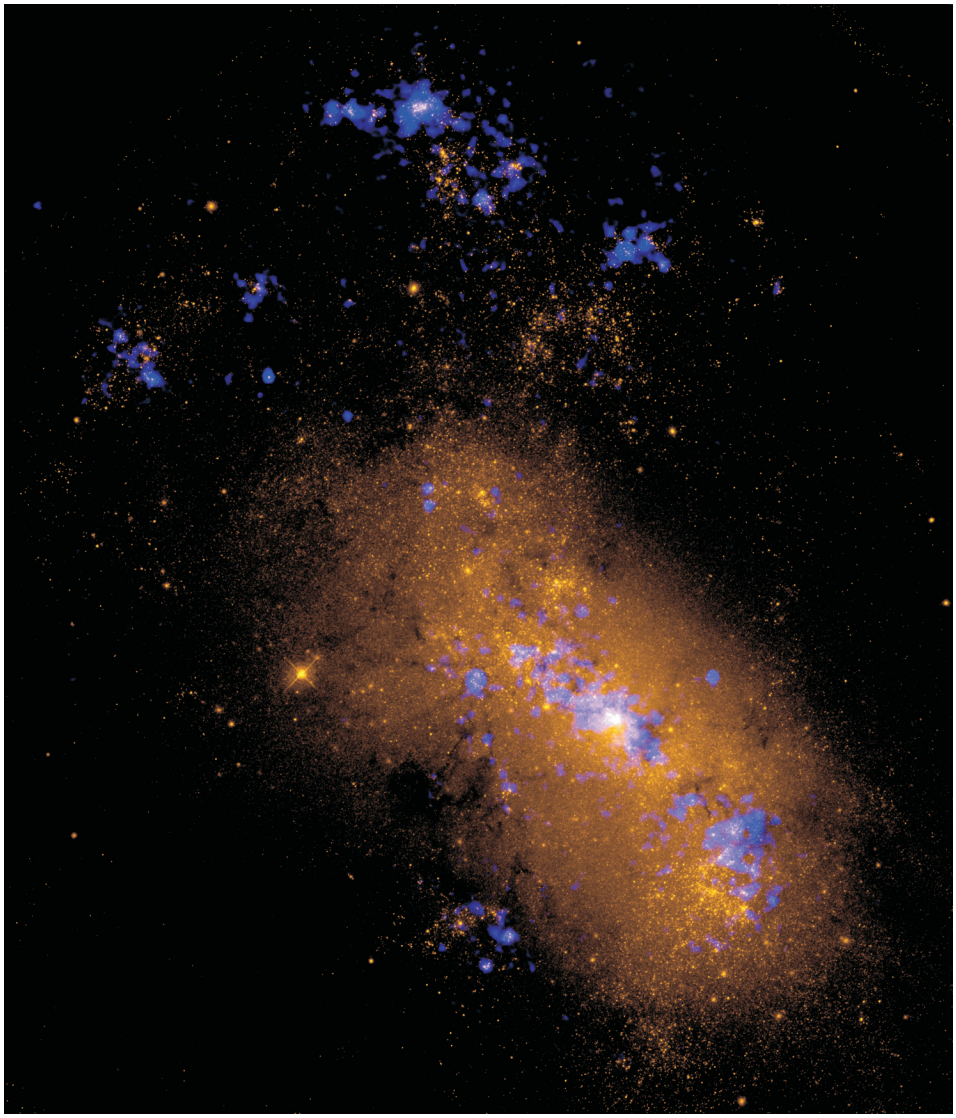
National Radio Astronomy Observatory



Quarterly Report

July – September 2007

NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

July – September 2007

Cover Image: This radio image from the Very Large Array reveals massive star clusters as they emerge from their birth material in the galaxy NGC 4449. These "super star clusters" contain tens to hundreds of thousands of stars. The young stars produce hot ionized gas that is detectable at radio wavelengths, shown in blue here. An image from the Hubble Space Telescope shows the visible starlight in yellow.

The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Science and Academic Affairs

During the third quarter the Office of Science and Academic Affairs (SAA) completed several searches for staff positions, including the Assistant Director for New Mexico operations, two scientific-staff positions for Socorro, a tenure-track scientist, and a new administrative head for SAA.

The predoctoral, co-op, visiting scientist, and summer-student programs remain healthy. Twenty-two summer students completed their terms at NRAO sites, and the interactions of NRAO staff with visiting scientists and interns proved productive.

The SAA Office completed and submitted the proposal for continued funding of the NSF Research Experience for Undergraduates/Teachers for the period 2009–2013.

The SAA office awarded research funds via the Student Observing Support program as well as through the Funds for Individual Engineering Research Project.

New Mexico Operations

Bob Dickman assumed the position of Assistant Director for New Mexico Operations on September 26, 2007. Claire Chandler and Peggy Perley were appointed Deputy Assistant Directors for Science and Operations, respectively, on October 9, 2007.

Very Large Array (VLA) - Expanded Very Large Array (EVLA)

Twelve EVLA antennas have been retrofitted and restored to routine service; the thirteenth is being retrofitted. The first two EVLA-only papers, produced in response to a call to exploit the extended tuning range of the EVLA's C-band receivers, have been submitted for publication in *ApJ (Letters)*; one is in press. The VLA's MODCOMP control computers were removed from service at the very end of last quarter and replaced by the new EVLA monitor and control system. The new system was commissioned in less than three weeks and with very few problems. All antennas in the array now operate under the new system.

Very Long Baseline Array (VLBA)

The program to increase the VLBA's sensitivity at 22 GHz, done in collaboration with the Max-Planck-Institut für Radioastronomie, continued through the third quarter. The completion date for this important upgrade has now been moved up by two months to the end of CY 2007; at that time all ten VLBA stations will have had their sensitivity in the scientifically important K band increased by as much as 50%. The St. Croix antenna was removed from service as scheduled on September 10, 2007 for repainting and structural maintenance; we expect it will return to service before the end of the year. The Hancock antenna suffered an azimuth-wheel failure and was repaired during the week of September 10.

New Initiatives

The fourth in a series of planning meetings was held for the tracking-station design for VSOP-2, scheduled for launch in 2012. This series now has produced a common design concept and block diagram for all VSOP-2 tracking stations. The deadline passed for Cycle 1 of the Guest Investigator program for

the Gamma-ray Large Area Space Telescope (GLAST), and over 20 proposals were received for collaborative observing with NRAO telescopes. The "Chicago–3" meeting took place, covering implementation of the Square Kilometer Array (SKA) in the context of the upcoming decadal survey in astronomy. The NRAO has formed an internal working group to coordinate NRAO participation in the SKA Program.

Green Bank Operations

The GBT azimuth-track replacement project was completed to the original specifications, on schedule and within budget. The telescope was released for motion on September 3, 2007. A direct comparison with data obtained on the old azimuth track showed three significant improvements in the performance of the new track. The Spectrometer long-term accumulator (LTA) upgrade was completed.

North American ALMA Science Center (NAASC)

NAASC staff members have started the "turno" staffing at the ALMA Test Facility in Socorro. The ANASAC held its annual face-to-face meeting in Charlottesville in August. The main issue considered was user funding associated with ALMA observing time. Joe McMullin and Debra Shepherd traveled to ESO to give a CASA tutorial to European ARC and ARC-node members in July, in preparation for a CASA beta release planned for October. Version D of the ALMA Operations Plan was completed.

