar-Processing Instrument (GUPPI) was released for shared-risk observations. Extensive tests on a single pixel of the K-Band Focal Plane Array (KFPA) were successful, and work began on a seven-pixel array. New GBT azimuth-track covers were designed, fabricated, and installed.

The National Science Council (NSC) in Taiwan and the U.S. National Science Foundation signed an Agreement for Cooperation in Astronomy and Astrophysics associated with ALMA. A budget summit was held in Chile to review the ALMA Operations budget in light of the Continuing Resolution budget situation. An ASAC-appointed working group made recommendations to the ALMA Board to ensure that ALMA development can maintain the instrument at the cutting edge over the next two decades. The ALMA proposal review process was refined. The principal work on the spectral-line database Splatalogue was completed and a demo was prepared for the AAS meeting.

EXECUTIVE SUMMARY

In collaboration with the University of Virginia Microfabrication Laboratory, sideband-separating and balanced SIS receivers based on AlN SIS junctions and NbTiN superconductors are being developed for the 385–500 GHz and 780–950 GHz ALMA bands. Efforts in the MMIC design and development area focused on characterizing the new 70 nm GaAs Power Amplifier chipset and experimenting with integrated analog/digital/photonic receiver architectures to enable large-format focal plane arrays.

Incoming Chief Scientist Chris Carilli led an internal working group that drafted a report on science priorities for NRAO facilities in the coming decade. This is part of a larger initiative to define the NRAO and the community approaches to the Decadal Survey that begins in 2009.

A new version of CASA analysis software was released. A computing cluster for improving performance of data-processing software was procured, configured, and installed in Socorro. The Centralized Authentication Service (CAS) was released as the Observatory-wide mechanism for user account management and single sign-on to web applications. The NRAO coordinated video participation in the three-day algorithm research and development meeting at Oxford, making it accessible to all NRAO sites, Cape Town, Munich, Penticton, and other sites. Computer and Information Services (CIS) completed the review and specification of the NRAO standard for computer hardware to improve supportability and reduce cost.

High-definition video and stills were acquired from the air and on the ground in Green Bank. A community open house was held in Green Bank. Planning for the International Year of Astronomy 2009 was completed. The NRAO science community exhibits were redesigned.

SCIENCE

1. SCIENCE HIGHLIGHTS

Very Large Array (VLA) and Very Long Baseline Array (VLBA)

VLA, Effelsberg Detect Most Distant Water in Universe: Thanks to the effect of a gravitational lens, researchers were able to detect water-maser emission in a quasar at redshift z = 2.64, the most distant water yet detected. The initial detection was made using the 100 m Effelsberg telescope. The VLA then was able to detect the water emission in two of the four lensed images of the quasar, confirming that the emission was indeed coming from it. This detection implies that giant water masers may have been more common in the early universe than today. Curiously the object, MG J0414+0534, is a Type I quasar seen nearly face-on, implying that the masers may be located in the jet rather than in the disk of the system.

Investigators: C.M. Violette Impellizzeri, J.P. McKean, A.L. Roy, C. Henkel, and A. Brunthaler (MPIfR); P. Castangia (MPIfR and INAF, Italy); and O. Wucknitz (Argelander-Institut für Astronomie, Bonn).

Milky Way Rotating Faster, More Massive, VLBA Astrometry Shows: A long-term VLBA project to map the Milky Way by observing water masers in star-forming regions showed that the Galaxy rotates 15% faster at the solar circle and is 50% more massive than previously believed. This makes the Milky Way as massive as the Andromeda Galaxy. Precision VLBA maps of the spiral-arm pitch angles support a four-arm, rather than a two-arm, structure for the Galaxy. The increased mass raises the likelihood of collisions with other galaxies in the Local Group in the future.

Investigators: M. Reid (CfA) and K. Menten (MPIfR).

Green Bank Telescope (GBT)

The kinetic temperature of a molecular cloud at redshift 0.9: ammonia in the gravitational lens PKS 1830–211: The molecular cloud at z = 0.9 seen in absorption against the radio source PKS1830–211 is the most distant known that can be studied in detail. GBT observations in ten absorption lines of ammonia show that it is not a dark cloud like Taurus, as previously proposed, but is more like the molecular cloud near Sgr B2 near the nucleus of our Galaxy. The absorbing gas is warm: most is around 80 K, but some has a temperature greater than 600 K. This cloud is unique in having a warm, extended, low-density molecular envelope in a spiral arm 4 kpc from the nucleus.

Investigators: C. Henkel (MPIfR), J.A. Braatz (NRAO), K.M. Menten (MPIfR), & J. Ott (NRAO/CSIRO), 2008.

An 84 μG magnetic field in a galaxy at redshift z = 0.692: The leading theory of magnetic-field generation predicts weaker fields in the past. The GBT measured an 84 μG magnetic field strength in a z = 0.69 λ = 21 cm HI line from a system thought to be the progenitor of a modern galaxy. Zeeman measurements of the Milky Way show an average magnetic field of only 6 μG today. The GBT data

suggest that magnetic fields are generic features of galaxies at high redshifts and may be more important for galaxy formation and evolution than hitherto realized.

Investigators: A.M. Wolfe (UC, San Diego), R.A. Jorgenson (UC, San Diego), T. Robishaw (UC, Berkeley), C. Heiles (UC, Berkeley), & J.X. Prochaska, (UCO Lick Obs).

2. OFFICE OF SCIENCE AND ACADEMIC AFFAIRS (OSAA)

Incoming Chief Scientist Chris Carilli led an internal working group that drafted a report on science priorities for NRAO facilities in the coming decade. This is part of a larger initiative to define the NRAO and the community approaches to the Decadal Survey that begins in 2009.

The OSAA began reorganizing the NRAO proposal and time-allocation process. A small internal working group was charged with writing a framework document that describes the current system, outlines a planned NRAO-wide system, and lays out a preliminary implementation plan with costing. In the first quarter of 2009 the framework document will be distributed for comment among members of the user community, and there will be further internal planning on implementation.

Following the retirement of Alan Bridle, Jeff Mangum took over the responsibility for running the student training programs within the OSAA. They now include the NRAO pre-doctoral program, the Graduate and Undergraduate Internship programs, the Student Observing Support program, and the Summer Student programs. Dale Frail took over the Visiting Scientist program.

The OSAA worked on career development for the research staff by producing a Process and Procedures document to guide the scientific performance review committees in recommending staff promotions.

Historical Archives

Processing work continues on post-1979 NRAO materials and on the papers of John D. Kraus. Processing of Ronald N. Bracewell's papers began, and a preliminary finding aid was posted on the web.

Work continued on discarding, from the historical image file of 26,000 black and white negatives, all negatives of figures included in papers published in the open literature; these figures were prepared by hand before image-generating software was available.

A shipment of four boxes of additional Reber materials was received from Tasmania and awaits processing until additional expected shipments are received.

We routinely receive information requests from NRAO staff, including a request this quarter for 1970 summer-student information because Energy Secretary nominee Steven Chu was an NRAO summer student that year. Because of the Archives web presence, use of our resources by people outside the NRAO continues to increase. During this quarter, for example, we provided Reber images for an exhibit at Adler Planetarium and for a researcher at University of York (UK), and we helped a Canadian PhD student visiting the Archives use Kraus materials in his dissertation research.

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

2. Office of Science and Academic Affairs

Library Program

The NRAO Library has completed and processed the exceptional $25k page charges for the AJ special issue on THINGS (AJ 136, #6, December 2008).

Beta testing the Data Vault/*NRAOPapers* link is underway, and we hope to have the two-way links fully operational within the next six months. The Library Web Page has been completely revamped.

The Librarian at Socorro, Holli Glassel, was married in December and has relocated to Dallas; therefore the Socorro library is unmanned at this time. A possible reorganization of NRAO library operations which will address this change is being considered.

Marsha Bishop and Robert Hanisch (Space Telescope) were selected to Co-Chair the IAU Working Group on Libraries (WGL) in November and will be responsible for the WGL Business Meeting at the IAU General Assembly to be held in Brazil in August 2009.

Scientific Appointments

Arrivals/Promotions

- Esteban Araya began his Jansky Fellowship on September 2.
- Crystal Brogan was promoted from Assistant Astronomer to Associate Astronomer on October 1.
- Eric Bryerton was promoted from Associate Scientist/Research Engineering to Scientist/Research Engineering on October 1.
- Chris Carilli began his new appointment as Observatory Chief Scientist in the Office of Science and Academic Affairs (OSAA) on October 1.
- Aeree Chung, Jansky Fellow, transferred to Socorro from her non-resident institution, the University of Massachusetts, in early October to complete the last year of her Fellowship.
- Stuartt Corder began an appointment on the ALMA Commissioning scientific staff in conjunction with his Jansky Fellowship in Chile on commissioning duties October 1.
- Adam Deller began his Jansky Fellowship in Socorro on November 4.
- Violette Impellizzeri, MPIfR, began her NRAO postdoc on September 29 in Charlottesville.
- Antonio Hales transferred to Chile as Assistant Scientist/Astronomy working as an ALMA Commissioning Scientist October 1.
- Brian Kent began his Jansky Fellowship in Charlottesville on September 2.
- Arthur Lichtenberger accepted a joint appointment with the NRAO and the University of Virginia as Scientist/Research Engineering with Continuing Appointment working with ALMA and CDL.
- Carol Lonsdale, Scientist/Astronomy, began working in Charlottesville as Assistant Director for the NAASC on October 1.
- Jeff Mangum, Scientist/Astronomy, became lead coordinator for all student activities: the NSF REU/RET Program, the NRAO Undergraduate Summer-Student Research Assistantships and Graduate Summer-Student Research Assistantships, the Engineering and Software Development Co-op Program, the Undergraduate Internship Program, and the Junior Fellows Programs.

2. Office of Science and Academic Affairs

- Karen O'Neil accepted a three-year appointment as Assistant Director for Green Bank Operations. Karen, Associate Scientist/Astronomy, has been serving as Interim Assistant Director for GB Operations since Richard Prestage departed in spring 2008.

Departures/Extensions

- Alan Bridle, Tenured Scientist, retired from the NRAO on October 15 in response to the Early Retirement Program offered by the Observatory.
- Carl Bignell, Scientist/Astronomy (also Early Retirement Program) will retire on April 30, 2009.
- D. J. Pisano completed his postdoctoral appointment on December 22 and accepted an appointment at West Virginia University.
- David Whysong's appointment as an NRAO Postdoc ended November 4. He accepted a postdoctoral appointment at UC, Berkeley.

A current list of NRAO Scientific Staff is available on the NRAO OSAA web page at: http://www.nrao.edu/administration/directors_office/currentscistaff.shtml. A list of current and past postdocs is also on line at http://www.nrao.edu/administration/directors_office/pastpostdocs.shtml.

Student and Visiting Scientist Programs

NRAO Summer Student Program

NRAO sponsored 12 of the 2008 NRAO Summer Student program participants to present their summer research results at the January 2009 AAS meeting in Long Beach, California. The presentation numbers, presentation titles, student presenters (in bold), and staff mentor(s) were:

- 410.09 "The Proper Motion of Cygnus X-3" by **Charli Sakari**, J. C. A. Miller-Jones
- 418.02 "Broadband Radio Spectra of Star-forming Galaxies" **by Joshua Marvil**, J. Eilek, F. Owen
- 420.09 "A VLBA Study of Core Wander and Relative Proper Motion of M87 and M84" by **Frederick Davies**, R. Walker, J. Wrobel, C. Ly, W. Junor, P. J. Hardee
- 436.02 "The Search for the Pulsar in SN 1986J" by **Evan Schneider**, S. Ransom
- 436.11 "A New Pulsar Data Acquisition System for the 140 Foot Telescope" by **Marc Eimers**, Maura McLaughlin, Dunc Lorimer
- 436.13 "Dynamic Power Spectra: Searching for Compact Binary Pulsars" by **Tim Pennucci**, Scott Ransom
- 467.03 "Data Preservation and Access for the NRAO 140ft and 12m Telescopes" by **Brian Sacash**, R. DuPlain
- 485.16 "Cold Chemistry In TMC-CP: Temperature Deduced From HC9N? Line Intensities" by **S. J. Moats**, Glen Langston, D. C. Soehl
- 486.02 "The Power Spectrum of HI Turbulence in the Outer Galaxy" by **Colin Slater**, A. H. Minter
- 491.26 "MSX And IRAS Two-Color Diagrams For Late-Type Stars" by **Stephanie Capen**, L. Sjouwerman, M. Claussen

2. Office of Science and Academic Affairs

- 612.06 "Prototype Tool for Interaction with Large Spectral Line GBT Data Sets" by **Delia Mocanu**, Bob Garwood
- 604.08 "The Structure of the Starless Bok Globule CB4" by **Alexander Savello**, R. Dickman, D. Lis

Predocs

- Katie Mae Chynoweth (Vanderbilt University) completed her graduate internship in August and transferred to a pre-doctoral position to continue working with Glen Langston in Green Bank on HI observations of interacting galaxies with the GBT and VLA.
- Rohit Gawande (University of Virginia) worked with Richard Bradley at the NTC developing and fabricating ultra-wide-band feeds for a variety of radio astronomy applications.
- Cheng-Yu Kuo (University of Virginia) completed a graduate internship in September and transferred to a pre-doctoral position to continue working with Jim Braatz in Charlottesville on reducing and analyzing VLBI observations of water-maser emission from galactic nuclei as part of the Megamaser Cosmology Project.
- Chatalili Parashare (University of Virginia) continued working with Richard Bradley at the NRAO Technology Center on instrumentation for low-frequency radio astronomy arrays.

Graduate Interns

- Nimish Sane (University of Maryland) continued a graduate internship working with John Ford in Green Bank on digital processing for radio spectroscopy.

Undergraduate Interns

- Colton Dunlop, Fred Davis, and Kate Theisen (all New Mexico Tech) started undergraduate internships working with Steve Durand on EVLA electronics.

Visiting Scientists

- Gabriella De Lucia visited the NRAO in Socorro to work with Veronica Strazzullo and Maurilio Pannella. Gabriella was from the Max Planck Institute for Astrophysics in Garching, Germany.
- Amanda Kepley, University of Virginia, began a Visiting Research Associate appointment at the NRAO in Charlottesville in November.
- Dongliang Liu, National Astronomical Observatory of China, began a three-month visit to NRAO in Charlottesville and Green Bank in November.
- Stacey Palen, Weber State University, began a six-month Visiting Astronomer appointment in Socorro in October.

2. Office of Science and Academic Affairs

Support Programs

Student Observing Support (SOS)

The NRAO Student Observing Support (SOS) Committee met in August 2008 to discuss proposals submitted during the previous trimester. The SOS committee, composed of five faculty members from U.S. universities, reviewed the science case and student-support application for each proposal, and selected those listed below for funding. Complete information on SOS program is available online at http://wiki.gb.nrao.edu/bin/view/Observing/NRAOStudentSupportProgram

- 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 Proto-planetary Nebulae."
- 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."
- 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."
- 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."

3. TELESCOPE USAGE

The NRAO telescopes were scheduled for research and for maintenance during the fourth quarter of 2008 as described in the table below. Time lost and actual observing times 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	1312.8	1005.8	1761.0
Scheduled Maintenance and Equipment Changes	205.0	211.0	201.0
Scheduled Tests and Calibrations	399.5	268.0	173.0
Time Lost	152.5	36.9	142.0
Unscheduled	226.7	667.3	72.0
Actual Observing	1160.3	968.9	1619.0

PROJECTS

1. EXPANDED VERY LARGE ARRAY (EVLA)

EVLA highlights for this quarter include:

- A total of 18 antennas have been retrofitted to the EVLA design and account for 66.1% of all antenna hours in scientific observations.
- A design review for the production readiness of the correlator's station and baseline boards was held in Socorro on December 2–3, 2008.
- An EVLA science workshop was held in Socorro on December 16–18. The workshop was followed by a meeting of the Science Advisory Group for the EVLA on December 19–20.
- The first cast aluminum dewar for the L-Band receiver was delivered.