Central Development Laboratory (CDL)

Activities at the Central Development Laboratory this quarter included:

Device and component research, development, and production:

- The design of demonstration amplifiers for ALMA Band 1 (31.3–45 GHz) and Band 2 (67–90 GHz) receivers has been completed.

- The University of Virginia Microfabrication Laboratory (UVML) has successfully fabricated NbTiN/A1N/Nb SIS junctions with good quality. This is a *major* milestone on the path to 350 μm (780–950 GHz) ALMA Band 10 mixer development.

Instrument development:

- Deployment of a 4-element pathfinder array of the Precision Array to Probe the Epoch of Reionization (PAPER) project in Western Australia was completed.

Chile

In site-related activities, this quarter marked the arrival of the second NA antenna to the OSF and the start of the AOS transporter hangar, as well as the completion of the second stage of the OSF ALMA camp enlargement. In local labor-related activities, a study has been completed of workplace-related health and safety risks, including the associated standing committees as required by Chilean law. NRAO Chile staff received training on online procurement processes. Among other EPO activities the first cycle of educational visits by the twin cities San Pedro–Magdalena, was completed.

End to End (E2E) Operations

NRAO Interactive Services was introduced at http://my.nrao.edu, the proposal submission utilities were upgraded, and the Common Astronomy Software Applications (CASA) data-reduction package was prepared for its beta release at the beginning of Q4. The VLA data-processing pipeline was refined and used to produce over 50,000 new VLA images (covering more than 9000 sky positions) that are being published to the NRAO archive and the Virtual Observatory (VO).

Computer and Information Services (CIS)

The upgrade of the network infrastructure on the GBT concludes a two year effort to upgrade and modernize the whole campus network, including the replacement of all of the 10-year old Ethernet switches.

The Annual System Administrators meeting was held in Green Bank. For the first time, this included representatives from Santiago. We look forward to a closer working relationship with that group.

Two people were appointed to form a webmaster group to provide technical infrastructure support for the new initiatives to produce improved web content development in e2e, EPO, and SAA.

There were no security incidents in this quarter.

Education and Public Outreach (EPO)

The National Science Foundation Information Technology Experiences for Students and Teachers (NSF–ITEST) program awarded full funding ($893K) to the joint NRAO–West Virginia University *Pulsar Search Collaboratory* (PSC) proposal submitted last May. Through this innovative PSC program, teachers and students will assist a worldwide team of astronomers in discovering new pulsars.

The GLOBE (Global Learning and Observations to Benefit the Environment) debuted in Green Bank. GLOBE is a worldwide hands-on, K–12 school-based science and education program. GLOBE students, teachers, and scientists collaborate on inquiry-based investigations of the environment and contribute scientific measurements to an international database.

Two new staff members joined the EPO team.

SCIENCE HIGHLIGHTS

Very Large Array (VLA)

***NVSS Analysis Reveals Giant Cosmic Void*—**Investigators analyzing data from the NRAO VLA Sky Survey (NVSS) in the direction of the "cold spot" in the cosmic microwave background (CMB) detected by the WMAP satellite found a dramatic drop in the number of radio sources in that region. They conclude that the drop is caused by a completely empty void with a 140 Mpc radius at a redshift $z \sim 1$ along the line of sight to the "cold spot." The 20 μK drop in the CMB temperature, they conclude, is due to a lack of matter that would slightly energize CMB photons through the integrated Sachs-Wolfe effect. The size of this void greatly exceeds current expectations from both observations and simulations.

Investigators: L. Rudnick, S. Brown, and L. Williams (U. Minn.).

Very Long Baseline Array (VLBA)

***VLBA Gets Parallactic Distance to Orion Nebula Cluster*—**The parallax and proper motion of the nonthermal radio star GMR A in the Orion Nebula Cluster have been determined using the VLBA. The parallactic distance, 389 parsecs, is considerably closer than the previously canonical distance of 480 parsecs. This change lowers the luminosities of the stars in the cluster by a factor of roughly 1.5. Such a change affects the age spread of pre-main-sequence stars and the agreement between the zero-age main sequence and the temperatures and luminosities of massive stars. By providing more accurate knowledge of the distance to the Orion Nebula, the VLBA makes an important contribution to the general understanding of star formation in this well-studied region.

Investigators: K. Sandstrom, J. Peek, G. Bower, A. Bolatto, and R. Plambeck (UC Berkeley).

Green Bank Telescope (GBT)

Complex organic molecules are very abundant near the Galactic center (GC), where physical conditions, e.g., temperature and density, are quite different from those near typical star-forming regions. Despite the difference, the relative abundances of some complex organics are similar in both types of source, suggesting that there might be a universal grain-mantle composition in the Galactic disk. Recent GBT observations of organic molecules in several different GC molecular clouds have shed new light on this issue.

The GBT data show a very high abundance of molecules such as HC_2CHO, CH_3CH_2CHO and HCCCHO relative to molecular hydrogen, and relative abundances which are quite similar among the GC clouds, even between those forming stars and those which are quiescent. The new data strengthen the suggestion that grain mantles in the GC share a common molecular history. The new data, however, also now clearly distinguish the chemistry of GC molecular clouds from that of the more common star-forming hot cores in the Galactic disk. The environment of the Galactic Center is unusual because of its high level of energetic X-rays, cosmic rays, and shocks. These apparently drive a very interesting chemistry which is able not only to produce complex species in cold environments, but also to distribute them broadly into the gas phase. The GC molecular clouds continue to be among the most promising sources of information on the chemical complexity of the interstellar medium.

Reference: Requena-Torres, Martin-Pintado, Martin, & Morris 2007, to appear in the ApJ (arXiv:0709.0542).

SCIENCE AND ACADEMIC AFFAIRS (SAA)

Promotion and Hiring of Outstanding Staff

Milestones	Original Date	Revised Date	Date Completed
1. Jansky Fellowships advertised			08/31/07
2. Tenure-track job advertised			09/12/07
3. Performance evaluation of scientific staff			09/20/07
4. Nomination of NRAO staff for AAS awards			09/30/07

Writing Various Documents

Milestones	Original Date	Revised Date	Date Completed
1. NSF REU/RET proposal			09/18/07
2. Writing sections of the annual Program Plan			08/31/07
3. Writing sections of the Long-Range Plan			09/03/07

Maintain Oversight of the NRAO Proposal and Time-Assignment Process

Milestones	Original Date	Revised Date	Date Completed
1. Student-support committee meeting			08/22/07
2. Agreement for joint GBT/Chandra proposals			08/30/07
3. Large Proposal evaluation and review			09/25/07

Office of Science and Academic Affairs

One of the major responsibilities of the office of Science and Academic Affairs (SAA) is to oversee and support the diverse activities of and for the research staff across all of NRAO. This oversight includes the co-op, undergraduate, graduate, postdoctoral, and outside visitor programs, as well as the Library and Observatory Archives, and the NRAO colloquium series. SAA also provides some funds and support for scientific travel so that NRAO staff can attend scientific meetings, participate in observing runs, etc.

The SAA administrative position has been filled this quarter, and the SAA office is now stationed at the NRAO headquarters in Charlottesville. We have begun to address the first of our goals, which is to clarify and streamline routine tasks such as approvals of travel forms, colloquia expenses, pay orders, leave reports, etc. for scientific staff. We have also begun to populate the SAA web page [http://www.nrao.edu/administration/dsaa/] with useful and timely information for the NRAO scientific staff as well as for the larger astronomical community.

2. Science and Academic Affairs (SAA)

Archives

After a year of work, the online catalog for the NRAO Archives, including links to digitized photographs and documents, is now available at http://jump.cv.nrao.edu/textbase/archivesearch.htm. Additional records will be added to the catalog as materials are processed. The catalog includes records for groups of material (e.g., NRAO Director's Office files on the annual Jansky Lectureships), as well as many individual-item records (e.g., Grote Reber's correspondence, documents and correspondence on the founding of the NRAO). The catalog database will grow steadily, since we add records as we process materials.

Library Program

The NRAO Library has added more than 950 engineering, physics, and other reference books to its collection via access to PhysicsNetBase and Knovel. We are currently adding the titles from these services to the catalogue, NRAOcat, which will allow staff to find books or search by topic. You may go to http://www.nrao.edu/library/ or link directly from http://www.nrao.edu/library/resources.shtml for the NRAOcat. We hope these new and expanded resources prove useful.

The Library will continue expanding information in the NRAO Papers database (papers utilizing NRAO telescopes or by NRAO authors) to make this a useful tool for scientists. We are looking for ideas for improvement, so please send any suggestions to Marsha Bishop at mbishop@nrao.edu.

All sites of the NRAO Library now have journals arranged alphabetically. For title changes, the journal is filed under the newest title. We hope that this will facilitate locating journals without the extra lookup step for a call number.

Scientific Appointments

Arrivals/Promotions

Brigette Hesman joined the Socorro Scientific Services Division as an EVLA commissioning postdoc in July. She completed her PhD at the University of Saskatchewan in 2005 and then worked with the Cassini team at the Goddard Space Flight Center before arriving at the NRAO. Brigette's science interests lie in the study of the atmospheres of Neptune and Uranus.

Jeff Mangum was promoted to Scientist with a Continuing Appointment this quarter. The decision to promote Mangum was made by the NRAO Director, and it received the approval from the AUI President. His past work on the 12 Meter telescope, the subsequent development of the on-the-fly mapping technique, and his singular dedication to students and users were keys to this promotion. More recently Jeff played a major role in testing the ALMA prototype antennas, and he is expected to take a critical role in the evaluation and acceptance of ALMA antennas.

James Miller-Jones began his appointment as a Jansky Fellow in Charlottesville in September. Miller-Jones was most recently a postdoc at the University of Amsterdam, working for Prof. Rob Fender. At the NRAO he will carry out research in the field of X-ray binaries, specifically investigating their speeds, energetics, duty cycles, and impact on their surroundings.

Emmanuel Momjian was appointed to an Assistant Scientist position to begin this fall in Socorro. Momjian will have an initial responsibility for leading the scientific performance verification tests of the

EVLA antennas. Emmanuel comes from Arecibo as a Research Associate focusing on the study of ultra-luminous infrared galaxies and high-redshift quasars.

Billie Orahood joined the SAA office as the Senior Administrative Assistant. Orahood comes to SAA via the Director's Office, where she helped look after the scientific staff for many years.

Beginning in 2009, Juergen Ott will be joining the scientific staff as an Assistant Scientist. Juergen is currently a Jansky Fellow based in Charlottesville, but he will spend 2008 at Caltech. At the beginning of 2009 he will spend a year based in Socorro helping to commission the basic science-observing modes using the WIDAR correlator.

In September, Marilio Pannella and Veronica Strazzullo, two NRAO Research Associates, arrived in Socorro from the Max-Planck-Institut für Extraterrestrische Physik and the European Southern Observatory, respectively, to work with Frazer Owen and Chris Carilli on multi-wavelength studies of extragalactic deep fields.

Departures/Extensions

Jansky Fellows Vincent Fish and C. C. (Teddy) Cheung completed their three-year appointments at the end of this summer. This quarter J. P. Macquart and Neal Miller's Jansky Fellowships were extended a few months beyond their third years, and Nissim Kanekar's appointment was extended to a fourth year via C. Carilli's Max Planck grant.

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

Predoctoral students supported by the office of Science and Academic Affairs (SAA) during this quarter were Kathryn Devine (University of Wisconsin) working on infrared dark clouds and high-mass star formation with Claire Chandler at the AOC and co-supervised by Prof. Ed Churchwell at the University of Wisconsin; Esteban Araya (New Mexico Tech) working on formaldehyde maser emission in the Galaxy with Miller Goss at the AOC, co-supervised by Prof. Peter Hofner at New Mexico Tech; Chatajili Parashare (University of Virginia) working on instrumentation for low-frequency radio astronomy arrays with Richard Bradley at the NTC, Buckner Creel (University of New Mexico) working with Mark Claussen at the AOC on VLBA astrometry of protoplanetary nebulae, co-supervised by Prof. Ylva Pihlstrom at the University of New Mexico; Hirofumi Kawakubo (University of Michigan) working with Tim Bastian and Richard Bradley in Charlottesville on the development of antenna stations for low-frequency interferometric arrays, specifically for a prototype for FASR and co-supervised by Prof. Chris Ruf of the Department of Electrical Engineering and Computer Science at the University of Michigan; and Alok Singhal (University of Virginia) working with Rick Fisher in Charlottesville and Karen O'Neil in Green Bank on parametric comparison of a kinematic model for HI in galaxies with rotation curves and HI distributions from aperture-synthesis and single-dish HI data, co-supervised by Prof. Ed Murphy at the University of Virginia.

During this quarter Katie Mae Chynoweth (Vanderbilt University) worked as a graduate intern with Glen Langston in Green Bank on modeling interacting galaxies in the M81/M82 cluster using GBT and VLA data; Ryan Lynch (University of Virginia) worked as a graduate intern with Scott Ransom in Charlottesville on improving spectral resolution of the GBT pulsar spigot and on pulsar observations with the GBT; and Paul Ries (University of Virginia) worked as a graduate intern with Richard Bradley in Charlottesville on measuring power patterns of low-frequency antennas using satellite downlink signals. Kevin Stovall (U. Texas, Brownsville) visited Charlottesville as a graduate intern to work with Scott

Ransom on pulsar data analysis. Alyson Ford (Swinburne University) worked as a graduate intern with Jay Lockman in Green Bank on analysis of the distribution, structures, and properties of HI clouds above the Galactic plane. Quinn Konopacky and Carl Melis (both UCLA) visited Socorro as graduate interns to work with Amy Mioduszewski preparing for astrometric observing programs with the VLBA. Urvashi Rao-Venkata (New Mexico Tech) began work as a graduate intern with Dale Frail in Socorro investigating parameterized deconvolution in radio synthesis imaging, specifically for high-dynamic-range imaging with the EVLA, ATCA, and VLBA.