Note on New Milestone Tables: Per NSF request, we have expanded the milestone tables with this report to include a *Start Date* of project activities. This is the date that substantial activity on the task actually commenced. If the task was delayed, the actual start date might be after the *Original Completion Date*, which was the estimated completion date on original project plans. If an activity is a simple milestone, such as a meeting or the installation of equipment with minimal duration, no start date may be listed. If the project activity has not yet commenced, the start date will be left blank.

EVLA Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Science Support System software PDR	12/08	11/07	03/09	
2. Science Data Model version 1.00 published	07/08	12/07	01/09	
3. Hardware acceptance tests of Antenna 28	10/08	10/08		10/08
4. Antenna 28 Turnover to Operations	10/08	10/08		10/08
5. Prototype S-Band receiver RF tests completed	11/08	10/08		12/08
6. Start EVLA design conversion on Antenna 15	11/08	11/08		11/08
7. Establish decision criteria for X-Band OMT	10/08	11/08		11/08
8. Project Data Model drafted	06/08	12/08		12/08
9. Alpha release of observation preparation tool	02/08	12/08		11/08
10. Design waveguide-style X-Band receiver	03/08	01/08	11/08	11/08

PROJECTS

1. Expanded Very Large Array

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
11. Provide capability for C-Band observing in OPT	06/08	02/09		11/08
12. WIDAR correlator CDR	10/08	06/08	12/08	12/08
13. 10-station correlator boards delivered		08/08	02/09	
14. Assemble 4 DTS modules with 3-bit samplers	08/08	08/08	11/08	
15. On-the-sky testing of 4-station prototype correlator completed	09/08	09/08	11/08	12/08
16. Start limited observing w/ 10-station-board correlator		09/08	03/09	
17. Prototype feed horn dry-air system installed	11/08	10/08	01/09	
18. Prototype S-Band receiver installed		11/08	01/09	
19. Four DTS modules with 3-bit samplers installed		11/08	03/09	
20. Hardware acceptance tests of Antenna 9	12/08	12/08	01/09	
21. Antenna 9 Turnover to Operations		12/08	01/09	
22. Start EVLA design conversion on Antenna 8		01/09		
23. Procure 3-bit sampler motherboards		01/09	02/09	
24. WBS cost, schedule, and risk data updated		01/09		
25. L-Band receiver design ready for production		01/09		
26. Hardware acceptance tests of Antenna 15		02/09		
27. Antenna 15 Turnover to Operations		02/09		
28. Alpha release of observation scheduling tool		02/09		
29. Make assessment of X-Band planar OMT design		02/09		
30. Begin production of S-Band receiver		02/09		
31. Begin production of L-Band receiver		02/09		
32. Make assessment of X-Band WG OMT design		03/09		
33. Prototype Ku-Band receiver complete		03/09		
34. Start production of Ku-Band feed horns		03/09		
35. Procurement of WIDAR CBE initiated		03/09		

PROJECTS

1. Expanded Very Large Array

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
36. Start production assembly of DTS modules with 3-bit samplers		03/09		

Management

Overall, the EVLA project remains on schedule. The conversion of antennas to the EVLA design is scheduled to be complete in Q3 of CY 2010. The installation of the WIDAR correlator is scheduled for completion in Q1 of CY 2010. The final EVLA receiver will be installed in late CY 2012.

A white paper was written to describe how a limited number of project personnel who are critical to the long-term operation of the EVLA will transition from the project budget to the NRAO operations budget. NRAO administrative staff in Socorro and Charlottesville are using this paper for long-term budget planning.

A preliminary plan was written to describe the transition from the old VLA correlator to the new WIDAR correlator. This plan is needed to facilitate the early shared-risk science programs for the EVLA. It calls for a shutdown of the VLA correlator in January 2010, with WIDAR observations commencing two to three months later. The plan will be refined over the coming months so that work in support of the transition can commence.

The committee's report from an NSF review of the EVLA project held in September 2008 was received. The committee noted the excellent progress on the project and the responsiveness of the project staff to the recommendations made by previous review committees. The committee cautioned against scope creep in software development and encouraged the NRAO to share its initial science operations plans with the community as soon as feasible. We presented our plans for initial science operations to the user community via an announcement in the February 2009 issue of the NRAO electronic newsletter. Some EVLA work is supported by NRAO operations funds, and the committee noted the risk to the EVLA project posed by inadequate funding of NRAO operations.

A science workshop on "*The EVLA Vision: Galaxies through Cosmic Time*" was held in Socorro on December 16–18, 2008. Nearly 100 scientists from around the world participated in the workshop. The workshop featured a number of science talks on galaxy evolution and cosmology plus presentations on the status of the EVLA project.

The science workshop was followed by a meeting of the Science Advisory Group for the EVLA (SAGE) on December 19–20. The charges to SAGE included requests for comments on a proposed program for resident shared-risk observing (RSRO), recommendations for early science experiments with the EVLA, and suggestions for improving the scientific visibility of the EVLA to the broader astronomical community. Although the final report of the SAGE has yet to be received, preliminary indications are that SAGE enthusiastically endorsed the RSRO program and recommended more science time for NRAO staff involved in EVLA commissioning.

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2. NEW INITIATIVES

Square Kilometer Array (SKA)

Several NRAO participants attended the kickoff meeting for Work Package 2 (WP2) of the European-led PrepSKA initiative. WP2 has a goal of developing a complete, costed system design for the SKA. A key outcome of this meeting was the understanding that the VLA site, probably the ALMA Test Facility (ATF) on the VLA site, is the preferred location for testing and verifying the leading antenna designs that come out of WP2. The NRAO has investigated the suitability of the ATF for this purpose and provided a summary memo plus additional information to the SKA Program Development Office (SPDO). It is likely that one or more SPDO engineers will visit the ATF in the first quarter of CY 2009.

The NRAO initiated a "Lab Notebook" column in its monthly electronic newsletter and published several articles in that column during the quarter. The column is intended to highlight technical developments being made by NRAO that are relevant to future centimeter- and meter-wavelength interferometers having large collecting areas.

The US SKA Consortium met in Madison, Wisconsin, during the quarter. The prime topics for discussion were the SKA-related decadal survey submissions and the presentation of status reports from the U.S. Technology Development Program. The day after the formal consortium meeting, there was an additional scientific session on the promise of neutral-hydrogen surveys with the SKA.

VLBA Partnerships

The VSOP-2 International Science Council met in Japan in December. This meeting focused on the mission status, the role of the Science Council, the key science programs, and the international resources required for the success of VSOP-2. The spacecraft (formally, ASTRO-G) is still on track for launch in early 2013. The partners in VSOP-2 are fully aware that NRAO participation in the VSOP-2 mission will depend on the availability of funding partnerships for the VLBA.

The Director of the National Astronomical Observatory of Japan is the Principal Investigator on a proposal being submitted to the Ministry for Sport, Science, Education, and Culture (MEXT), for a joint VLBA/VERA astrometry program from 2009 through 2014. This program would develop a high-frequency global reference frame and an astrometric mapping of the structure of the Milky Way, and it includes a request for approximately $500,000/yr to support VLBA observing amounting to approximately 300 hours per year. If the initial proposal passes its review, a more detailed proposal will be requested in the first quarter of 2009.

Several discussions were held with two of the Directors of the Max Planck Institut für Radioastronomie (MPIfR) about possible operational support for the VLBA as part of the more global cooperative agreement between the NRAO and the MPIfR. These discussions included the possibility of building an EVLA-like suite of wideband receivers for the Effelsberg telescope and collaboration on development of a 4–8 GHz receiver capability for the VLBA; the latter capability would be aimed primarily at investigations of Galactic structure using the 6.7 GHz methanol line.

NASA delayed the Mars Science Laboratory mission for two years, from a 2009 launch to a 2011 launch, with an associated cost increase of approximately $400 million. The extremely high profile of this mission, coupled with the fact that the Mars encounter in 2012 will occur at a far-southern declination, has led to increased interest in the use of the VLBA as an additional capability for angular tracking and reference-frame construction. A meeting with the Deputy Associate Administrator for Space Communications and Navigation has been scheduled for the first quarter of 2009.

Frequency Agile Solar Radiotelescope (FASR)

The proposal for the Frequency Agile Solar Radiotelescope, submitted to the ATM division of the NSF, was not funded. Future steps are under consideration.

Other Activities

Meetings were held with Los Alamos National Laboratory (LANL) regarding the possible use of the VLBA for imaging geosynchronous satellites illuminated by radar. A proposal to DARPA for a proof-of-concept demonstration, which would include 15–20 hours of observing using the VLBA, was submitted by LANL. Additional discussions were held with personnel from LANL and the Allen Telescope Array (ATA) to explore the possibility of a collaboration on rapid transient detection and follow-up. These preliminary discussions included exploring the feasibility of transient-source detection with the ATA and follow-up high-sensitivity imaging with the EVLA. A preliminary collaboration plan is under development.

New Initiatives Office Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. EVN Directors meeting	Ongoing	11/08		11/08
2. US SKA Consortium meeting	Ongoing	11/08	11/08	11/08
3. VISC-2 meeting	Ongoing	12/08		12/08
4. Submit final report on VLBA Phoenix results	01/08	10/08	03/09	
5. Decision on MPIfR partnership for VLBA ops	06/06	05/09		
6. VSOP-2/VERA collaboration meeting	09/08	04/09	06/09	
7. Decision on VLBA partnership for NASA tracking	05/03	06/09		

OPERATIONS

1. GREEN BANK OPERATIONS

Green Bank highlights for this quarter include:

- Extensive on-telescope and lab tests on a single pixel of the K-Band Focal Plane Array (KFPA) were successful; work began on a seven-pixel array.
- The Critical Design Review of the GBT Dynamic Scheduling System was completed and all users were surveyed for comments and suggestions.
- MUSTANG arrived in Green Bank and new manager software was completed for the winter observing season.
- The Traditional Holography receiver was reinstalled and exceptional first maps were created.
- Out-of-Focus Holography (OOF) became a regular Ka-Band and Q-Band observing tool.
- Zpectrometer shared-risk observations began.
- Completion and shared-risk release of most incoherent modes for GUPPI occurred.
- The GBT computing environment was upgraded to Red Hat 5 Enterprise Edition.
- New GBT azimuth-track covers were designed, fabricated, and installed.

During this quarter the K-Band Focal Plane Array (KFPA) team completed a single-pixel dual-polarization receiver that was laboratory tested, characterized, and installed on the telescope for on- and off-axis efficiency measurements. The new basic monitor-and-control hardware and web-based software necessary to complete the measurements were utilized for these tests. Laboratory tests consisted of baseline stability characterization, receiver noise-temperature measurements, and measurements of calibration values. Spurious-signal investigations revealed problems with the two-conversion downconverter. A design change to a one-conversion downconverter is currently being implemented. The replacement downconverter was delivered and is currently under test. The investigations of efficiency are consistent with expected values (~5% less for > 3 half-power beamwidth offset). The system noise measured astronomically was higher than laboratory measurements as a result of the spurious response and limited LO tuning range. This discrepancy is being investigated and appears to be lowered by the new downconverter. A second, shorter set of tests on the telescope in December indicated that the IF spurs were gone with the new downconverter, and the revised single-pixel receiver was validated as the baseline design for the remaining six pixels. The observing-mode memo was completed and distributed for comment. Work also continued on the pipeline software, guided by the observing memo.

A comprehensive online survey of both NRAO and external users of the new Dynamic Scheduling System (DSS) was conducted following the beta tests that ran during the summer 2008 trimester. Approximately 40% of the users responded to the survey, and the responses were generally positive, although a number of concrete suggestions and issues were noted. The dynamic scheduling team conducted an NRAO-wide review of the project as well as an external progress review. Both reviews went well, with the overall message being that the new DSS is much needed and should be developed with all possible speed. Using the experiences of the project team in supporting the system and users, plus the survey and review results, the team completed a planning exercise to lay out the next release of the

system. This will include changing the underlying operating architecture, implementing the enhanced scheduling algorithms refined during the beta test, overhauling the project look and feel, and tying the dynamic scheduling project into the NRAO-wide databases that are being developed (e.g. single sign-on and authentication, closer ties to the PST database, and use of the NRAO-wide user database). Details of the DSS and access to the system are available on-line at http://www.gb.nrao.edu/dss.

The optics of the MUSTANG receiver (a 90 GHz 64-pixel bolometer array being built in conjunction with the University of Pennsylvania, NASA, and NIST) were changed to increase the speed of the focal plane, with the goal of increasing the receiver sensitivity and field of view. Lab tests proved that this upgrade was successful and that the optical efficiency is comparable to what was measured with the old optics (50%). A new power supply was constructed to allow separate control of the electronics crate and the Mark III MUX tower, plus to free up space in the crate for the DAQ computer. Locating the DAQ computer in the crate eliminated numerous connecting cables passing through the crate and significantly increased reliability. New software capabilities include cryogenic control and monitoring, data monitoring, and a graphical user interface. The science team determined that the extended response of the GBT 90 GHz beam is a significant factor for photometry of extended sources, characterized the issue, and developed and implemented a deconvolution algorithm. The team has also been working with PTCS to design MUSTANG OOF holography observations and data analysis; this work promises to reduce low- to moderate-order beam aberrations. MUSTANG will be installed on the GBT in early January 2009.

The PTCS project to increase the efficiency and gain of the GBT comprises several sub-projects focused on the antenna surface, servo control, and instrumentation. The major sub-projects are covered below.

Pointing

An eight-hour pointing check at Ka-Band shows performance consistent with last fall. Inclinometry results show that the new azimuth track continues to hold its shape. Pointing research is now focused on calibrating the quadrant detector and determining the best filtering method for removing slow changes in DC offset primarily caused by the elevation-dependent flexure of the GBT feed arm. For the first time, there is a procedure for providing a running estimate of the dynamic pointing error in azimuth and elevation caused by motion of the feed arm with respect to the primary mirror. Software changes will be made to implement the necessary changes to the quadrant-detector manager and to propagate the pointing-error data to the gbtstatus screen in real time. New scripts that apply the corrections to MUSTANG image data are being tested with promising results.

Out-of-Focus (OOF) Holography

The new AutoOOF tool was released for use by high-frequency (Ka- and Q-Band) observers. The tool creates a map of the GBT and applies error corrections to the active surface, providing improvements in beam shape and efficiency during daytime observations at the cost of 20 minutes of observing and overhead time. Good progress has been made in understanding the experimental OOF holography results from the previous season of MUSTANG data. The data from most of the 64 pixels can be used simultaneously to solve for the GBT surface deformation. This technique will allow quicker measurement and less overhead time during the coming observing season.

OPERATIONS

1. Green Bank Operations

Traditional Holography

Two new dielectric resonant oscillators with digital phase-locked loops were installed into the reference and test receivers, and system tests for phase drifts and phase noise were completed. The test-receiver mechanical design and layout were changed to fit the test receiver into the Zpectrometer mounting bracket so that the test receiver can be available on the GBT for longer periods of time without occupying a turret receiver slot. The reference-receiver thermoelectric units were refurbished, the 50 MHz IF filters were installed, system gain measurements were completed, and the receivers were installed on the GBT. Initial tests and maps have been produced during system commissioning, and the results matched expectations. Examples of those early maps are included as Figures 1 and 2. Work remaining is to complete commissioning and apply the correction values from the maps to the active surface.