Co-op students and engineering interns at the NRAO this quarter included Jesse Pomeroy (an Electrical Engineering major at South Dakota School of Mines and Technology), who completed a co-op program with Dan Merteley in Socorro on the design of an antenna for precision RF measurements in the EVLA/ALMA shielded chamber at the VLA Site; Kendra Krueger, who is pursuing a dual major in Electrical Engineering and Physics at Rensselear Polytechnic Institute, began a co-op placement in Socorro working with Dan Merteley and the Interference Protection Group at the VLA Site; Brandon Rumberg, a senior undergraduate majoring in Computer and Electrical Engineering at West Virginia University, who completed an undergraduate engineering internship with Randy McCullough in Green Bank on the Advanced Digital Backends project; and Hannah Clevenson, a 2007 graduate of Western Albemarle High School, who completed a summer internship working with Richard Bradley on instrumentation and testing projects at the NTC in Charlottesville.

Drs. Duncan Lorimer and Maura McLaughlin (West Virginia University) completed visiting-scientist appointments at Green Bank, working on a large-scale pulsar drift-scan survey with the GBT and a fast data-acquisition system for pulsar studies with the 140 foot telescope. Dr. Laurent Lionard (UNAM–Morelia) visited Socorro to work with Amy Mioduszewski on multi-epoch VLBA observations of low-mass protostars, with the goal of measuring their trigonometric parallaxes. Dr. Pat Palmer (U. Chicago) visited Socorro again this summer to work with Miller Goss on parallax and proper-motion studies of excited-state OH masers in DR21, and other topics.

Dr. Malcolm Gray (University of Manchester, U.K.) began a sabbatical year in Socorro during which he will work with NRAO staff on theory and computational models associated with astrophysical masers in various environments.

Support Programs

Student Observing Support

The SAA office and the Award Committee met in August and awarded five GBT observing proposals for trimester 07C with support totaling to $90,000.

This program is intended to strengthen the proactive role of the Observatory in training new generations of telescope users. At the current time, regular proposals submitted for the Green Bank Telescope (GBT), the Very Long Baseline Array (VLBA) and the High Sensitivity Array (HSA) are eligible for funding, while regular VLA proposals are not. Large proposals for the VLBA, GBT, HSA, VLA and any combination of these telescopes are also eligible. General information on the program structure and background is available in the "Introduction to the NRAO Student Observing Support Program" found online at http://wiki.gb.nrao.edu/bin/view/Observing/NRAOStudentSupportIntro.

Funds for Individual Engineering Research Projects

In FY 2007 the NRAO set aside a total of $75,000 for individual engineering research projects. Research Engineers in the ranks of Assistant Scientist/RE, Associate Scientist/RE, and Scientist/RE are eligible to apply for portions these funds. Proposals are evaluated by three senior members of the Observatory Technical Council plus the Technical Leader for R&D, and informal reviews of the funded research will be conducted by this group 6 and 12 months following the allocation of funds.

During this quarter a call for proposals was issued and two proposals were received. The remaining funds in the program were awarded to one proposal, for a total of three proposals funded during FY 2007.

TELESCOPE USAGE

The NRAO telescopes were scheduled for research and for maintenance during the second quarter of 2007 as described in the table below. Time lost and actual observing for the arrays are computed as fractions of the total antenna arrays. For example, losing 27 VLA antennas for one hour counts as 1.0 hours of array time lost, while losing one out of ten VLBA antennas for one hour counts as 0.1 hours of array time lost. Antennas being modified for the EVLA are counted as lost for observing.

We now schedule approximately 15% of the VLA time dynamically, prototyping our dynamic-scheduling process for the EVLA. There are voids in this process, since 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, since the mixed VLA configurations are not useful for the majority of our astronomical observations. In addition, EVLA testing and commissioning now takes priority for virtually all dynamic time, even at short notice. 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 scheduling voids for astronomical programs with the VLBA, which we fill with tests, calibration, and maintenance:

(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 that 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	1569.21	882.95	1051.00
Scheduled Maintenance and Equipment Changes	223.00	220.40	458.00
Scheduled Tests and Calibrations	415.80	153.05	699.00
Time Lost	237.00	78.14	26.00
Actual Observing	1332.21	804.81	1025.00

EXPANDED VERY LARGE ARRAY (EVLA)

EVLA highlights for this quarter include:

- A meeting of the EVLA Advisory Committee was held on September 6–7.
- Twelve antennas have been retrofitted to the EVLA design and account for 39.5% of all antenna hours in scientific observations.
- Deformatter racks were relocated to the new correlator room to allow future expansion of EVLA electronics.
- The new Ka-band (26–40 GHz) receiver was assembled and tested.
- A contract was issued for the procurement of the 3-bit, 4Gsps samplers.
- A new connectivity scheme for the WIDAR correlator was reviewed and approved for production.

EVLA Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Begin production installation of M302/3 utility system	07/05/07		07/05/07
2. Start EVLA conversion of antenna 25	06/20/07	07/05/07	07/05/07
3. Develop correlator installation plan	04/23/07	07/09/07	07/09/07
4. Assemble prototype Ka-band receiver	02/28/07	07/12/07	07/12/07
5. WBS Updates	07/18/07		07/18/07
6. Complete tests of 2–4 GHz signal path	06/25/07	07/09/07	07/19/07
7. WIDAR Connectivity review	07/31/07		07/31/07
8. Hardware acceptance tests complete on antenna 11	07/24/07		08/02/07
9. Antenna 11 turnover to Operations	07/25/07		08/03/07
10. Update project risk register	04/11/07	07/13/07	08/06/07
11. 4/P-band receiver system restored	08/24/07		08/24/07
12. Start EVLA conversion of antenna 1	09/04/07		09/04/07
13. Issue FY 2008 budget plan	09/05/07		09/05/07
14. Project Advisory Committee meeting	09/06/07		09/07/07
15. Hardware acceptance tests complete on antenna 25	09/25/07		09/19/07
16. Antenna 25 turnover to Operations	09/26/07		09/20/07
17. 12 antennas retrofitted to EVLA design	09/28/07		09/21/07
18. Prototype Ka-band receiver ready for use	06/11/07	10/04/07	
19. EVLA Science Data Model (SDM) review to ALMA	08/10/07	10/05/07	
20. Agreement on common ALMA+EVLA Science Data Model	09/04/07	10/08/07	
21. Status of hardware solutions for phase instability	09/14/07	10/08/07	
22. CASA Beta release	09/30/07	10/15/07	
23. Antenna reference transmitter and RTP racks completed	08/24/07	10/19/07	

1. Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
24. C-band OMT—broadband test in receiver	08/31/06	10/26/07	
25. Develop production schedule for Q-band receiver	10/26/07		
26. Start EVLA conversion of antenna 4	10/30/07		
27. Develop requirements for EVLA-designed weather station	11/01/07		
28. Develop production schedule for Ka-band receiver	11/01/07		
29. Install wideband C-band receiver on antenna	11/02/06	11/06/07	
30. L-band dewar drawings ready for fabrication	11/08/07		
31. Decision on new DDS design for L302	11/15/07		
32. Start L-band receiver OMT testing	11/15/07		
33. Hardware acceptance tests complete on antenna 1	11/27/07		
34. Antenna 1 turnover to Operations	11/28/07		
35. Correlator-room access control implemented	12/05/07		
36. Complete design of C-band OMT	04/27/07	12/07/07	
37. Access to archive tool via portal	06/14/06	12/15/07	
38. Delivery of high-speed cables from Penticton	12/18/07		
39. Common ALMA+EVLA SDM (v. 3.0) accepted	12/31/07		
40. Common ALMA+EVLA CalDM accepted	12/31/07		
41. Begin production of C-band OMT	02/28/07	01/07/08	
42. Science Support System software PDR	06/05/07	01/09/08	
43. OPT outputs an EVLA observe script	10/25/06	03/13/08	

Management

The EVLA Advisory Committee met in Socorro on September 7–8, 2007. The committee's formal report has yet to be submitted, but the committee's preliminary findings were reported during an exit interview with NRAO management at the meeting. The committee found that the project was responsive to its previous recommendations and was impressed by the overall progress on the project. The preliminary recommendations of the committee included suggestions to examine the correlator integration schedule for schedule recovery, and to develop detailed science-driven task schedules for the commissioning and start-of-science phases of the project.