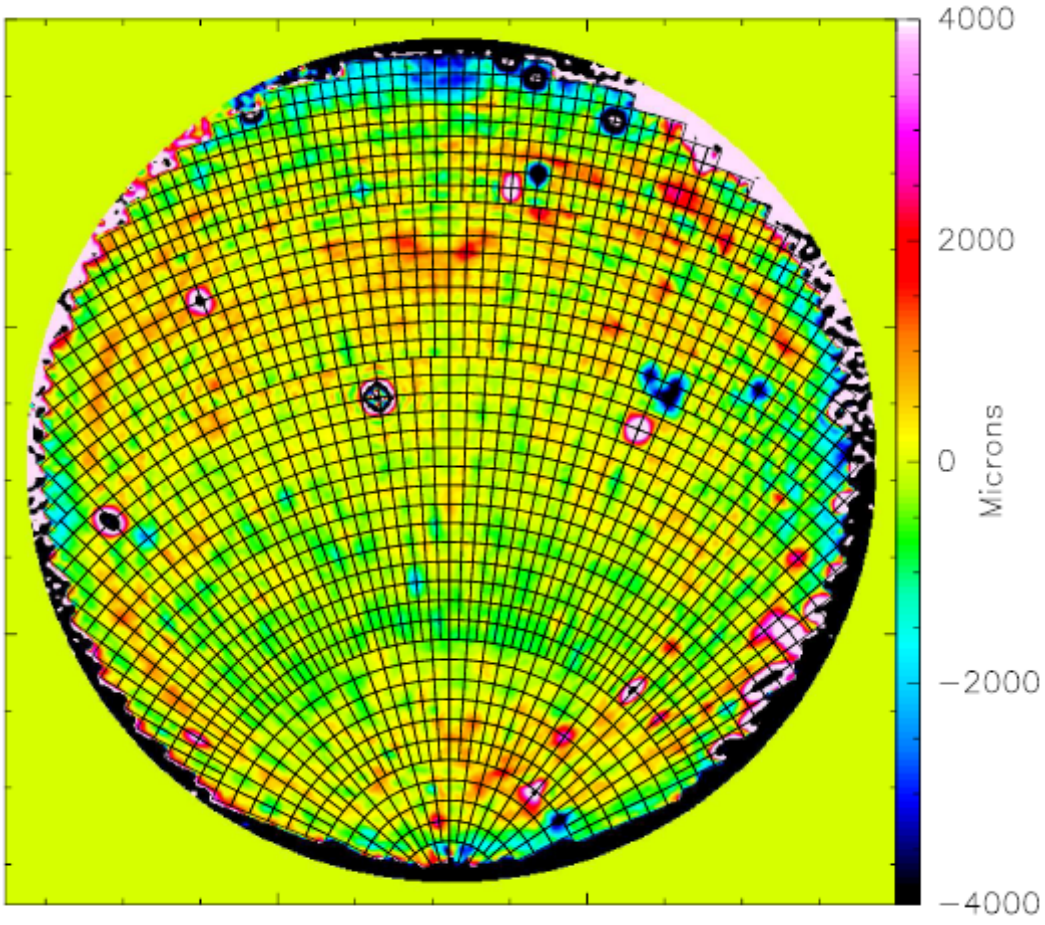


Figure 1. This overall map of the GBT surface from early commissioning runs shows the regions where offsets in the actuator levels are causing significant errors. Once identified, these offsets can be readily removed. The black lines indicate the locations of GBT surface panel borders.

OPERATIONS

1. Green Bank Operations

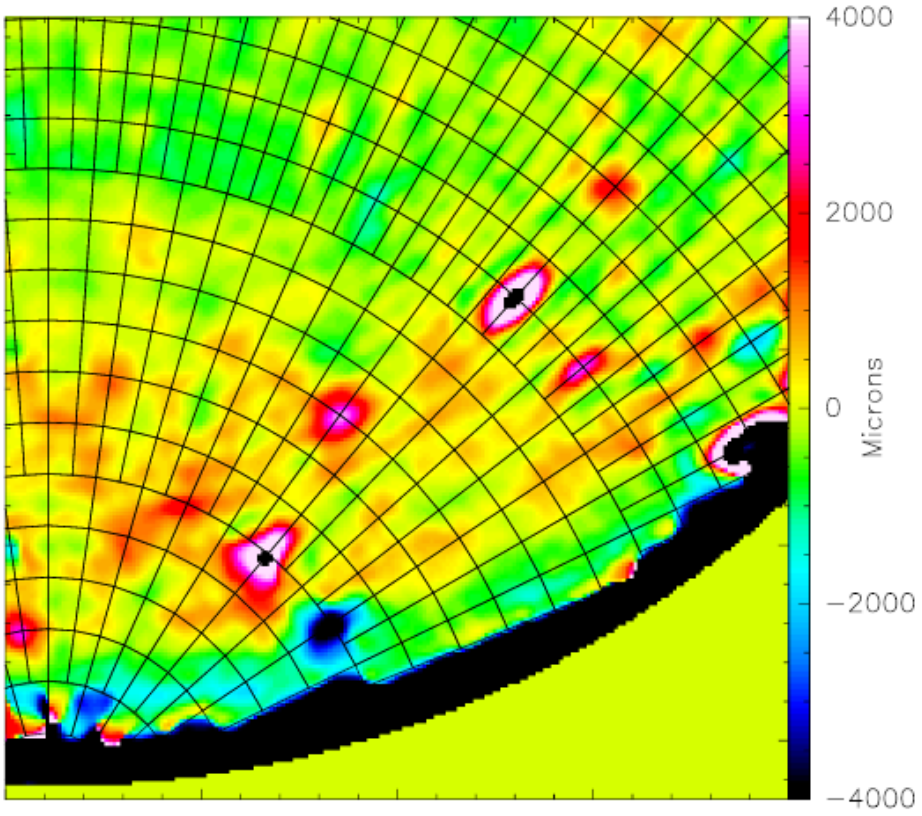


Figure 2. Detail of the bottom corner of a GBT surface map showing several regions with large actuator errors.

Laser Range Finder (LRF)

A photo-detector for the LRF that eliminated the need for multimode fiber was built and tested. Range measurements with the new photo-detector revealed nonlinearities in the distance measurement depending on returned laser power. The problem was isolated to the phase detector circuit, which exhibited sensitivities to the difference in phase between the LO and RF ports as well as sensitivities to the returned power level. Another photo-detector was tested and showed improvements. A new layout and mechanical design were completed to isolate the RF port from the LO port, as this is believed to be a source of the nonlinearities.

Servo System Improvements

Multiple sub-projects for improving the servo system response are underway:

- Servo Resonance Suppression
  - A new position-loop control board was installed that removes the oscillations and instabilities seen in lab tests of the original control board. On-telescope tests verified proper operation of the control board, and it was placed into service in early December.

Subsequent testing revealed additional oscillations are occurring outside of the position-loop board. Extensive test data were gathered. Follow-on analysis, and potentially tests in the lab using the spare rate-loop board, is ongoing. Based on this analysis, the team will decide the next steps in addressing the servo resonances.

- New Digital Servo
  - The digital-servo team has adopted, pending completion of the current proof-of-concept, a new architecture for interfacing the new servo-control software to the existing analog motor controllers. A series of distributed interfaces with embedded microprocessors and interfaces will be installed adjacent to each motor controller. Control signals are sent to the interfaces via a conditioned and clocked Ethernet network and the translation and I/O signals are performed by the distributed interfaces. This will simplify the interconnecting control and status wiring considerably and allows the GBT to use proven, off-the-shelf, factory automation control techniques for the digital servo system. Critical telescope-protection applications will be programmed in to the remote interfaces, providing an additional level of protection completely isolated from the servo control software.
  - Preparation continues for a Servo Replacement Design Review, now scheduled for the spring of 2009. As part of the overall GBT resource planning, the digital servo project has redirected some project team members to complete a number of shorter-term GBT projects to integrate the new instruments into GBT operations and improve observations in 2009. Once these projects are complete, the resources will return to finish the digital servo design and implementation.

Most of the effort on the Configurable Instrument Collection for Agile Data Acquisition (CICADA) project for the quarter was on the Green Bank Ultimate Pulsar Processing Instrument (GUPPI). Nearly all of the incoherent de-dispersion modes have now been implemented and tested. GUPPI has been offered as an "expert" tool for select astronomers and the first use by outsiders was well received, confirming a keen desire for GUPPI as a general-use backend for pulsar astronomy. Additional operating modes were constructed with tests of the 200, 400, and 800 MHz wide modes. Additional low-bandwidth "fast dump" modes are under development along with planning and initial design of coherent de-dispersion modes. Specifications for integration into the GBT Astrid and configuration tools were drafted, and development is planned for the first quarter of 2009 using development resources reassigned from the PTCS project. The project team will present their GUPPI work at the January at the URSI meeting in Boulder.

The Zpectrometer was installed on the GBT on October 30, and the first shared-risk observations were successfully completed in November. There were 1,144 requested Zpectrometer hours and 257 approved hours of shared-risk observing for the 08C and 09A trimesters.

In an orchestrated effort by Green Bank divisions, all systems used for GBT observing and observer control were migrated to Linux Red Hat 5, Enterprise Edition. This brings the GBT systems up to date with the latest functionalities, capabilities, and security features of the new operating system. This effort required extensive testing, modifying, and retesting various Linux-based GBT applications, plus informing the observing community of the new computing environment and changes to the remote-access procedures.

OPERATIONS

1. Green Bank Operations

In time for the winter weather, the Green Bank telescope engineers and mechanical shop designed and fabricated a track cover system for the GBT. These covers travel between the GBT trucks and provide protection for the new GBT track as well as improve traction of the GBT azimuth wheels in wet and slippery weather conditions.

Figure 3. New GBT Azimuth Track covers.

GBT Site Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
Dynamic Scheduling[1]				
1. Incorporate feedback from trial run into system design	09/08	08/08	01/09	
2. External review	11/08	12/07	12/08	12/08
3. Release barebones DSS system for general use	11/08	06/08	09/09	
4. Release enhanced DSS system for general use	10/08	10/09	09/10	
5. Release complete suite of telescope scheduler tools	10/10	10/11		
CICADA (GUPPI)[2]				
1. Incoherent pulsar backend complete	08/08	09/08	12/08	
2. Coherent de-dispersion modes added; testing begins	01/09	06/08	03/09	
3. Release as common user instruments; project complete	08/08	06/08	08/09	

OPERATIONS

1. Green Bank Operations

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
KFPA[3]				
1. Single-pixel testing complete, with Critical Design Review acceptance	01/08	08/08	02/09	
2. K-Band focal plane array prototype pixel accepted	n/a	11/08	02/09	
3. Monitor and control software complete	06/08	02/09		
4. Multi-pixel construction complete	01/08	06/09		
5. System integration and fully laboratory tested		11/09		
6. Data pipeline complete	08/08	02/10		
7. K-Band focal plane array commissioned		11/10		
8. K-Band focal plane array released for use		11/10		
MUSTANG[4]				
1. MUSTANG open for shared-risk proposals	06/08	10/08		10/08
2. Offline data-reduction pipeline complete	03/08	07/09		
3. Available as a facility instrument		10/08	10/09	
4. Online data-reduction pipeline complete		12/09		
PTCS[5]				
1. Recommission traditional holography receiver	04/08	04/08	11/08	
2. Small-scale surface errors characterized by traditional holography	03/07	08/08	12/08	
3. Small-scale surface error initial corrections applied		04/09		
4. PTCS servo Critical Design Review	09/08	01/09		
5. Complete implementation and testing of new digital servos	05/08	09/09	TBD	
6. Servo performance improvements complete	n/a	09/10		
7. Initial deployment of AutoOOF (Out-of-focus holography) for observations	09/07	11/08		11/08
8. Optimization of AutoOOF procedure complete	02/08	07/09		
Zpectrometer[6]				
1. Switch-over to use as a facility instrument		10/09		

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.
3. The KFPA Critical Design Review is scheduled for February 6, 2009.
4. MUSTANG (formerly called the Penn Array Receiver) is a University Collaboration with the University of Pennsylvania.
5. Deployment of digital servo system will be delayed by reallocation of development resources.
6. The Zpectrometer is a University Collaboration with Andy Harris at the University of Maryland.

2. NEW MEXICO OPERATIONS

New Mexico Operations management highlights for this quarter include:

- New Mexico operations management continued to work with NSF's Division of Astronomical Sciences and the NSF Office of General Counsel to determine whether there may be legal bases for Federal action to challenge the routing of the UPC power line close to the VLA site.
- Discussions were initiated with UPC/First Wind about a mutually satisfactory route for the proposed power line that will avoid producing RFI levels detrimental to VLA science operations. A meeting with UPC/First Wind upper management is provisionally planned for January 2009.
- The VLA/VLBA Proposal Scheduling Committee met in Socorro December 3 and 4, 2008.
- CASA development was transferred to NM Operations and ALMA as a joint development task, and a management structure was developed in close consultation with the ALMA Computing IPT.

VLA-related highlights for this quarter include:

- An EVLA workshop, *The EVLA Vision: Galaxies Through Cosmic Time,* was held in Socorro from December 16–18, 2008 and attracted nearly 100 participants.
- The NRAO Science Advisory Committee for the EVLA (SAGE) met in Socorro on December 19 and 20, 2008.
- Eighteen EVLA antennas have now been retrofitted and restored to routine service with the VLA.
- Tests of the prototype WIDAR correlator installed at the VLA site progressed, and a pre-production Critical Design Review was successfully held on December 2 and 3, 2008.

VLBA highlights for this quarter include:

- The major CY 2008 VLBA maintenance program for the Saint Croix site was completed.
- Tiger-team visits to KP and MK were deferred until at least June and August 2009, respectively, owing to budget uncertainties arising from the duration of the FY 2009 Continuing Resolution.

New Mexico Operations Management and Scientific Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Proposal deadline		10/08		10//08
2. Antenna 28 turnover to operations (18th EVLA antenna)		10/08		10/08
3. Replace 2 AZ wheel assemblies and 1 EL bearing on SC	10/08	10/08		11/08
4. Install refurbished subreflector on SC antenna	10/08	10/08		11/08

OPERATIONS

2. NEW MEXICO OPERATIONS

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
5. WIDAR station-board production review		12/08		12/08
6. Proposal Scheduling Committee meeting ends	12/08	12/08		12/08
7. SAGE Science Workshop and meeting ends	12/08	12/08		12/08
8. Freeze AIPS version 31DEC08, begin 31DEC09		12/08		12/08
9. Antenna 9 turnover to operations (19th EVLA antenna)		12/08		
10. BnA reconfiguration completed		01/09		
11. Antenna 15 turnover to operations (20th EVLA antenna)		02/09		
12. B reconfiguration completed		02/09		
13. Draft Transition Plan for EVLA Operations		02/09		
14. EVLA Advisory Committee meeting		03/09		

Computer Infrastructure Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Establish EVLA/AOC fiber plan	08/08	11/07	01/09	
2. Assist with ETK rollout	09/08	07/08	10/08	11/08
3. Redhat EL5 upgrade	08/08	10/08	12/08	12/08
4. Bring up EVLA antenna-9 network	11/08	11/08		11/08
5. Support 10 station board correlator installation	10/08	11/08	02/09	
6. Migrate to new 40 TB archive disk storage	09/08	12/08	02/09	
7. Bring up EVLA antenna-15 network	12/08	01/09	01/09	
8. Bring up EVLA antenna-8 Network		02/09		
9. Host Annual NRAO Sysadmin conference		04/09		

Notes:
1. Start delayed by available time, not yet time critical.
2. CIS unique involvement is complete.
5. Board shipment delayed.
6. Start delayed, in progress.

OPERATIONS

2. NEW MEXICO OPERATIONS

Electronics Division Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Lab Prototype DBE with samplers, attenuators, and anti-aliasing filters in a proper enclosure	01/08	03/08	09/09	
2. Install Mark5 pressure enclosure at MK-VLBA	01/08	05/08	04/08	04/08
3. Delivery of the Mark5C recorders (units 1-3)	06/08	06/08	01/09	
4. Install an EVLA-compatible API at the VLA	01/08	08/08	02/09	
5. Install the FRM brake power supply and new interface board for testing in one VLA antenna.	06/08	09/08	02/09	
6. VLA P-Band receiver-upgrade white paper	10/08	10/08		11/08
7. Scheduled Maintenance Visit at SC-VLBA	10/08	11/08		11/08
8. Implement Servo Board upgrade		02/09		
9. Order Mark5A to Mark5C Upgrade Kits		03/09		
10. Initial DBE/M5C installation at one VLBA site		04/09	09/09	
11. Complete DBE installation at 10 VLBA sites		08/09	11/09	
12. Order software correlator cluster		08/09		

Notes:

1. Revisions to the Berkeley ROACH computer card delayed the board manufacturing. Version 1 hardware was tested in June. Version 2 hardware was delivered in December for testing. Complete DBE testing is estimated to start January 2009 after the Mark 5C recorders are 100% functional.
2. This is a low priority task and will be completed as time permits.
3. Conduant Inc. delivered the three Mark 5C chassis in June 2008. The 10GE daughter cards will be delivered in January 2009.

4., 5. The EVLA project has priority over this task.

Engineering Services Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Complete A array reconfiguration	09/08	10/08		09/08
2. St. Croix visit: subreflector, paint, EL brg., AZ wheel assy. replacement, general mech. maint.	10/08	10/08	11/08	11/08
3. St. Croix antenna painting	09/07	12/07	11/08	11/08
4. Replace 3,600 ties (see note)	08/08	11/08		11/08

OPERATIONS

2. NEW MEXICO OPERATIONS

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
5. Complete BnA array reconfiguration		01/09		
6. Complete B array reconfiguration		02/09		
7. Upgrade fuel tanks to comply with NMED requirements.	11/08	02/09		
8. Repair BW-9, BW-6, BW-3 intersections		03/09		
9. Complete CnB array reconfiguration		05/09		
10. Kitt Peak VLBA Maintenance Visit		06/09		
11. Mauna Kea VLBA Maintenance Visit		08/09		
12. Complete DnC array reconfiguration		09/09		
13. Replace Ant. 20 azimuth bearing		09/09		
14. Complete D array reconfiguration		10/09		

Note:
4. Changed number of ties installed. Need to reserve ties for intersection repairs and emergency repairs.

3. NORTH AMERICAN ALMA SCIENCE CENTER (NAASC)

NAASC highlights for the quarter include:

- The second fully public version of the CASA offline system (2.3.0) was released, with user support provided by the NAASC.
- The ALMA Operations budget for 2009 was reviewed.
- Public demos of the CASA ALMA simulator, the *splatalogue* spectral line database, and the ALMA observing tool were developed for use at the NRAO booth at the upcoming AAS meeting.
- In collaboration with the UVML, balanced and sideband-separating SIS receivers are being developed for 385–500 GHz and 780–950 GHz based on AlN SIS junctions and Nb and NbTiN superconductors, and a hot-deposition system was ordered.

NAASC Personnel

Staffing remains a high priority for North American (NA) ALMA operations. Harvey Liszt joined the NAASC staff this quarter, where he will serve as the NA ARC liaison to the ALMA Observing Tool and Pipeline teams, helping to organize NA participation in tests of these important end-user software systems. Preparations were made to interview candidates for the jobs that were posted last quarter—a second NAASC Commissioning Liaison, a CASA developer, and the first two NAASC postdocs. The two postdoc positions are targeted towards young submillimeter experts who will (1) exercise the scientific capabilities of the CASA offline software package, and (2) contribute to the content and evaluation of the molecular spectral-line database *splatalogue.*

Community Support

The ALMA Science Advisory Committee (ASAC) working group on ALMA development held telecons to discuss projects that would ensure that ALMA remains at the cutting edge of capability in mm/submm-wave astronomy out to 2030. A preliminary report was presented to the ALMA Board at its November meeting and circulated to the community for discussion in December. One identified key goal is to provide the ALMA main array with a collecting area equivalent to at least fifty 12 m antennas; a study produced by A. Wootten suggests that during regular operations only 46–47 antennas may be available at any given time. The disposition of the Vertex prototype antenna is being discussed with the community. Possibilities include operation as a VLBI station, inclusion in an existing array, or operation as an independent submillimeter facility, possibly in conjunction with the similar antenna at APEX on Chajnantor.

The draft implementation plan for the ALMA proposal-review process was reviewed and refined, and a summary document was sent to the ALMA Board subcommittee on this topic. Further review of this plan will be assigned as a charge to the ANASAC in the coming quarter.

NAASC support and testing of ALMA offline software continued. The major activities during this quarter included (1) a face-to-face coordination meeting in Socorro of the internal CASA scientific oversight committee; (2) intensive pre-release testing in advance of the CASA beta release 2.3.0 on November 25, 2008; (3) setting development targets for the next CASA Beta release (2.4.0) in late Q2 2009; (4) the

cookbook and public webpages for the CASA ALMA simulator `almasimmos` were updated, and a demonstration `almasimmos` was developed for use at the upcoming AAS meeting. CASA staff also provided the bulk of external user support during this period. Approximately 80 external user helpdesk tickets were submitted this year. CASA release 2.3.0 contains significant improvements to CASA that allow reduction and imaging of data from current millimeter interferometers such as CARMA (heterogeneous imaging) and the SMA (spectral window independent bandpass calibration). Most importantly, these improvements will be essential for ALMA.

Planning for the NAASC helpdesk system began with a review of systems currently in use at other facilities. A visit to the National Herschel Science Center has been planned to investigate the capabilities of their adopted system, Kayako, for use both by both ALMA and the EVLA.

NAASC staff participated in a meeting between the NRAO and members of the faculty of Howard University (lead by Prof. Marcus Alfred). The meeting was the first step in (a) building a relationship aimed at enhancing the growth and prestige of Howard's science and engineering programs as they advance science and technology in this HBCU institution, as well as (b) continuing the goal of NRAO in broadening the pool of science and technical university graduates in astronomy and related fields. Follow-up activities are in the works and will include scheduling colloquium visits to Howard U. by NRAO staff.

Education and Public Outreach

Regular articles on the status of the ALMA construction project were published in each monthly NRAO eNews, the NA ALMA calendar was issued biweekly, and NAASC staff contributed to the first JAO ALMA Newsletter, slated for January distribution.

An article on the 3rd NAASC Science Workshop *"Transformational Science with ALMA: The Birth and Feedback of Massive Stars Within and Beyond the Galaxy"* was published in the October issue of the NRAO eNews, and electronic versions of the workshop talks were posted to http://www.cv.nrao.edu/php/meetings/massive08/program.shtml. Planning for the next NAASC Science Workshop is making significant progress, including generating an internal report on "lessons learned" from previous workshops, to streamline future planning.

NAASC staff used `almasimmos` to produce a mosaic of Vega's debris disk, starting from a numerical simulation (Fig. 1) by Mark Wyatt. The mosaic observation used simulated data, with both thermal and corrected phase noise, from the Atacama Compact Array and several of the more compact 12m ALMA configurations. The mosaic will be used for ESO's ALMA education and public outreach.

3. North American ALMA Science Center

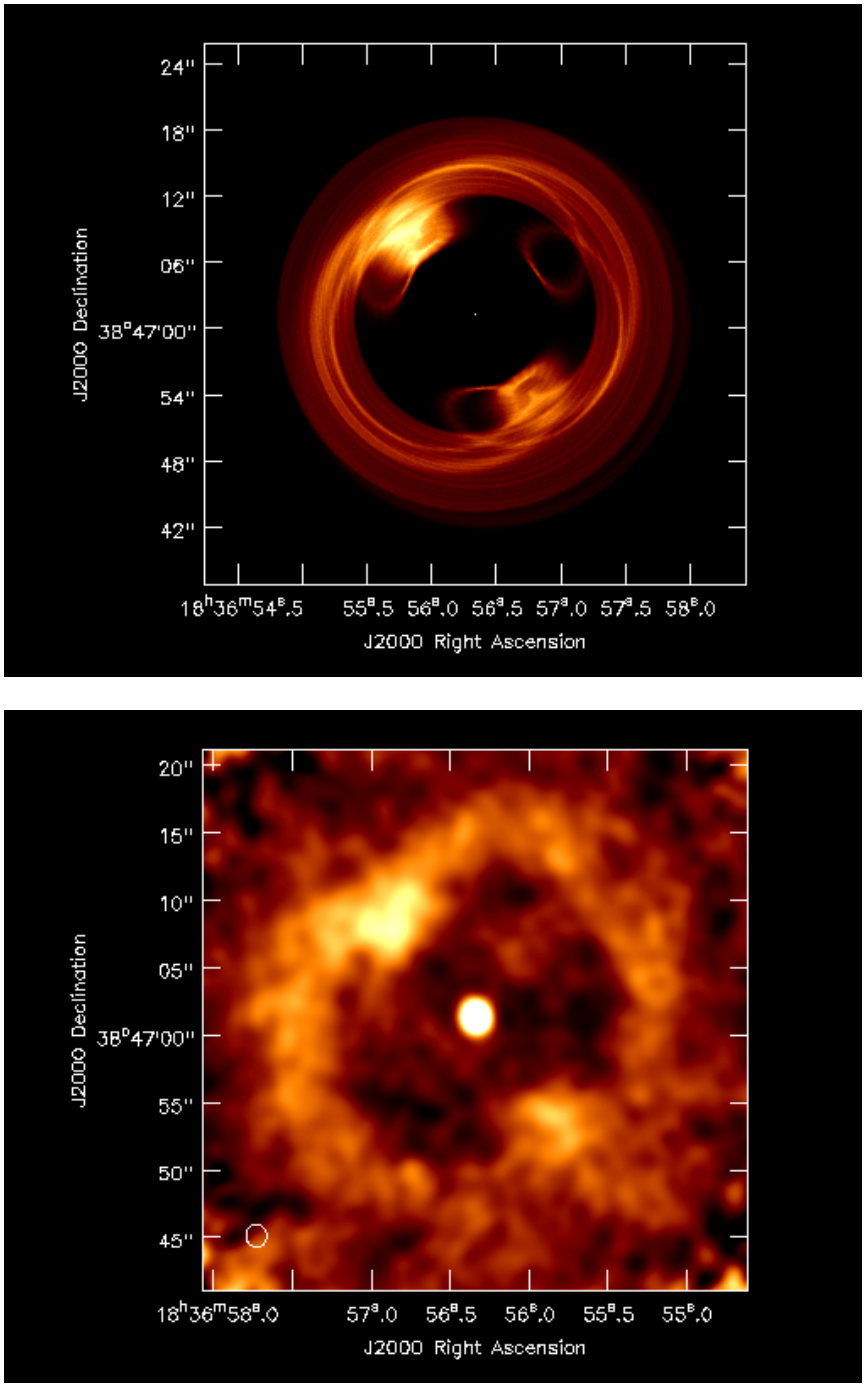


Figure1. (top) Numerical simulation of a debris disk around the main-sequence star Vega, produced by Mark Wyatt (IoA, Cambridge). (bottom) Simulation of the Vega debris disk as it would appear in an ALMA observation including the ALMA Compact Array.

NAASC staff developed material for distribution at the January 2009 National Radio Science meeting and the AAS meeting. This included recording and producing video demonstrations of progress-to-date of the ALMA Observing Tool, developed at the UK Astronomy Technology Centre, and the Splatalogue Astronomical Spectral Line Database, developed at NRAO. It also included a slide presentation demonstrating the use of CASA as an ALMA simulator. A new NRAO booth configuration with a large-screen projection display was constructed for the AAS meeting. A looping multimedia NRAO/ALMA presentation was developed for display on the screen, including video footage recently acquired at the ALMA site and random "button box" access to in-depth ALMA content for interested booth visitors.

NRAO EPO staff contributed towards two press releases including video footage and consultation on joint development by all ALMA EPO partners of a press release celebrating the acceptance of the first (MELCO) antenna, and production of a NRAO-specific version of this release, which was distributed via the AAS. NAASC staff also created and posted/distributed an NRAO press release announcing Taiwanese participation as a "North American" ALMA partner.

NAASC EPO staff participated in a number of ongoing development projects including: consultation with ESO on a draft script for an ESO-sponsored ALMA planetarium show; the JAO EPO Implementation Plan including the JAO's idea to produce "EPO building blocks"; tests of a digital asset management software system (for NRAO's internal image/video library); a new ALMA Media Prospectus document, to be designed and released in Q2, undertaken by engaging the services of an outside freelance designer; advocacy of a standard-format image credit line that acknowledges the executives in all images provided by the JAO and used on their ALMA website; and conversion of existing NRAO NAASC and ALMA web content for the new NAASC site.

NAASC staff attended a number of meetings and gave science talks featuring discussions of the potential for ALMA. These included an ALMA public lecture to the top University of Virginia engineering students in the Rodman Lecture series and science colloquia at James Madison University, the University of British Columbia, the Herzberg Institute for Astronomy, and the University of Washington (Brogan). A. Wootten organized ALMA special sessions for the January 2009 National Radio Science Meeting and the AAS meeting. He also prepared a talk on Exoplanet Science Capabilities of ALMA to be delivered at the NASA Astrobiology Institute's (NAI) Planetary System Formation Focus Group (PSFFG) to be held in conjunction with the AAS meeting. NAASC staff attended the EVLA workshop in Socorro, Dec 16–18 (Lonsdale) in support of potential joint user-support activities between ALMA and EVLA.

International Partnerships

On behalf of the National Science Council (NSC) in Taiwan and the U.S. National Science Foundation, the Taipei Economic and Cultural Representative Office (TECRO) and the American Institute in Taiwan (AIT) signed an Agreement for Cooperation in Astronomy and Astrophysics associated with the Atacama Large Millimeter/submillimeter Array Project on October 27, 2008. The agreement provides for annual contributions by the NSC to support the North American (NA) construction of ALMA and for a share of the NA operation after construction. The Academia Sinica Institute of Astronomy and Astrophysics (ASIAA) and the NRAO have been designated by the TECRO-AIT agreement as the institutions to carry out the responsibilities associated with Taiwan's participation in the ALMA Project. Activities under the agreement will include joint research projects, development projects, collaboration on construction,

support of observatory operations, and other forms of cooperation. Access to ALMA observing time will be shared, as will membership on advisory committees.

There is a parallel Taipei-American Program in Radio Astronomy (TAPRA), an agreement between ASIAA and the NRAO, similar to the NAPRA agreement between the HIA and the NRAO that basically affords all Taiwan astronomers the same treatment as U.S. astronomers in regard to all NRAO facilities and encourages further collaborations. The details of the benefits that this agreement will bring to ALMA will be detailed in the coming months.

NAASC staff participated in an emergency budget summit in Chile to review the preliminary ALMA Operations budget update to version D1. A memo was written to the JAO detailing NA and East Asian planning and reporting requirements and suggesting procedures to avoid the need for emergency summits. The final JAO budget was reviewed and comments were provided to the NSF. Input was provided on the Executive reconciliation process, and the NAASC FY 2009 budget was re-evaluated based on the preliminary D1 budget with shifted milestones to fit within the potentially yearlong Continuing Resolution budget.

Special Projects

The principal work on the NAASC-developed spectral-line database Splatalogue (www.splatalogue.net) was completed. Splatalogue data from the CDMS, JPL, SLAIM and the Lovas/NIST lists have been completely reconciled and resolved for consistency. Splatalogue continues to be rigorously tested for completeness and reliability, with a goal of 100% reliability by the AAS meeting in January 2009. A new java software application was created to display predicted line strengths in the LTE low-optical-depth case. A splatalogue demo was developed for use at the NRAO booth at the upcoming AAS meeting.