The cost data sheets for elements of the EVLA's work breakdown structure (WBS) were updated in July 2007. The consolidation of the updated data sheets into a project cost summary shows a remaining contingency of $3.4M, or 14.6% of the cost to complete the project.

An update of the project risk register was completed in August 2007. When compared to the initial risk register, which was compiled in December 2006, the total number of risks to the project has decreased from 79 to 69, the total financial risk to the project has decreased from $11.2M to $7.4M, and the sum of weighted risks has decreased from $3.3M to $2.8M. The project contingency exceeds the sum of weighted risks, suggesting that adequate contingency exists to cover the risks facing the project.

1. Expanded Very Large Array

Project performance metrics were updated for the third time in FY 2007. The project's cost-performance index improved to CPI=0.97, and its schedule performance index improved to SPI=0.89.

Systems Integration

The primary goal of the EVLA project in FY 2007 was retrofitting 12 antennas to the EVLA design by September 30, 2007. This goal was achieved on September 21, nine days ahead of schedule, when antenna 25 was returned to array operations for astronomical observing. The 12 EVLA antennas now account for over 39.5% of all antenna hours used for routine scientific observations.

A program-plan goal for FY 2008 was completed on September 26, 2007 when the EVLA deformatter racks were relocated to the new correlator room. The rack relocation was necessary prior to the completion of the 13th EVLA antenna, which could not be supported in the existing correlator room owing to space limitations. The rack relocation required the removal and reinstallation of all the racks and networking, fiber optics, and coaxial cables supporting the 12 operational EVLA antennas. At the same time cables were installed to support the 13th EVLA antenna. In the following weeks an additional rack and all of the fiber required to support the next set of 12 EVLA antennas will be installed.

Civil Construction

The civil construction WBS element of the EVLA project is basically complete. Over the last quarter, civil construction provided electrical power for the deformatter racks that were relocated to the new shielded room. The only remaining work for civil construction is to assist the Electronics Division with the installation of the WIDAR correlator in the new shielded room, to install control and alarm wiring for the air-conditioning equipment in the shielded room, and to activate the FM200 gas cylinders in the fire-suppression system of the shielded room once the correlator is installed.

Antenna

Mechanical outfitting of the 13th EVLA antenna was started. The platform extensions and other structural modifications for a total of 15 antennas are now complete. Assembly of the feed cones for the next three EVLA antennas will begin in October.

The fiberglass lamination of L-band feed horns 1 through 23 is complete. Fabrication of the rings for all the L-band horns is complete, and fabrication of the rings for the S-band horns has begun.

The designs for the Ku-band feed horn and its mounting tower were completed. The VLA shop is building mounting tower numbers 1 through 3. The Green Bank shop will build all of the Ku-band horns and tower numbers 4 through 28. A Ku-band tower and feed alignment fixture is being made at the VLA shop.

An engineering study of the antenna vertex hoist and its operation was conducted with the goal of improving safety. As a result, equipment modifications and training are being implemented.

Front Ends

During the past quarter, the eleventh and twelfth EVLA antennas were outfitted with interim L- and X-band receivers as well as fully EVLA-compliant K-band systems.

1. Expanded Very Large Array

The construction of C-band receivers is slowly catching up from the delay caused by production problems with their card cages. Interim C-band receivers were installed on antennas 21 and 19. The C-band receiver for antenna 11 will be installed in early October, and the C-band receiver slated for antenna 25 is currently being assembled in the laboratory.

The Q-band receiver upgrade is also recovering from the delay caused by fabrication problems with its custom post-amplifiers. Interim Q-band receivers were installed on antennas 21 and 19. The prototype of the first fully EVLA-compliant system is undergoing tests and is scheduled for installation on antenna 11 in early October.

Cryogenic testing of the prototypes for the C-band orthomode transducer (OMT) continues. Excellent sensitivity across the full 4–8 GHz frequency range was measured in the laboratory with the receiver temperature across most of the band being less than 10K. Earlier results had been less than satisfactory owing to large bumps in the frequency response above 6 GHz. The degradation in sensitivity was eventually traced to the commercial calibration couplers used in front of the low-noise amplifiers. The couplers developed a high insertion loss when cooled. The prototype OMTs do show some smaller variability in sensitivity when cooled. Tests are underway to improve the thermal stability before moving on to the production phase of the unit.

The top-level design of a new L-band cryogenic dewar for cooling the large 1–2 GHz OMT is well underway and has passed its first peer review. Once the full set of mechanical drawings is complete, a prototype will be fabricated. Cryogenic tests should begin in early 2008.

The top-level RF design of the new 2–4 GHz OMT is being carried out in Green Bank and is largely complete. Machinist drawings of the OMT's three-dimensional model have also been generated, and a prototype OMT should be fabricated and ready for testing by year's end. Since the old VLA L-band dewar will be reused for the new S-band receiver, drawings for the design modifications are currently underway.

The new 26–40 GHz Ka-band receiver was assembled and tested. At the band center, the right circularly polarized (RCP) channel has a receiver temperature of about 25K while the left circularly polarized (LCP) channel has a somewhat poorer 30K performance. The frequency response of the LCP channel also has more ripples than the RCP channel. However, the performance of both channels is below the EVLA Project Book specification. More tests will be carried out to ensure optimum performance.

Local Oscillator and Intermediate Frequency Systems

Modules for the local oscillator (LO) and intermediate frequency (IF) systems of the EVLA continue to be built to meet the antenna retrofitting schedule. The modules may still need some level of retrofit, mostly owing to upgraded hardware and RFI requirements.

Phase-stability issues are still being investigated in some of the LO and IF modules. Each module has been or will be tested for phase stability, and a specific plan is being developed for each module that may have a phase-stability issue.

The design of the L352 round-trip-phase (RTP) module is being enhanced. Testing has begun and is expected to be complete by the end of the calendar year. The full-scale production of the L352 modules will begin as soon as testing verifies that the performance specifications are being met. The procurement of the gain-slope equalizer board for the IF downconverter was initiated.

1. Expanded Very Large Array

Fiber Optic System

Modules for the digital transmission system, formatter, and deformatter continue to be built to meet the antenna retrofitting schedule.

The vendor selection for the 3-bit, 4Gsps samplers was approved by the NSF, and the contract was awarded to the successful vendor.