A Purchase Order was issued to the UVML for the manufacture and supply of replacement SIS mixer chips for ALMA, and for the design of 500 GHz and 900 GHz SIS mixers using A1N junctions. The delay in the contracting process and the loss of a key collaborator at the Arizona Radio Observatory has necessitated a revision of the milestone completion dates shown in the milestone table.

The UVML has placed an order for a hot deposition system to be used in this work. The hot deposition system will allow fabrication of superconducting thin films with critical temperature close to the bulk value and normal metal films with low resistivity. Designs for the RF hybrids have been completed, and a mask set for their fabrication is being laid out at the UVML. These hybrids are a crucial part of the 500 GHz and 900 GHz balanced and sideband-separating SIS mixers and also of the LO couplers. A 4 K mixer test set is being constructed for use at 385–500 GHz and 780–950 GHz.

Other Efforts

NAASC staff participated in NRAO-wide planning for observatory-wide science operations, with a particular emphasis on how ALMA support operations can be leveraged across the NRAO. A document on NRAO Integrated Science Operations was drafted and distributed at the NRAO Executive AD meeting. This document will be refined in the next quarter.

OPERATIONS

3. North American ALMA Science Center

NAASC Milestones October to December 2008[1]

Milestone	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Participate in Pipeline Test 5	11/07	11/07	12/08	
2. Science center visits–Herschel, Spitzer, and JWST	11/07	11/07	03/08	01/09
3. Spectral-line catalog—release 2	01/06	12/08		12/08
4. ARC CASA testing Q4 (ver 2.3.0)	01/06	09/08	10/08	10/08
5. CASA release 2.3.0	01/06	09/08		11/08
6. Hire Scientist 5 (CSV liaison)	09/07	04/08	07/09	
7. Decision on NA ALMA archive—buy or outsource	08/07	05/08	07/09	
8. Advertise for Archive Tech 1	06/08	06/08	07/09	
9. Participate in ObsTool Test 5.1 (at ATF)	01/07	08/08		12/08
10. Review ALMA Ops CY 2009–2015 budget	07/08	08/08	10/08	10/08, 12/08
11. Software demos for January 2009 AAS meeting (splatalogue, almasimmos, observing tool)	10/08	12/08		12/08

Notes:
1. SIS Mixer development milestones are included in the CDL section of this document.
2. Delay caused by revised project milestones.

Ongoing Activities
1. Developing outreach materials, including news, press releases, and brochures
2. Updating NAASC web pages and maintaining their synergy with the ALMA project
3. Maintaining and upgrading the Splatalogue database and functionality
4. Maintaining and upgrading the almasimmos simulator, and developing a library of astronomical simulations of interesting objects
5. Testing and exercising CASA tools and pipeline
6. Fostering interactions with the general community through the ANASAC committee, conferences, workshops, visits, etc
7. Planning the helpdesk and archive installations
8. Maintaining strong connectivity between the NA ARC and the international project through telecons, meetings, visits, etc.
9. Participating in the re-structuring of NRAO user-support services towards the "One Observatory" goal, through meetings and site visits
10. Planning to start a community-led effort to develop a modeling environment to simulate ALMA and EVLA spectra from complex astrophysical sources

4. CENTRAL DEVELOPMENT LAB (CDL)

CDL highlights for the quarter include:

- The 70 nm GaAs Power Amplifiers designed earlier this year and probe tested during the last quarter have now been proven to work in the ALMA Local Oscillator Modules.
- A new class of reflectionless filter prototypes has been developed. They have no reflection in either their pass- or stop-bands and lend themselves easily to integration within compact receiver assemblies.

Low Noise Amplifier Design and Development Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Development of prototype ALMA Band 1 and Band 2 low-noise amplifiers	06/07	03/09		

Notes:

1. Demonstration low-noise amplifiers for ALMA Band 1 (31–45 GHz) and Band 2 (67–90 GHz) receivers has been designed. Experimental evaluation awaits the availability of technician time.

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

Ongoing Activities
1. Build/upgrade/repair cryogenic amplifiers using Cryo-3 TRW devices for the EVLA covering the frequency range from 1 to 50 GHz
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
3. Improvements to existing measurement systems

Notes:

1. and 2. New amplifier production included four 1–2 GHz low noise, four 1–2 GHz high dynamic range, two 2–4 GHz, four 4–8 GHz, two 4–12 GHz, three 18–26 GHz and two 38–50 GHz amplifiers. Repair, upgrade, and retesting of amplifiers included six 18–26 GHz, one 26–40 GHz and two 38–50 GHz amplifiers. In total, 30 amplifiers were shipped. EVLA and GBT amplifier production is on the average approximately on schedule. We are behind in shipment of four 2–4 GHz amplifiers and four 26–40 GHz amplifiers but ahead in shipment of four 18–26 GHz and four 38–50 GHz amplifiers. Production activities will be adjusted accordingly (see next paragraph). Deliveries of amplifiers for the GBT K-Band focal plane array as well as the deliveries of 38–50 GHz amplifiers in support of the Korean VLBI network are on schedule.

Bill Lakatosh retired from the amplifier group after 23 years of service. We are currently training a new assembler, Stacy Knighton. Both the retirement of Bill and the effort devoted to training Stacy have had some negative effect on the production this quarter.

4. Central Development Lab

MMIC Design and Development Milestones

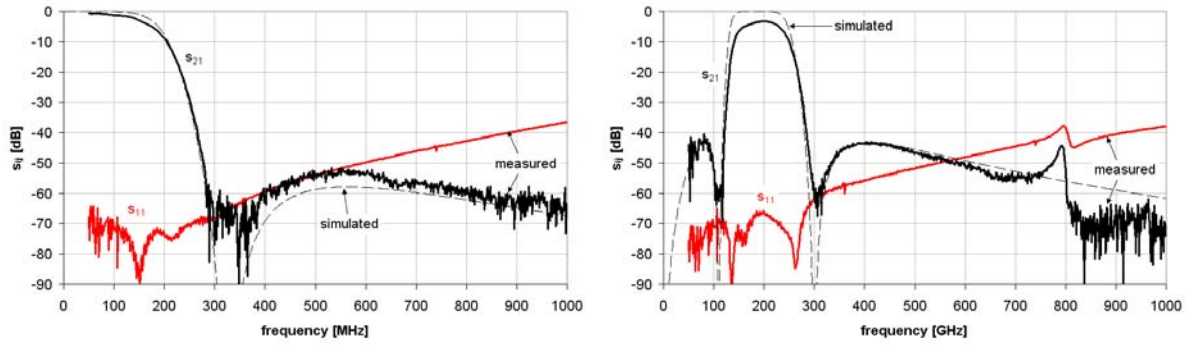
Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Develop differential LNA for balanced feeds	10/06	12/06	12/09	
2. Develop integrated wideband LNA–feed package	10/06	12/06	12/09	
3. Design and test GaAs W-Band (75–110 GHz) power amplifiers to improve reliability of mm-wave local oscillators	10/06	03/07	12/08	12/08
4. Demonstrate wideband, digitally enhanced sideband-separation receiver at L-Band in an integrated package	07/08	12/08		11/08
5. Improve integrated wideband digitally enhanced sideband-separation receiver at L-Band	11/08	06/09		
6. Demonstrate digitally enhanced polarization-isolation receiver at X-Band in an integrated package	07/08	12/08	06/09	
7. Integrate analog and digital components for digitally enhanced receivers in single compact housing	07/08	06/09	12/09	

Notes:

1. At this point, further progress on this task must wait for an appropriate MMIC wafer run.
2. The high-impedance transition between quad-wire and differential microstrip which was developed at the CDL during the previous quarter has been tested at JPL with promising results (better than 20 dB return loss). Further fine-tuning will be performed with the aid of a differential network analyzer. Additional components related to integration with a cryostat have been procured for further tests.
3. Characterization of the 70 nm GaAs MMICs within ALMA modules has been performed with the hoped-for results. These chips are now being integrated in ALMA production LO assemblies.
4. The integrated L-Band converter has been tested. While the achievable sideband isolation is excellent, the measured calibration coefficients show a great deal of frequency structure, which has been traced back to cavity effects in the package. As this might have an impact on calibration stability, we decided to revise this module before moving on to integrating the digital components within the housing. This has pushed back the completion dates of milestones 6 and 7.
5. Design of the revised L-Band digitally enhanced sideband-separating receiver is complete, and the parts are on order.
6. Although procured in the previous quarter, some of the components for the digitally enhanced OMT package have still not arrived. The analog downconverter needed to process the output of this OMT will also be delayed pending the resolution of issues encountered with the L-Band downconverter module in milestone 4.
7. This has been delayed pending resolution of the issues encountered with the downconverter in milestone 4.

4. Central Development Lab

Other:
While trouble-shooting the L-Band downconverter, Matt Morgan prototyped a new class of filters that, unlike previous filter designs, absorb the stop-band portion of the spectrum rather than reflecting it. Measured results on the first two such filters are shown in the figure below. Such filters may have a wide range of applications not only in radio astronomy but in many areas of commercial electronics. The CDL is in the process of filing a provisional patent application for this serendipitous invention.



(a) (b)

Figure 1. Measured and simulated performance of prototype low-pass and band-pass reflectionless filters. Simulated s_{11} in dB is infinite.

Additional time was used to organize the 20th International Symposium on Space THz Technology (ISSTT2009), to be held on April 20–22 at the Omni Hotel in Charlottesville, VA.

Electromagnetic Support Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Develop a dual-band 345/800 MHz feed for the GBT	06/05	09/05	09/09	
2. Design and prototype an EVLA X-Band (8–12 GHz) OMT	05/08	09/08	03/09	
3. Design and prototype an EVLA X-Band phase shifter	10/08	09/08	06/09	
4. Measure and complete the design of the Ku-Band (12–18 GHz) phase shifter	12/07	09/08	05/09	
5. ALMA Band 8 (385–500 GHz) optics design	11/08	12//08	03/09	

Notes:
1. Work on this project is on hold due to other priorities.
2. The design of the OMT was completed. The mechanical design done by M. Solatka is shown in Figure 2. The OMT fits within a circle of radius 5″ and measures 2.7″ from the flange of the square

port to the flange of the rectangular port. The input return loss is better than -17.5 dB and the cross-polarization isolation is better than 50dB in the 8–12 GHz range. Fabrication of the OMT is underway.

4. Postponed owing to the fabrication delay of the outside machine shop.
5. Preliminary design of the feed horn is complete. Optics design is underway.

Other Projects:
The far-field patterns of a lens-corrected corrugated feed of the ALMA Band-3 receiver was measured in the Green Bank Indoor Antenna Range.

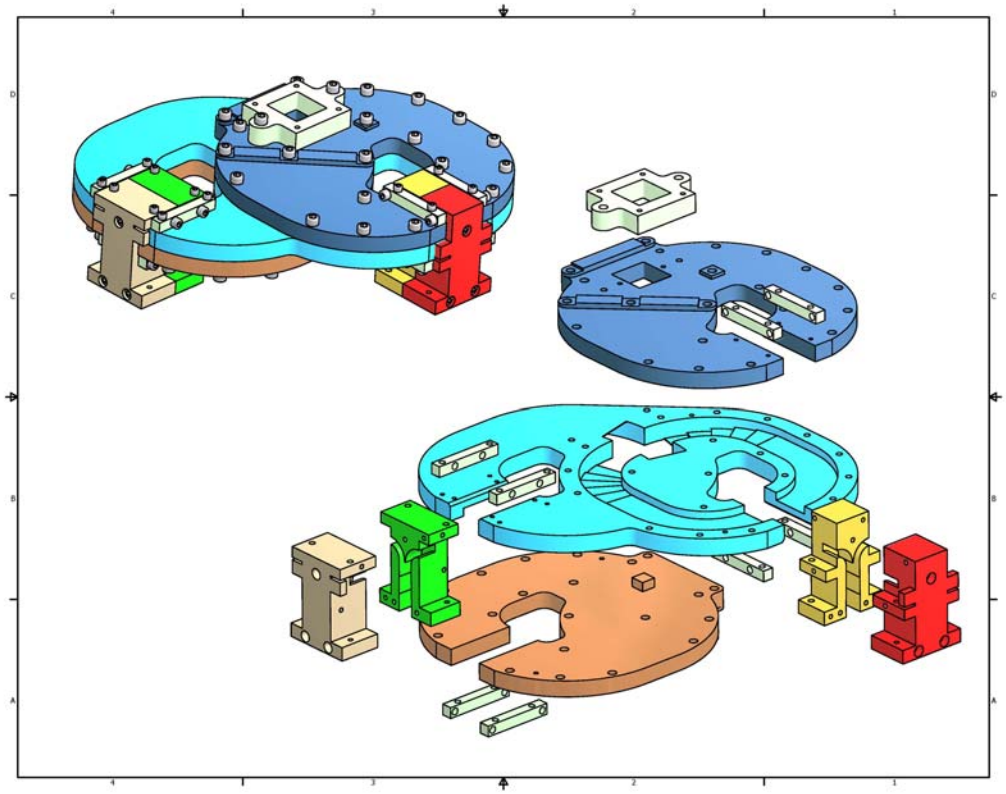


Figure 2. EVLA X-Band OMT.

4. Central Development Lab

Superconducting Millimeter-Wave Receiver Development Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. PO issued to UVML	07/07	01/08	06/08	12/08
2. Hot deposition system ordered by UVML	07/07	10/08	12/08	12/08
3. Complete 500 GHz mixer test set	01/08	12/08	03/09	
4. Measure the drop-in hybrid and LO coupler at 500 GHz	06/08	01/09		
5. First measurements of the 500 GHz SIS mixer	05/07	01/09	03/09	
6. Design $\lambda = 350$ μm optics	01/08	04/09	06/09	
7. Complete initial design for a900 GHz mixer	05/07	04/09	06/09	
8. Complete a 900 GHz mixer test set	01/08	06/09	12/09	
9. Measure the first 900 GHz receiver	05/07	09/09	03/10	

Notes:
Start dates indicate the beginning of design and feasibility studies, which in all cases commenced before substantial funding became available.
1, 2, 3, 4, 5, 6, 7, 8, and 9. Schedule revised following: (i) the six-month delay in establishing a contract between the NRAO and the UVa after NSF approval had been received; and (ii) the loss of a key collaborator at the Arizona Radio Observatory.
2. The hot deposition system will allow fabrication of superconducting thin films with critical temperature close to the bulk value and normal metal films with low resistivity.
4. RF hybrids are a crucial part of the 500 and 900 GHz balanced and sideband-separating SIS mixers.
5. Development of the 500 GHz SIS mixer is an essential step on the way to the 900 GHz SIS mixer. They share the same new basic design and much of the new fabrication technology. This (and item 3) is being supported in part by the Arizona Radio Observatory.
7. The 900 GHz SIS mixer will be based on the 500 GHz design.
8. This is an extension of 1, with different optics and LO and signal sources.

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

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. 32-element array in Western Australia	06/08	04/09		

Frequency Agile Solar Radiotelescope (FASR) Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date

OPERATIONS

4. Central Development Lab

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Prototype FASR B Subsystem	10/08	03/09		

Lunar Array for Radio Cosmology (LARC) Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Array Concept Study	10/08	04/09		

Ongoing Activities
1. Gold Plating
2. Copper Electroforming
3. Waveguide plating
4. Resolving issues with "hard" gold chemistry.