Correlator

The new connectivity scheme for the EVLA correlator was formally reviewed and accepted in July. We are making final circuit-board changes resulting from this scheme and from initial prototype testing. The work package for manufacturing the baseline boards will be distributed to prospective vendors in October. Design changes to the station board have been delayed.

The correlator chip is now in full production. The correlator group in Penticton is working with the chip contractor, iSine, on developing and putting into place an appropriate production screen to minimize the possibility of chip failures on boards.

Many of the components for the correlator racks have now arrived in Penticton, and assembly of the racks has begun with an in-house contractor now working and dedicated to this task. The rack assembly appears ready to meet testing and delivery schedules next year.

Correlator software development continues to keep pace with hardware. All necessary software should be in place to support site testing next year. Work is also progressing on transferring knowledge of correlator capabilities to the NRAO scientific staff with a view towards development of test cases and incorporation into the EVLA observation preparation tool.

Monitor and Control

The major event for the EVLA Monitor and Control (M&C) Group during the quarter was the retirement of the old Modcomp-based VLA Control System and the rollover to the new EVLA M&C Transition System. The EVLA M&C Transition System completely replaces the old VLA Control System. It accepts observational specifications in the form of VLA-style observe files or EVLA control scripts; can monitor and control EVLA antennas, VLA antennas, and the VLA correlator; and writes standard archive records that can be read by the AIPS post-processing software. It will provide a basis for operating and testing the WIDAR prototype correlator and a foundation for developing the final version of the EVLA M&C System.

The rollover to the EVLA M&C Transition System took place during the last week of June 2007. The Transition System has been used continuously, with no fallback to the old VLA Control System. The group's focus over the quarter was to more thoroughly and completely validate the Transition System, to eliminate bugs found during operational use, and to further develop and expand the capabilities of the Transition System. Validation was done by examining the results of every observation conducted during the first months of operation of the array by the Transition System. Problems were found and corrected. The need to closely scrutinize every result produced by the system is no longer present.

The next quarter will be devoted to further debugging of the Transition System, to preparations for the WIDAR prototype correlator, and to the start of development efforts on components of the final version of the EVLA M&C System.

Science Support Systems

The Observation Preparation Tool (OPT) now has two component tools that work both inside the OPT and as independent applications. These are the Source Catalog Tool (SCT) and the Resource Catalog Tool (RCT). The SCT presents users with standard calibrator catalogs and also allows them to maintain their own catalogs of calibrators and observational sources. The RCT will give observers similar capabilities with respect to instrument configurations.

The software staff in the Science Support Systems (SSS) group recently engaged a group of observatory astronomers to act as a user committee to help craft and test EVLA software applications. The group meetings provide valuable feedback from the people who will use the software.

The software collaboration with the ALMA project continues, most recently reorganizing and renaming parts of EVLA code to align with ALMA code. This was an effort to make sure that, between the EVLA and ALMA projects, things with the same meanings share the same names, and things with the same names share the same meanings. This is especially important for concepts that wind up in the Science Data Model (SDM). We continued to align the SDM with ALMA by holding a major meeting and making progress on a joint document that describes the common model.

A personnel vacancy in the SSS group was filled in August. The new software engineer will assist with the development of the OPT, SCT, RCT, and the Observation Scheduling Tool.

NEW INITIATIVES

Square Kilometer Array (SKA)

The "Chicago 3" meeting on "Implementation of the Square Kilometer Array Program for the US Community" was held in Washington for two days in August. It had four primary parts: presentations and discussion on each of the low-, mid-, and high-frequency components of the SKA, plus a general summary and panel discussion. The US SKA Consortium formed a subgroup, with two NRAO members, to translate the results of the Chicago series of meetings into documentation and proposals for the decadal survey scheduled to begin in 2008.

The NRAO formed an internal SKA Working Group, chaired by the Head of the New Initiatives Office, to coordinate NRAO efforts in support of the SKA. Members are participating in all four of the primary working groups of the international SKA Project Development Office, as well as the International SKA Steering Committee (ISSC).

A draft revision was made of the specifications for the different phases of the SKA by a specifications "tiger team" commissioned by the ISSC. This revision was the focus of discussions in late September at a three-day series of meetings of the four international SKA working groups that was held in Manchester, UK. A primary result of these working group meetings was that the previous concept of bounded SKA "phases" should be replaced by a continuous scientific and technical evolution, with key science and technology milestones achieved along the way.

Frequency Agile Solar Radiotelescope (FASR)

The Frequency Agile Solar Radiotelescope (FASR) is a priority facility designed to address solar, heliospheric, and space-weather physics. The project is under development by a consortium under AUI management that includes the NRAO and a number of university partners: NJIT, Berkeley, the University of Michigan, the University of Maryland, and Caltech. The partners signed a letter of intent at a team meeting in August 2007. The consortium expects to submit a pre-proposal for construction to the NSF/ATM by the end of the calendar year and plans to submit a full proposal by June 2008. If successful, the project could be funded by the end of FY 2008.

VLBI Space Observatory Programme 2 (VSOP-2)

In August the NRAO hosted the fourth in a series of VSOP-2 tracking-station planning meetings in Green Bank. As a result of this meeting, the international participants in VSOP-2 have converged on a common tracking-station design that will be implemented at all VSOP-2 tracking stations. The first implementation will be made in Japan as part of the tests of engineering models of the spacecraft hardware for VSOP-2, scheduled for launch in 2012.

NASA released a Research Announcement calling for Small Explorer and Mission of Opportunity (MoO) proposals, due on January 15, 2008. The NRAO has been working with its JPL and Japanese partners in order to prepare a US science proposal for this MoO call, which will include construction of one or two tracking stations, funding a US science team, and operations funding for NRAO telescopes in support of a US key-science program. A preliminary US science team was formed, and plans were made for a key-science meeting in Japan in October, 2007. We anticipate that work on the MoO proposal will begin in earnest after this key-science meeting.

External Partnerships

Final agreement was reached on a Memorandum of Understanding (MOU) with the Max Planck Institut fűr Radioastronomie, covering future cooperation in a variety of areas in radio astronomy. The first area, implementation of improved 22 GHz systems on the VLBA, is now well along, with 6 of 10 VLBA systems already upgraded. Final signature on the MOU was delayed until the fourth quarter for logistical reasons.

The proposal submission deadline for Cycle 1 of the GLAST (Gamma-ray Large Area Space Telescope) Guest Investigator program has passed. Of approximately 120 proposals received, more than 20 requested observing time on NRAO telescopes, primarily the VLBA but also with considerable GBT and VLA time requested. The NRAO will participate in the peer review of these Cycle-1 proposals in the fourth quarter.

New Initiatives Office Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Host fourth VSOP-2 tracking-station design mtg.	09/07/07		08/30/07
2. Organize and attend US SKA Implementation Mtg.	09/15/07		09/15/07
3. Attend International SKA Working Meeting	10/07/07		09/29/07
4. Attend International SKA Steering Committee mtg.	10/07/07		
5. Attend VSOP-2 key-science meeting in Japan	10/23/07		
6. Final signatures on MPIfR Cooperation MOU	06/22/07	11/15/07	
7. Attend VSOP-2 tracking-station meeting in Japan	12/08/07		
8. Submit NASA MoO proposal for VSOP–2 support	01/15/08		
9. FASR Team Meeting	08/01/07		08/01/07
10. MSI Program Pre-proposal	01/01/08		
11. MSI Proposal:	06/01/08		

GREEN BANK OPERATIONS

Green Bank highlights for this quarter include:

- Refurbishment of the GBT track was completed September 18, 2007.
- Excellent telescope performance after track replacement was restored September 30, 2007.
- Spectrometer LTA (Long-Term Accumulator upgrade complete September 5, 2007.