Notes:

1. The Chemistry Lab's gold-plating output (bondable and "hard" golds) for the quarter was again seven Troy ounces (217 g). This represents a gold cost to us of about $5,880 and a commercial plating value of $88,000. Primary "customers" continue to be ALMA and the EVLA.
2. The new copper-electroforming system continues to perform well, and we have gained confidence in our ability to "string" two or three components in a "Siamese twins–triplets" configuration. Where the original, large, open-top electroforming tank could at best produce 5–10 components per month, the new system and parts configuration can yield 20–40 electroforms per month with a commercial value of $10,000. That production rate actually exceeds our ability to machine and finish the components, so we have abandoned as unneeded establishing a second such electroforming system.
3. The lab continues to produce a large volume of gold plating, copper electroforming, and specialized plating (20 pieces) such as internal waveguide plating in support of NRAO sites and major projects.
4. Performance issues were encountered with the bright "hard" gold-plating system in late December, and technical support from the vendor, Cookson Electronics, indicated that the bath chemistry had reached its life expectancy of three years. The initial performance of the replacement bath was unsatisfactory and perplexing. Analysis is still underway, but there are indications that we received a defective formulation. Our application choice of bright vs. pure gold is often based on cosmetics and tradition, and some production has been shifted to the pure (bondable) gold process while the issues are resolved.

5. CHILE OPERATIONS

Chile Operations highlights for the quarter include:

- New local and international hires for ALMA.
- A significant number of entries into the NRAO/AUI Business metrics.
- Implementation of ongoing EPO activities.

Local Labor Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. New ALMA local hires by NRAO: 11 (Local Labor Contract No. 134 signed)	10/08			12/08
2. New hire: Payroll Assistant in the NRAO Chile Office in support of ALMA Ops.	10/08			10/08
3. New hire: Admin Assistant for the NRAO Chile Office at the ALMA Site in support of ALMA Ops.	11/08			11/08

Business/ Environment Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. CONAMA (Chile Environmental Agency) Site inspection passed	10/08			10/08
2. New Purchase Orders: 133 ($5.65M)	10/08			12/08
3. Payments made: 759 ($8.44M)	10/08			12/08
4. FY 2009 HR Recovery Fee submitted to ALMA Executives	11/08			11/08
5. Accreditation of two new expat arrivals (including relocation support)	10/08			12/08

EPO

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Deliver material from third filming trip of NRAO ALMA activities at site	10/08			10/08

6. END-TO-END OPERATIONS

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

- CASA v2.3.1 (Beta Release, Patch 3) is available at http://casa.nrao.edu/betarelease.shtml. A computing cluster for improving performance of data processing software was procured, configured, and installed in Socorro.
- The NGAS archive is now storing data from EVLA tests in ALMA Science Data Model (ASDM) format.
- KML Now! Visualization service for Virtual Observatory (VO) in Google Sky was released (see http://go.nrao.edu/kmlnow).
- The Centralized Authentication Service (CAS) was released as the Observatory-wide mechanism for user account management and single sign-on to web applications.
- The NRAO coordinated video participation in the three-day algorithm research and development meeting at Oxford, making it accessible to all NRAO sites, Cape Town, Munich, Penticton, and other sites.
- Participation in the Astronomical Data Analysis and Software Systems (ADASS) conference and Supercomputing 08.

Management & Administration

Building on the NRAO Director's Office MOU with MeerKat (South Africa) to collaborate on monitor and control systems and algorithm research, the NRAO hosted a visit by four members of the South African team in November. They visited Charlottesville, Green Bank, and Socorro and met with CDL staff, software engineers, electronics engineers, and staff scientists. They also visited the VLA site and the ALMA Test Facility. As a follow-up to their visit, a few NRAO staff participated in the Karoo Array Telescope Preliminary Design Review in late December. End-to-End Operations also participated in the Green Bank Dynamic Scheduling System (DSS) review in December.

Cooperative efforts involving the NRAO and other institutions continued this quarter. In particular, preliminary work started between the NRAO and NCSA to create a pulsar archive for observations from the GBT in 2009. End to End Operations also collaborated with the Computing and Information Services division and University of Virginia computational science faculty to identify mutually beneficial opportunities related to parallelization of NRAO code. The bulk of this work will occur in Q1 2009. Unfortunately, the NSF proposal submitted by lead institution Penn State in Q3 2008 (to fund a three-year Focused Research Group to study statistical pattern detection in the enormous data sets that will be produced by the EVLA and ALMA) was turned down this quarter.

This quarter, there were several shifts in the target dates originally specified in the original FY 2009 Program Plan. First, preparation of an operations plan for VO at the NRAO is dependent on pending funds, and this task will not be started until those funds are available. Second, we recognized an opportunity to move forward with the VO–Google Sky integration and work on a plan for making the VO "real" to the NRAO scientific staff and user community. As a result, we shifted the originally scheduled data-mining work that was planned for Q3 2009 to Q4 2008. All changes in dates on this quarterly report reflect the resources that were shifted to accommodate that change.

Data Processing/Common Astronomy Software Applications (CASA)

CASA development was transferred to NM operations and the ALMA Project as a joint development task during the quarter. In future reports, CASA updates will be included as part of the developing Observatory Science Operations organization that provides user support, including data pipelines and analysis tools, to the community.

CASA v2.3 (Beta Release, Patch 3) was released on schedule in Q4, managed by B. Glendenning of ALMA with joint oversight by B. Butler from EVLA. The major improvements that have been included in this new release are:

- Single-field VLA data reduction (L-Band and above is now supported).
- Wide-field imaging is available.
- Heterogeneous mosaics and combined single dish+interferometry are supported.
- Full Stokes polarimetry is supported.
- The Science Data Model (SDM) filler for ALMA and the EVLA was released.
- The image analysis package was improved for stability and performance.

CASA was a key part of the testing efforts conducted at the ALMA Test Facility (ATF) at the VLA site over the past year. The tests were successfully completed in December 2008 and the ATF was retired. The next major release (v2.4.0) will occur in June 2009. A patch release to version 2.3 (2.3.1) will be release in Q1 2009 with a number of bug fixes and modest improvements (e.g., improved (*u,v*) continuum subtraction with many spectral windows, MacOS distribution of SDM filler).

Algorithm Research & Development (R&D)

A charter for the algorithm R&D working group was written this quarter and is now posted on the NRAO Software wiki. The group started its activities this quarter, which included attending a 3-day conference hosted by eMerlin at Oxford. This meeting attracted most of the world's experts on developing algorithms for telescopes similar to those at the NRAO. In addition to attending the meeting, the NRAO also coordinated an international video link to minimize travel costs for our staff. This enabled many more people to benefit from these meetings than would otherwise have been able to attend. International discussions will resume at the February 2009 science conference in Cape Town and continue through the April 2009 SKA algorithms meeting in Socorro.

In support of high-performance computing this quarter, an Observatory-wide team of software engineers and electronics engineers attended the Supercomputing 08 conference in Austin, TX. This provided a venue for discussions with NCSA and other institutions regarding storage solutions and collocated data processing.

Archive and Pipeline Operations

The Next Generation Archive System (NGAS) developed by ALMA has now been used to archive the operational EVLA WIDAR data stream. The data are stored in the formats jointly developed by ALMA and the EVLA—the ALMA Science Data Model (ASDM) and Binary Data Format (BDF).

End to End Operations also collaborated with the NRAO library to establish a link between the NRAO papers system and the datasets studied in those journal articles. Although not all papers have links to data and vice versa, the library is still actively collecting proposal-code information from the observing teams, and the number of links will continue to increase as a result.

Proposal Operations

After the October 1, 2008 proposal deadline, work started in earnest on development for the Q1 2009 update release to the Proposal Submission Tool (PST) software. The highlight of this development cycle was the construction of the Centralized Authentication Service (CAS) based on a recommendation from EVLA staff member Stephan Witz. CAS makes it possible for all web-based applications across NRAO to authenticate users from a single database. In addition, it enables single sign-on for those software services, so that users can log in once and switch from application to application without having to re-enter their usernames and passwords.

CAS deployment also required streamlining the user registration process and substantial load testing. Other smaller additions were made, including new resources for VLA, VLBA, and GBT and more control functions on the Proposal Edit page. End to End Operations also participated in discussions about revising the Observatory-wide proposal submission process.

Virtual Astronomical Observatory (VAO) Operations

The NRAO still awaits funding for the Virtual Astronomical Observatory (VAO), the "facility" phase of the NVO, which has been delayed but is still anticipated to go forward towards the end of FY 2009. Development of a broader VO program at the NRAO cannot proceed until the VAO is funded and begins operations. In the meantime our focus continues to be on participation in the development of the VO technical infrastructure, continued work on standards development, and delivering tools such as "KML Now!" that can help us achieve our goal of making the VO more real to the NRAO staff scientists and user community.

A first draft of the IVOA specification for the Table Access Protocol (TAP) was presented and discussed at the IVOA interoperability workshop held at Johns Hopkins University in late October. Key issues relating to the second-generation IVOA image access protocol, which includes support for remote access to large spectral data cubes, were also discussed. A second revision of the TAP protocol was produced following the workshop, and a round of prototyping is planned for both data-access protocols in the months leading up to the next IVOA interoperability workshop to be held in Strasbourg in May 2009.

A special session on the applications framework project (an effort to develop a common framework for processing data from the major observatories) was held at the ADASS conference held in Quebec in early November. Representatives from AUI, AURA, NVO/VAO, and OPTICON chaired the session, which had over one hundred attendees, producing a lively and supportive discussion. A white paper summarizing the goals and architecture of the planned system has since been produced by a joint effort by representatives of the NVO (including the NRAO) and OPTICON. The AURA observatories are producing a similar white paper to guide future software development at AURA, with D. Tody serving as

a co-chair of the AURA effort to provide a liaison with related efforts such as CASA within AUI/NRAO and the VAO. An initial round of prototyping is planned to take place over the next year.

Office of End to End Operations Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
Management & Administration				
1. Launch Management Dashboard v1.0	07/08	12/08	03/09	
2. Launch Management Dashboard v2.0	07/08	09/09		
Data Processing (CASA/Services)				
1. CASA Release 2.3.0	07/08	10/08		10/08
2. Procure and install computing cluster	07/08	11/08		11/08
3. Identify benchmarking cases and datasets	07/08	12/08		12/08
4. Complete ALMA Director's Review of CASA	07/08	12/08		12/08
5. CASA Release 2.4.0	07/08	06/09		
Algorithm Research & Development/High Performance Computing				
1. Procure and install computing cluster, construct test scenarios	07/08	11/08		11/08
2. Identify emerging trends at Supercomputing 08 in Austin, TX	07/08	11/08		11/08
3. Complete group charter for algorithm R&D	07/08	12/08		12/08
4. Complete at least one prototype/working group for exploratory R&D	07/08	06/09		
5. Conduct at least two outreach efforts, including Spring 09 SKA meeting	07/08	06/09		
Archive & Pipeline Operations				
1. Integrate 12 m/140 ft data into the collection	07/08	10/08	01/09	
2. Integrate semantic search capability into Data Vault	07/08	11/08	06/09	
3. Develop an archive interface for CASA to acquire data	07/08	12/08	03/09	
4. Install prototype GBT data service to archive for testing	07/08	03/09		
5. Integrate spectral line search (SLISE) into Data Vault	07/08	03/09		
6. Produce images for common VLA/Chandra, Spitzer, & HST searches	07/08	06/09		
7. Complete specifications for initial pulsar archiving	07/08	06/09		
8. Make progress on radio background in Google Sky with new Google team	07/08	09/09		

OPERATIONS

6. END TO END Operations

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
Proposal Operations				
9. Complete standalone authentication prototype for PST, BOS, EVLA	7/08	02/09		12/08
10. Deploy http://proposals.nrao.edu to expand search capabilities on proposals	7/08	01/09	05/09	
11. Create modules to export proposal objects to EVLA/GBT observing systems	7/08	02/09		
12. Add "referee" user type and online access to proposals for review	7/08	06/09		
13. Complete specifications for streamlined proposal handling (with OSAA)	7/08	09/09		
Other Contributions, including Virtual Astronomical Observatory (VAO)				
1. Complete operations plan for VAO at the NRAO	7/08	12/08	Awaiting funding	
2. Complete one relevant prototype to start making VO real to user community	7/08	08/09		12/08
3. Implement Live Chat for proposal and archive system	7/08	02/09		
4. Deploy http://code.nrao.edu to serve as software repository for sharing	7/08	06/09	09/09	
5. Continue to support high-performance computing for GBT CICADA program	7/08	09/09		

7. COMPUTER AND INFORMATION SERVICES (CIS)

CIS highlights for this quarter include:

- Defining an NRAO-wide hardware standard for laptop/desktop and server configurations.
- The NRAO Image Gallery was updated and secured.
- Expansion of E2E archive server for Data Vault and "Little Things" project.
- Integration of the NRAOPapers bibliography service with Data Vault archive references.
- Large SMP software development system release to science software development team.
- Integration of Internal Wiki and web data authentication to central Active Directory.
- Attendance at the SC08 High Performance Conference: established dialog with NCSA/LSST.
- Reviewed and accepted ALMA archive architecture (NGAS) for the U.S. regional center.
- AUI cooperative agreement and LMI audit review responses completed.
- Integrated monitoring of CV system status with Nagios tool.
- Initiated migration process of Windows mail users to Exchange 2007 architecture.
- Planning and initial execution of training and upgrade to Office 2007 NRAO-wide.
- Enhancement of CV Wireless access filtering for improved security and accessibility.
- Business Office System (BOS) migrated to new server, OS, and application platform.
- IMS-400 data center integrated environmental monitoring system active.

Observatory-wide Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Upgrade link between UVa and NRAO-CV	01/07	01/07	On Hold[1]	
2. Definition of Standard Computer hardware specification (b)	9/08	10/08		10/08
3. Voicemail upgrade for GB site (d)	10/08	11/08	On Hold[1]	
4. Migrate Outlook users to Exchange 2007 server (b)	9/08	12/08	01/09	
5. Consolidation of Directory Service (b)	10/08	12/08	06/09	
6. Fair Opportunity for GSA Networx contract (d)	10/08	01/09	05/09	
7. Coordinate Scalable Computing workshop	11/08	01/09		
8. Service Management review for operational support	10/08	01/09		
9. Evaluate calendar and room-reservation systems (b,c)		02/09		
10. Upgrade the central disk filer in GB (d)		03/09		
11. Train users and deploy Microsoft Office 2007	07/08	03/09		

7. Computer and Information Services

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
12. Complete deployment of new Linux RHEL5 (b)	05/08	03/09		
13. Pilot release, Web Content Management System (c)	10/08	03/09		
14. Design new Risk Management Framework (a)		03/09		
15. System-administrators meeting in Socorro (b)		04/09		
16. Evaluate migration of mbox to maildir (b)		04/09		
17. Review Network Architecture/Perimeter Defenses (a,d)	11/08	05/09		
18. First annual employee security training presentation (a)		06/09		
19. Coherent and consistent NRAO-wide system monitoring (b)	08/08	07/09		

Notes:
1. Installation postponed due to budget concern and funding prioritization

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

Charlottesville Computing Milestones

Milestones	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Initial implementation plan for US ARC	09/08	10/08	11/08	11/08
2. Limit internal network access for un-trusted machines	10/08	11/08		11/08
3. Support expansion of E2E archive infrastructure	09/08	12/08	01/09	

8. EDUCATION AND PUBLIC OUTREACH

EPO highlights for this quarter included:

- High-definition video and stills were acquired from the air and on the ground in Green Bank.
- NRAO science community exhibits were redesigned.
- The Sister Cities student exchange between San Pedro de Atacama, Chile and Magdalena, New Mexico were completed.
- ALMA media-prospectus design was initiated.
- IYA 2009 planning was completed.
- The 4th annual AUI/NRAO Image Contest awarded six prizes.
- Six press releases were distributed.
- A Community Open House was held in Green Bank.