The GBT azimuth-track replacement project was completed to the original specifications, on schedule and within budget. The GBT foundation was found to be in good shape, with only a couple of areas that needed more than surface repairs. The track installation was completed and the telescope was released for motion on September 3, 2007. At that point the PTCS pointing team began collecting inclinometer data. A direct comparison with data obtained on the old azimuth track showed three significant improvements in the performance of the new track: a reduction in the large-scale features in the local tilt (by a factor of ~5), elimination of the periodic small-scale features in the local tilt, and reduction of the disturbances during joint passages. A large quantity of all-sky and single-source pointing data were obtained at X band. The data were fit using the new pointing model that includes lookup tables for track effects at a resolution of 0.1 degrees. The new model (PFM5c) was implemented and tested prior to the established deadline, and it provides good blind pointing performance with a standard deviations of only 3.4″ in cross-elevation and 3.8″ in elevation during nighttime observations. The GBT is now back in service with available receivers.

A number of modifications to the MUSTANG 90 GHz array receiver were made following the *1/f*-noise breakthrough in the spring of 2007. A new vibration-mitigating heat strap was produced and tested; it gives better cryogenic performance than the old vibration-mitigating heat strap. We installed the receiver on the GBT in August, and we verified that the vibration mitigation works *in situ* and that no new sources of vibration excite *1/f* noise. Significant progress towards a third, lower-noise detector array was made; a broken column in the series array was repaired; and a new, wider bandpass filter was ordered from Cardiff, who has started constructing it. The pulse-tube cooler was sent back to the vendor after our GBT run, and the vendor confirmed there was a problem with it, which they are fixing. Work was initiated at Green Bank to write a long-term replacement for the interim NASA IRC data-acquisition package, and significant progress made towards this goal. At the end of the quarter the project team prepared and submitted a GBT early-science proposal for this winter.

The Ka-band receiver was modified this quarter to increase the symmetry in the circuitry before the first hybrid. Also the 50 K heat shield was lined with RF absorber to damp possible resonant-cavity modes. Zpectrometer test results with the dewar cold showed much improvement in both stability and common-mode signal rejection. Some baseline ripple remains, but it is much more stable and broad enough that it should not affect narrow-line detections. The receiver temperature was reduced by ~ 10 K across most of the band and by > 10 K in the 36–39 GHz range, thus increasing the useful frequency range of the Ka-band receiver. The improvement in system temperature is about a factor of 1.25, less than the 1.41 that would compensate for the loss of half the channels, indicating that observing times will need to increase by about 25%. The receiver and Zpectrometer were installed on the telescope near the end of the quarter, and commissioning results generally agree with those from the lab.

In addition to its work restoring telescope pointing after the track replacement, the PTCS team is preparing to revisit the technique of out-of-focus (OOF) holography on the GBT. The primary goals are to gather available software tools into a more streamlined general-user tool and to investigate the possible benefits of using OOF to actively maintain the surface shape during daytime observations. The team also

held an informal workshop on OOF Holography and Phase Retrieval Techniques with attendees from the NASA/JWST Wavefront Sensing Group, the Large Millimeter Telescope (LMT) project, and the MUSTANG project. During the workshop, we held a brainstorming session that resulted in an activity list for the next quarter aimed at investigating the possibilities of doing OOF holography at 90 GHz with MUSTANG. We also heard an update on LMT plans and progress. At the conclusion, tentative plans were made to hold the next workshop on OOF and traditional holography at the University of Massachusetts sometime next year.

With the goal of measuring the remaining small-scale surface errors of the GBT, the PTCS team is also upgrading the computer hardware and software interface to the traditional holography system. During the third quarter, the software manager was ported to Linux and brought up to date in terms of its structure and library calls. Following this milestone, work began on integrating a modern digital I/O card to control the correlator. We also released a draft project note describing an accurate surface model that is being used to simulate the results from future traditional-holography observations on the GBT in order to better understand the limitations we may face. During the third quarter, the majority of the PTCS servo-systems efforts went into implementing a new interlock system. A PLC-based system was built and tested to allow better diagnostics, shorter repair times, and increased reliability from the main-axes servo systems. The first phase of the interlock upgrade will be installed in the first quarter of FY 2008 on the main axes, and phase 2 of this system will be installed in June of 2008 on the secondary-optics axes.

The K-band Focal Plane Array project team spent the quarter revising their initial proposal to reflect realities of available technical staff, schedule, and budget. A specific science case was written taking into account these considerations. A project plan was devised and a charter was developed for a K-band seven-feed focal plane array integrated into the existing IF system and using the GBT spectrometer as a backend. The component development projects were assigned to staff members with approval from their supervisors. The final proposal was presented to primary stakeholders as a pathfinder instrument for a focal-plane-array development program. This presentation resulted in approval to begin designs culminating in a conceptual design review during the second quarter of 2008.

Since its deployment on October 1, all visitors to Green Bank and New Mexico are using the new online reservation system, the Green Bank Software Development Division (SDD)-supplied Business Office System, exclusively for site visits. The Business Office System is accessible through each site's webpage or directly at https://bos.nrao.edu. The SDD is working with the E2E Division to ensure that a link to the Business Office System is also provided on the Dashboard in NRAO Interactive Services so that proposers can easily make their reservations and to closely tie in to a single NRAO user's database and authentication system for software NRAO-wide.

As the 2007 fiscal year began on October 1, we have modified the GBT's goals here to reflect the goals established in our 2007 Program Plan. Additionally, we have consolidated the goals to reflect the project, rather than the division in which work will be done. These goals will be tracked through FY 2007. Some goals completed in earlier quarters are shown for consistency with previous reports.