Extensive high-definition video and high-resolution digital images were acquired from the air and the ground in Green Bank in mid-October. New high-quality video B-roll was produced from this material and from the similar VLA video shoot that took place in mid-September. These video B-roll products are being made available to the media via our web site.

The NRAO 2009 Calendar was produced. It featured the 2008 Image Contest prizewinners and a selection of other high-quality images from our on-line Gallery.

Work continued on the development of a modern, unified, and visually compelling NRAO brand that incorporates our recently adopted new logo, including a comprehensive style and design guide.

More then 400 guests participated in a Community Open House held in Green Bank on October 26 and enjoyed a day of science demonstrations, lectures, activities, and behind-the-scenes tours of the GB electronics lab, machine shop, and the GBT.

Six press releases were written and distributed, including two releases that described key ALMA achievements, three releases that described new science (one GBT, two VLA), and a release that described a major new NRAO-university partnership for the Center for Chemistry in the Universe. The NRAO press release describing the first accurate measurement of magnetic field strength at a significant redshift ($z = 0.692$) by Art Wolfe (UCSD) et al. garnered much media attention.

The NRAO displays for science community outreach underwent an inexpensive but major re-design, and new multimedia content was created for use with the new displays at the January 2009 AAS meeting in Long Beach, CA. Planning for the NRAO Town Hall at the Long Beach AAS meeting was completed. A new brochure that describes all NRAO research facilities was written and published. Design work began on an ALMA media prospectus for release next quarter.

A new on-line program to celebrate the 50th anniversary of the successful NRAO summer student program was conceived and prototyped in collaboration with scientific staff. This program will debut in early 2009.

OPERATIONS

8. Education and Public Outreach

Consultation continued on the draft script for an ESO-sponsored ALMA planetarium show. EPO completed its planning for NRAO participation in the International Year of Astronomy 2009, including several Global Cornerstone Projects: Quiet Skies/Dark Skies Awareness, 100 Hours of Astronomy, Portal to the Universe, and 365 Days of Astronomy.

Work began on the design of "One Observatory" exhibits for the GB Science Center and the VLA Visitor Center. Several digital asset-management software systems were tested for managing the internal EPO image and video libraries. Job descriptions were developed for an ALMA Multimedia Designer and Web & Application Developer positions.

Education and Public Outreach Milestones

Milestone	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. NRAO Town Hall planning for winter AAS meeting	09/08	10/08	12/08	12/08
2. Install *ViewSpace* at the GB Science Center and the VLA Visitor Center		11/08	09/09	
3. Redesign the science-conference exhibit booth	09/08	11/08	12/08	12/08
4. Multimedia presentation for new exhibit booth	11/08	12/08		12/08
5. Sister Cities student exchange complete	08/08	12/08		12/08
6. Hire ALMA web developer		01/09	09/09	
7. Summer student 50th anniversary program debuts on-line	10/08	01/09		
8. Media prospectus complete (for AAAS)	11/08	01/09		
9. Complete One Observatory exhibit design for GB Science Center and VLA Visitor Center	10/08	02/09	04/09	
10. Draft NAASC/NRAO ALMA web site map complete	10/08	02/09		
11. Craft science symposium proposals for 2010 AAAS Annual Meeting		03/09		

Notes:

2. Milestone delayed by FY 2009 Continuing Resolution budget constraints.
5. Two Magdalena, NM students spent the northern hemisphere fall semester (Aug–Dec 2008) attending school in San Pedro de Atacama, Chile; and two San Pedro students spent their southern hemisphere spring semester attending school in Magdalena, New Mexico.

6. Hire delayed by FY 2009 Continuing Resolution budget constraints.
9. The GB Science Center design will be completed February 2009; the design for the VLA Visitor Center will be completed in April 2009.
11. AAAS Annual Meeting proposals will be due April 2009.

MANAGEMENT

1. OBSERVATORY MANAGEMENT

NRAO senior management addressed follow-up tasks from the AUI Cooperative Agreement renewal, including the development of an Executable Business Plan for the years FY2010 through FY2012. The FY2009 Program Plan was submitted to NSF.

To position NRAO for projected budget reductions in FY2010, an Early Retirement Program was completed in mid-October. Fourteen (14) NRAO employees took early retirement and one (1) moved to part-time employment. The NRAO Human Resources department, Assistant Directors, and many line supervisors were heavily involved in the process.

The FY2009 Federal budgetary Continuing Resolution resulted in considerable additional analysis to develop alternative operations plans under a variety of budget scenarios, according to the duration of the Continuing Resolution, and the level at which budgets were ultimately restored. An analysis of consequences was presented to the NSF and information was provided to the NRAO staff.

A face-to-face Assistant Director's (ADs) meeting was held in Charlottesville on 19-20 November 2008. Over twenty ADs and Deputy ADs attended and discussed a number of strategic planning topics, including the development of integrated Observatory Science Operations and long range budget options.

2. ADMINISTRATION

Environment, Safety, and Security (ES&S)

Milestone	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Oversee DSOC (formerly AOC) mechanical-room refurbishing	06/08	06/08		12/08
2. NM Tech re-piping project ES&S Support at the DSOC	12/08	01/09		
3. NRAO New Mexico safety manual review and revision	06/08	06/08	03/09	
4. Conduct DOT training for supervisor and drivers located at Green Bank	10/08	11/08	03/09	
5. Develop hazard-assessment checklist. Submit for review	08/08	12/08		12/08
6. A new AED was installed in the Green Bank Works area	10/08	12/08		12/08
7. Maintain Area Card-Access System	05/08	10/08	06/09	

Ongoing Activities
1. Weekly "tailgate" safety meetings designed and scheduled (SOC)
2. No Sewer Treatment Permit Violations (GB)

3. HUMAN RESOURCES

Compensation

NRAO's new Senior Compensation Analyst completed the 2008 salary review process on schedule, managing the process for the first time under difficult circumstances. Uncertainty regarding NRAO's FY 2009 budget resulted in a month-long delay in the start of the salary review process (from early August to early September). She assisted managers through a very tight timetable and was able to provide Payroll with the salary actions in time to meet the October 1 effective date. Following the Salary Review Process, she resumed her work assessing NRAO jobs to determine the equity position of NRAO staff to market. Her analysis included developing a job description questionnaire, examining the exempt status of jobs, and NRAO's grade structure. By the end on the quarter, the majority of the work was completed and is scheduled to be reported to NRAO senior management in the following quarter.

Benefits

The 2009 annual benefits enrollment process was completed. As a result of higher medical plan utilization during the prior year, premiums increased significantly for 2009. Through aggressive negotiations with CIGNA, NRAO's benefits consulting firm, Aon Consulting, was able to reduce the increase in premiums from 38% to 18.7%. A change in vendor was made for the Flexible Spending Accounts to improve service to employees. NRAO changed the policy on medical premiums for new retirees, which had previously been frozen at the rates in effect at the time of retirement. Beginning in 2009, medical rates for employees who retire on or after January 1, 2009 will increase each year based on the change in rates for active employees with the same level of coverage.

International Staff – ALMA

Working with KPMG, the NRAO is re-examining its Cost of Living calculation for its U.S. expatriates working for ALMA in Chile. Certain expatriates cited problems with the COLA payments not covering their increase in costs due to the weakness of the U.S. dollar and taxes paid on their allowances. Although the rise of the dollar's strength has helped mitigate some of their concern, taxes are still an issue. KPMG is gathering tax and income information on each NRAO U.S. expatriate to understand the exact financial impact each is facing to determine what, if any, changes the NRAO should make to its COLA calculation. This review will be completed in the next quarter.

Diversity

Diversity Committee: NRAO's Diversity Committee met in December during its quarterly meeting. Fred K. Y. Lo attended and contributed his thoughts and support on diversity within the NRAO. A commitment was made by Dr. Lo to devote the financial resources necessary to provide diversity training to supervisors and employees by mid-year, and continue this training in subsequent years. This commitment will align the diversity budget alongside critical projects such as the EVLA and ALMA. To provide the necessary training, two separate training courses would be developed, one designed for supervisors and one for employees.

3. Human Resources

NRAO's commitment to partner with minority universities such as Howard University was also supported by the Director. Finding ways to bring students to the NRAO and sending our scientists to these schools to promote career opportunities at the NRAO were emphasized.

Diversity Outreach Activities: The following minority articles and recruiting activities advanced the Observatory's mission to promote diversity outreach to future NRAO employment recruits and associated institutions.

K. Y. Lo was the highlighted interview in the October/November 2008 Anniversary Edition of the Diversity Careers in Engineering and Information Technology magazine http://www.diversitycareers.com/articles/pro/08-octnov/anniversary.htm. The Magazine has a professional readership of over 100,000; college readership is 75,000, and career fair distribution is 30,000, with an additional 170,000 visitors per month to the magazine's web page.

Hispanic Electronics Engineer, Hector Malagon, Socorro, NM was interviewed for the 2008–2009 Winter/Spring College edition of Diversity Careers in Engineering & Information Technology magazine http://www.diversitycareers.com/articles/college/08-winspr/jm_ee_grads.htm. The Winter/Spring college edition highlighted recent Hispanic engineering school graduates in science and government.

Hispanic Electronics Engineer, Ms. Juanita Banda, NRAO Technical Center in Charlottesville, VA was interviewed for the February/March 2009 Diversity Professional edition of Careers in Engineering & Information Technology magazine. The article will highlight Juanita as one of several Hispanic professional engineers currently working in the science and government sectors.

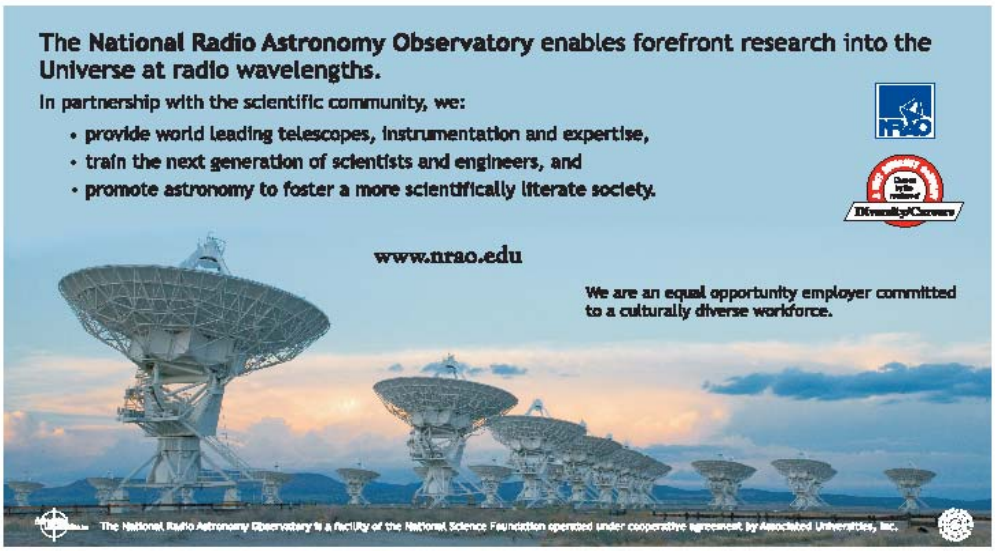
The Employment Manager is working in conjunction with the Howard University liaison, Dr. M. Alfred, Associate Scientist in Physics and Dr. Chouikha, Dean of the Engineering, who have identified two students for placement in NRAO's 2009 Co-Op and summer-student programs. The NRAO also committed to provide two speakers to the Physics or Engineering Departments during the 2009 spring semester.

Volunteers from the NRAO staff manned a recruitment exhibit at the Society of Women Engineers 2008 conference and careers fair this past fall. Those volunteers in the SWE08 NRAO exhibit booth were Melinda Mello, GB Software Engineer, Vidhya Saidsprada, CV Mechanical Engineer, and Roy Norville, Employment Manager. Resumes of interested persons were received from ten full-time job seekers and five possible interns or Co-Op candidates.

3. Human Resources

Figure 1. The new exhibit booth design for FY 09 was built with replaceable panels that highlight the careers to be recruited at the specific career fairs; i.e. scientific careers, engineering careers, or general administrative careers. This was a cost savings measure allowing the division to maintain one versus three exhibit booth inventories.

NRAO's HR Division designed a new recruitment advertisement for use in diversity recruitment publications.



3. Human Resources

Employment

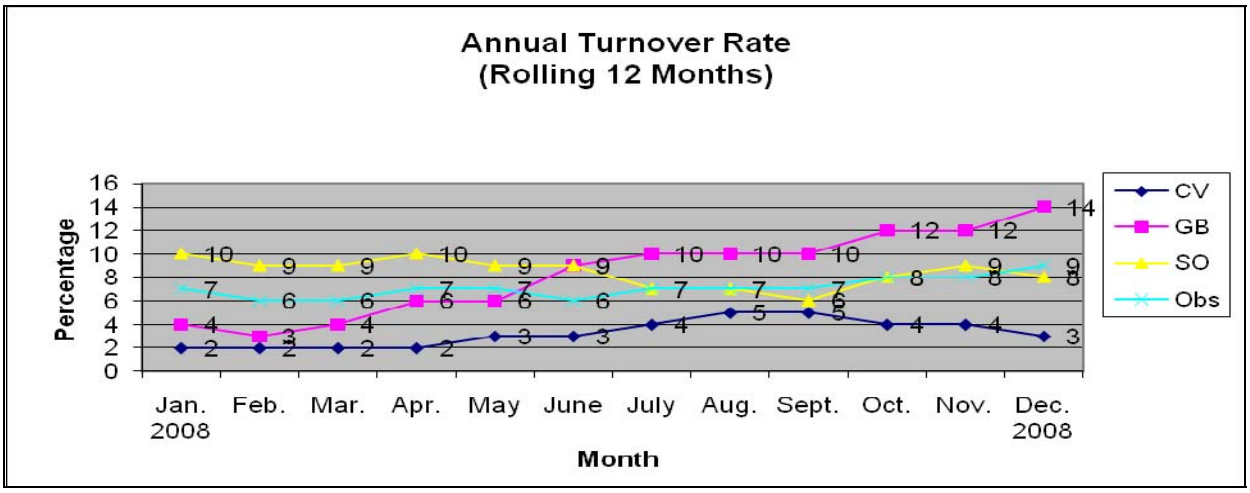
Diversity Employment Results

- Promotions
  - 2 Scientific to the rank of Assistant Scientist (1) Female (1) Hispanic
  - Sr. Manager (1) Female
  - 3 Administrative (3) Female
- New Hires
  - Sr. Manager (1) Female

Recruitment/Application Tracking: NRAO HR is implementing a new recruitment system, which it is now operating in a test environment. The system is PeopleAdmin and it is recognized as Best of Class for over 400 U.S.-based universities, research institutes, and government agencies. The web-based system supports the job requisition, posting, position description, application tracking, and candidate evaluation and selection processes. The system will also offer supervisor self-service in the recruitment and selection processes. It will also eliminate the majority of paper now used to manage NRAO's employment process, thereby supporting a paperless, *Green* environment. It will play an important role in supporting NRAO recruitment and employment of females and minorities.

NRAO e-news: The HR Division in cooperation with the EPO office has begun publishing all NRAO and ALMA scientific and technical professional job openings in the monthly science NRAO e-newsletter. The e-newsletter reaches over four-thousand scientists and educators throughout the year.

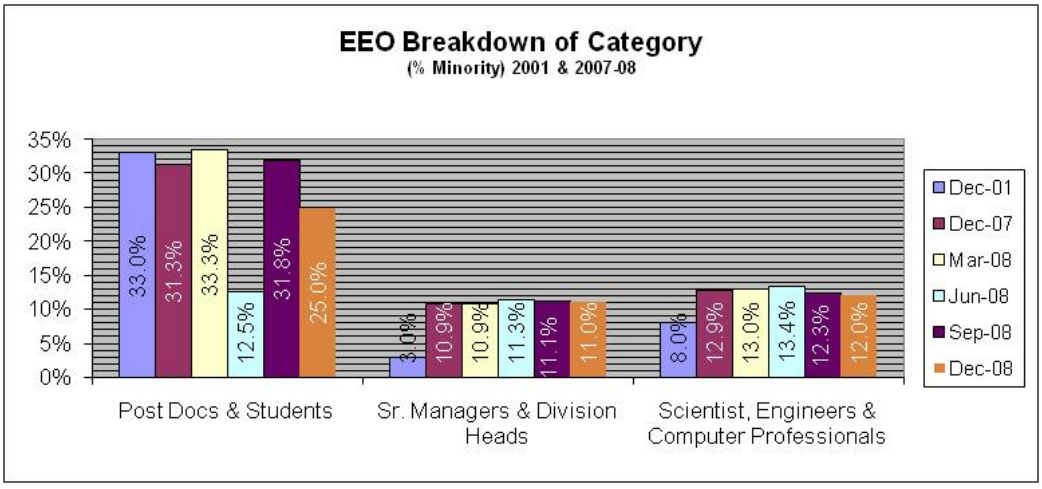
Turnover: The Observatory-wide turnover rate increased by 2% in this quarter due to the Early Retirement program that was implemented in October. At the site level, Green Bank incurred a 4% increase (10% to 14%) and Socorro experienced a 2% increase (7% to 9%).



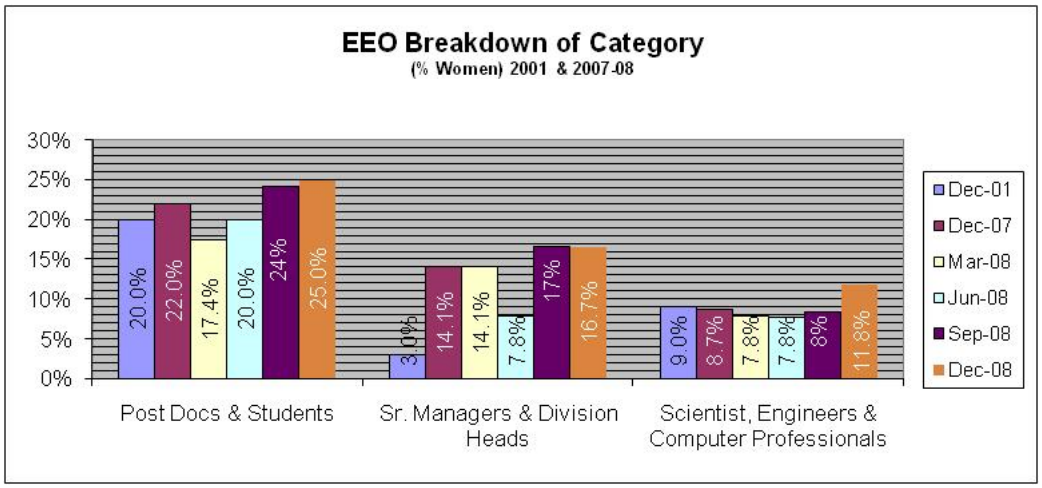
3. Human Resources

Recruitment

The following Affirmative Action charts reflect the continued minority and women diversification efforts of the Observatory in the science and professional/technical workforce.



Minority Representation — Hiring during the quarter was limited in the scientific/professional and management arenas. The Observatory continues to maintain 4% and 8%, respectively, increases in the minority employment of S, E, & CP and Sr. Management staff over the December 2001 benchmarks.



Women Recruitment — There was a marked advance in S, E, & CP employment of women, a net increase of roughly 4%. Sr. Management's increase in the quarter was the result of the employment and promotion of Drs. Lonsdale and O'Neil, respectively. The Post Doc and Student employment percentage improved by 1 this quarter.

3. Human Resources

Human Resources Milestones

Milestone	Start Date	Original Completion Date	Revised Completion Date	Completion Date
1. Establish site-based diversity feedback process		04/09		
2. Develop diversity recruiting and hiring metrics report		03/09		
3. Develop diversity report on promotions, transfers, pay actions, and departures		03/09		
4. Implement Resume Management/Applicant Tracking System Observatory-wide	09/08	09/08	04/09	
5. Develop a strategy to correct the equity shortfall across the Observatory.	6/08	02/09		
6. Using a total compensation approach, develop a recommendation for the 2009 benefits program.	8/08	10/08		10/08
7. Deliver diversity-related training for supervisors Observatory-wide		06/09		
8. Provide support for individual career development training courses for females and minorities.		03/09		
9. Develop NRAO ISM related procedures/materials for hiring, benefits and compensation.		05/09		

3. Human Resources

Personnel

	NEW HIRES	
Clarke, David	Software Engineer I	11/04/08
Corder, Stuartt	Jansky Fellow/ALMA Commissioning Scientist	10/01/08
Deller, Adam	Jansky Fellow	11/03/08
Hill, John	Staff Shop Tech I	10/06/08
Litton, Casey	Technical Specialist II	10/01/08
Lonsdale, Carol	Assistant Director, NAASC	10/01/08
Shannon, Michael	Project Manager III	10/01/08
Stahlman, Gretchen	Documentation Specialist	12/23/08
Suoranta, Ville	Software Engineer II	10/01/08
	RETIREMENTS/TERMINATIONS	
Aragon, Steve	Technical Specialist I	11/11/08
Bridle, Alan	Astronomer	10/15/08
Glassel, Holli	Librarian	12/30/08
Hartley, Kenneth	Scientific Associate III	10/15/08
Lakatosh, William	Technical Specialist I	10/15/08
Leyba-Newton, Laura	Electronics Engineer II	10/03/08
Pisano, Daniel	Research Associate, Other	12/22/08
Romero, Terry	Administrative Assistant, Sr.	10/15/08
Serna, Rey	Technical Specialist I	10/15/08
Shank, William	Technical Specialist I	10/15/08
Taylor, Aaron	Technician, Sr.	12/01/08
Whysong, David	Postdoc	11/04/08
Ziegler, Carol	Buyer, Senior	12/31/08
	PROMOTIONS	
Brogan, Crystal	Associate Astronomer	10/01/08
Bryerton, Eric	Scientist/RE	10/01/08
Hales, Antonio	Assistant Scientist/A, ALMA Commission Scientist	10/01/08
Miller, Theodore	Manager, ALMA Admin/NA Business Manager	
Norrod, Kathy	Buyer II	11/08/08
	APPOINTMENTS/TRANSFERS	
Carilli, Christopher	Deputy Assistant Director/Chief Scientist	10/01/08

4. BUDGET

During the first quarter of FY 2009, the NRAO Operations operated under a continuing resolution with funding frozen at FY 2008 levels. At these funding levels, the FY 2009 new funding is $45,096k including $39,086k for NRAO Operations and $6,010k for EVLA. To relieve a projected cash flow shortfall in the third quarter, the NRAO requested and received a 75% advance funding totaling $33,822k of the authorized continuing resolution funding level.

Once the continuing resolution is lifted, it is anticipated that the FY 2009 funding will be $49,820k including $43,630k for NRAO Operations and $6,190k for EVLA. When combined with prior-year commitments and prior-year carryover, the NRAO Operations total budget, less EVLA, is $47,706k.

Overall, the NRAO Operations budget is approximately 6.7% below a linear spending rate of 25% through the first quarter assuming the full FY 2009 budget level (and prior-year commitments/carryover) of $47,706k instead of the CR level budget. 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 is well behind linear spend owing to collection of the Directly Associated Costs (DAC). To ensure adequate cash flow during the continuing resolution the NRAO collected 75% of the DAC from ALMA Construction and ALMA Operations.

NRAO Operations Expenses and Commitments FY 2009 Year to Date (October 1, 2008 to December 31, 2008) in $000							25.0%	
WBS Level 1	Salaries & Benefits	Materials & Services	Travel	Revenue or Cost Recovery	Total	Linear Spending	Actual Exp + Comm	Actual Percent Expended & Committed
Observatory Management	6,017	3,058	333	-250	9,157	2,289	-338	-3.7%
Education and Public Outreach	616	145	37	-125	674	168	229	34.0%
Central Development Lab	1,513	240	23		1,777	444	400	22.5%
Green Bank Operations	8,624	2,833	167	-463	11,161	2,790	2,440	21.9%
New Mexico Operations	14,955	3,955	191	-73	19,028	4,757	4,384	23.0%
Computer and Information Services	1,045	784	25		1,854	464	498	26.9%
Science and Academic Affairs	1,777	1,886	392		4,055	1,014	1,116	27.5%
NRAO Operations total	34,547	12,901	1,169	-911	47,706	11,927	8,730	18.3%

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
AAAS	American Association for the Advancement of Science
AAS	American Astronomical Society
AD	Assistant Director (NRAO)
ADASS	Astronomical Data Analysis and Software Systems
AED	Automated External Defibrillator
AIPS	Astronomical Image Processing System
AIT	American Institute in Taiwan
ALMA	Atacama Large Millimeter Array
AlN	Aluminum Nitride
ANASAC	ALMA North American Scientific Advisory Committee
AOC	Array Operations Center (now DSOC)
APEX	Atacama Pathfinder Experiment
API	Atmospheric Phase Interferometer
ARC	ALMA Regional Center
ASAC	ALMA Scientific Advisory Committee
ASDM	ALMA Science Data Model
ASIAA	Academica Sinica Institute of Astronomy and Astrophysics
ATA	Allen Telescope Array
ATF	ALMA Test Facility
ATM	NSF Division of Atmospheric Sciences
AUI	Associated Universities, Incorporated
AURA	Associated Universities for Research in Astronomy
Band 1	31–45 GHz ALMA band
Band 2	67–90 GHz ALMA band
Band 8	385–500 GHz ALMA band
Band 10	780–950 GHz ALMA band
BDF	Binary Data Format
BOS	Business Office System
C-Band	4–8 GHz
CARMA	Combined Array for Research in Millimeter-wave Astronomy
CAS	Centralized Authentication Service
CASA	Common Astronomy Software Applications
CBE	Correlator Back End (WIDAR)
CDL	Central Development Laboratory (Charlottesville, VA)
CDMS	Cologne Database for Molecular Spectroscopy
CDR	Critical Design Review
CICADA	Configurable Instrument Collaboration for Agile Data Acquisition
CIS	Computer and Information Services
CMOS	Complementary Metal-Oxide Semiconductor
COLA	Cost Of Living Adjustment
CR	Continuing Resolution
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
CSV	Commissioning and Science Verification (ALMA)
CV	Charlottesville
DAC	Directly Associated Costs
DAQ	Data Acquisition
DARPA	Defense Advanced Research Projects Agency
DBE	Digital Back End
DOT	Department of Transportation
DSOC	Domenici Science Operations Center (formerly AOC)
DSS	Dynamic Scheduling System (GBT)
DTS	Digital Transmission System
E2E	End-to-End
EPO	Education and Public Outreach
ES&S	Environment, Safety, and Security (NRAO)
ESO	European Southern Observatory
ETK	Electronic Time Keeping
EVLA	Expanded Very Large Array
EVN	European VLBI Network
FASR	Frequency-Agile Solar Radiotelescope
FPGA	Field-Programmable Gate Array
FRM	Focus/Rotation Mount
FY	Fiscal Year
GaAs	Gallium Arsenide
GB	Green Bank
GBT	Green Bank Telescope
GHz	Gigahertz
GSA	General Services Administration
GUPPI	Green Bank Ultimate Pulsar-Processing Instrument
H_2O	Water
HBCU	Historically Black Colleges and Universities
HBT	Heterostructure Bipolar Transistor
HI	Neutral Hydrogen
HIA	Herzberg Institute of Astrophysics
HPC	High-Performance Computing
HR	Human Resources
HST	Hubble Space Telescope
IF	Intermediate Frequency
IPT	Integrated Product Team (ALMA)
ISM	International Staff Member, Interstellar Medium
IYA	International Year of Astronomy 2009
IVOA	International Virtual Observatory Alliance
JAO	Joint ALMA Observatory
JPL	Jet Propulsion Laboratory

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
JWST	James Webb Space 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)
KML	Keyhole Markup Language
KP	Kitt Peak (VLBA station)
kpc	kiloparsec
Ku-Band	12–18 GHz
L-Band	1–2 GHz
LANL	Los Alamos National Laboratory
LARC	Lunar Array for Radio Cosmology
LMI	Logistics Management Institute
LNA	Low-Noise Amplifier
LO	Local Oscillator
LRF	Laser Range Finder
LSST	Large Synoptic Survey Telescope
LTE	Local Thermodynamic Equilibrium
M	Million
MELCO	Mitsubishi Electric Company
MHz	Megahertz
MK	Mauna Kea (VLBA station)
mm	millimeter
MMIC	Monolithic Microwave Integrated Circuit
MOSFET	Metal-Oxide Semiconductor Field-Effect Transistor
MOU	Memorandum of Understanding
MPIfR	Max Planck Institut fűr Radioastronomie
μm	micrometer
MUSTANG	Multiplexed Squid TES Array at Ninety GHz (GBT "Penn Array" receiver)
MUX	Multiplexer
NA	North American
NAASC	North American ALMA Science Center
NAPRA	North American Partnership for Radio Astronomy
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputing Applications
NGAS	Next Generation Archive System
NIO	New Initiatives Office
NIST	National Institute of Standards and Technology
nm	Nanometer
NMED	New Mexico Environment Department
NRAO	National Radio Astronomy Observatory

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
NSC	National Science Council (Taiwan)
NSF	National Science Foundation
NTC	NRAO Technology Center (Charlottesville)
NVO	National Virtual Observatory (now VAO)
OH	Hydroxyl radical
OMT	Orthomode Transducer
OOF	Out Of Focus (holography)
OPT	Observation Preparation Tool
OS	Operating System
OSAA	Office of Science and Academic Affairs (NRAO)
P-Band	310–344 MHz
PAPER	Precision Array to Probe the Epoch of Reionization
PDR	Preliminary Design Review
PO	Purchase Order
PrepSKA	Preparation for the SKA
PST	Proposal Submission Tool
PTCS	Precision Telescope Control System (GBT)
Q	Quarter
Q-Band	40–50 GHz
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
SAGE	Science Advisory Group for the EVLA
SC	Saint Croix (VLBA station)
SDM	Science Data Model
SIS	Superconductor–Insulator–Superconductor
SKA	Square Kilometer Array
SLAIM	Spectral-Line Atlas of Interstellar Molecules
SLISE	Spectral-Line Search Engine
SMA	Sub-Millimeter Array
SMP	Symmetric Multi-Processor
SOC	Socorro, NM
SOS	Student Observing Support (NRAO program)
SPDO	SKA Program Development Office
TAP	Table Access Protocol
TAPRA	Taipei-American Program in Radio Astronomy
TB	TeraByte
TBD	To Be Determined

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
TECRO	Taipei Economic and Cultural Representative Office
TRW	TRW Corporation
U-Band	12–18 GHz
URSI	International Radio Science Union
UVa	University of Virginia
UVML	University of Virginia Microfabrication Laboratory
VAO	Virtual Astronomical Observatory
VERA	VLBI Exploration of Radio Astronomy (Japanese VLBI array)
VISC-2	VSOP-2 International Science Council
VLA	Very Large Array
VLBA	Very Long Baseline Array
VLBI	Very Long Baseline Interferometry
VO	Virtual Observatory
VSOP-2	VLBI Space Observatory Program successor
W-Band	68–117 GHz
WBS	Work Breakdown Structure
WG	WaveGuide
WIDAR	Wideband Digital Interferometric Architecture (EVLA correlator)
WP2	Work Package 2 (PrepSKA)
X-Band	8–12 GHz