GBT Site Milestones for FY 2007

Milestones	Original Date	Revised Date	Date Completed
Azimuth Track Refurbishment			
1. Refurbishment complete	08/31/07		09/18/07
2. Telescope performance restored	08/31/07	09/30/07	09/30/07

OPERATIONS

1. Green Bank Operations

Milestones	Original Date	Revised Date	Date Completed
C-band Receiver Upgrade [Note 1]			
1. Design Review	04/24/07		04/24/07
2. Upgrade Complete	02/15/07	09/30/07	09/30/07
3. Commissioning Complete	03/01/07	11/15/07	
Dynamic Scheduling [Note 2]			
1. Stage II tests begin	08/15/07	06/01/08	
2. Stage II tests complete	09/30/07	09/30/08	
3. Design Review	12/01/07	12/01/08	
4. Release Stage III software for general use	06/01/08	10/01/09	
CICADA [Note 3]			
1. GUPPI (Next Generation Pulsar Machine) Common User Machine released	12/01/08		
MUSTANG [Note 4]			
1. Verify improved noise & cryogenic performance on the GBT	08/30/07		08/30/07
2. Install on GBT for engineering & early science run	12/15/07		
3. Document results from 2nd engineering run	03/30/08		
PTCS [Note 5]			
1. Trajectory Generation and Servo Improvements complete	12/31/06	11/30/07	
2. PLC interlock system main servo complete	08/31/07		08/31/07
3. PLC interlock system complete	08/31/07	08/31/08	
4. Small-scale surface errors characterized	08/31/07		08/20/07
5. Laser rangefinder V2 development complete	09/31/07	03/01/08	
6. Recommissioning of traditional holography receiver	04/01/08		
Spectrometer LTA Upgrade [Note 6]			
1. LTA upgrade complete	10/01/07		09/05/07
Zpectrometer [Note 7]			
1. Commissioning tests complete	10/13/06	10/15/07	
2. Science validation complete	06/01/08		

Notes:

1. The C-band completion date was moved to accommodate MUSTANG work. Commissioning was moved to accommodate high-frequency commissioning activities.
2. Dynamic-scheduling work was delayed by work on the high-frequency receivers.
3. CICADA (FPGA Development Project) is a University Collaboration with the University of Cincinnati and West Virginia University.
4. MUSTANG (Penn Array Receiver) is a University Collaboration with the University of Pennsylvania. MUSTANG progress has been slowed by difficulties in fabricating the detector array.
5. Only slow-speed tracking improvements done for the Servo improvements. Due to necessary engineering work on other antennas, it was not possible to complete design work on the secondary-optics part of the PLC upgrade. That work has been deferred until next summer's painting and inspection period.
6. The LTA card will be repaired, not upgraded. Completion time has been moved up accordingly.
7. The Zpectrometer is a University Collaboration with Andy Harris at the University of Maryland.

NEW MEXICO OPERATIONS

New Mexico highlights for this quarter include:

- Twelve EVLA antennas have been retrofitted and restored to routine service, with a thirteenth now in retrofit.
- The first 2 EVLA-only papers have been submitted for publication in *ApJ (Letters)* and one is in press. These papers are based on observing time granted in response to a call to exploit the extended tuning range of the EVLA's new C-band receivers, and both papers are based upon observations of 6 GHz OH masers.
- The VLA's MODCOMP control computers were removed from service at the very end of last quarter and replaced by the new EVLA monitor and control (M&C) system. Commissioning of the new system was completed in less than three weeks and with remarkably few problems. All antennas in the array now operate with the new M&C system.
- The program to increase the VLBA sensitivity at 22 GHz, done in collaboration with the Max-Planck-Institut für Radioastronomie, continued through the third quarter of 2007. The milestone date for completing this important upgrade has now been advanced by two months, to the end of calendar 2007. At that point all ten VLBA stations will have their sensitivities in the scientifically important K band increased by as much as 50%.
- The St. Croix VLBA antenna was removed from service on September 10, 2007 for repainting and structural maintenance; it is expected to return to service before the end of the year.
- The Hancock antenna suffered an azimuth-wheel failure and was repaired during the week of September 10, 2007.
- Bob Dickman assumed the position of Assistant Director for New Mexico Operations on September 26, 2007.
- Claire Chandler and Peggy Perley were appointed to the positions of Deputy Assistant Directors of Science and Operations, respectively, on October 9, 2007.

VLA and VLBA Milestones

Management and Scientific Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Proposal Selection Committee with six outside members	08/08/07		08/08/07
2. Return EVLA antenna 11 to operational EVLA	07/25/07	08/30/07	08/30/07
3. Remove St. Croix from VLBA for rust repair	09/15/07	09/10/07	09/10/07
4. Return EVLA antenna 25 to operational VLA	09/26/07		09/20/07
5. New Assistant Director on board for VLA/VLBA	09/30/07		09/26/07
6. VLA–VLBA Proposal Deadline	10/01/07		10/01/07
7. Appointment of new Deputy Assistant Directors	10/15/07		10/09/07
8. Complete reconfiguration to B array	10/19/07		
9. Start EVLA conversion of Antenna 4	10/30/07		
10. Return EVLA Antenna 1 to operational array	11/17/07		
11. Return St. Croix to VLBA after rust repair	12/15/07		
12. First shared-risk science with EVLA 1.2–2 GHz	12/31/07		
13. Complete 22 GHz low-noise retrofit of VLBA	02/28/08	12/31/07	

Computer Infrastructure Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Bring up EVLA Antenna-25 Network	08/15/07		09/07/07
2. Install 80 upgraded Windows/Linux systems in FY 2007	09/30/07		09/30/07
3. Install new central Network Appliance file server	12/31/06	10/06/07	
4. Bring up EVLA Antenna-1 Network	11/15/07		
5. Install prototype paging system in Antenna 1	11/15/07		
6. Establish EVLA/AOC fiber plan	11/30/07		
7. Establish network tunnel to DRAO	08/31/06	12/31/07	
8. Establish network tunnel to ESO	09/30/06	12/31/07	
9. Prepare for 64-bit Windows migration	12/31/07		
10. Prepare for 64-bit Linux migration	12/31/07		

Notes:
3. Netapp shipped incorrect model, replacement model to arrive mid July, installations delayed by observation scheduling conflicts.
7. Requires further cooperation from DRAO under way – Establish network tunnel to DRAO
8. Requires further cooperation from ESO
9 and 10. Required for eventual migration to 64-bit OSs spring/summer of 2008.

Electronics Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Scheduled Maintenance Visit at Brewster VLBA	07/31/07		07/31/07
2. Pickup refurbished Maser #13 from Symmetricom	09/20/07		09/20/07
3. Build a prototype VLBA software-correlator computer cluster	11/15/07		
4. Complete K-Band sensitivity upgrade in the VLBA	12/14/07		
5. Develop a plan to address the VBLA maser issues	01/18/08		
6. Upgrade 12 P-Band receivers with COTS Amps	01/18/08		
7. Place into operation 12 additional Mark5 disk packs	02/15/08		
8. Begin testing a Digital Back End for the VLBA	03/15/08		
9. Install the Mark 5 pressure enclosure at MK VLBA	05/09/08		
10. Scheduled Maintenance Visit at Owens Valley VLBA	05/15/08		
11. Install the WIDAR correlator BGA rework machine	06/27/08		
12. Design and install an EVLA-compatible API	07/30/08		
13. Complete a VLA prototype ACU system	08/01/08		

Engineering Services Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Complete A-array reconfiguration	06/12/07		05/24/07
2. Hancock VLBA Foundation and Subreflector Repair	07/30/07		07/30/07
3. Repair three intersections (AW6, AW5, BW9)*	05/30/07	07/31/07	07/19/07

2. NEW MEXICO OPERATIONS

Milestones	Original Date	Revised Date	Date Completed
4. Complete BnA-array reconfiguration	09/21/07		09/18/07
5. Complete B-array reconfiguration	10/12/07	10/19/07	
6. Replace 4,000 Ties	11/30/07		
7. St. Croix Antenna Painting	12/15/07		
8. Complete CnB-array reconfiguration	02/15/08		
9. Complete C-array reconfiguration	03/07/08		

Notes:

3. Intersection repairs delayed by two months by array reconfiguration and crane equipment failure.
5. Array reconfiguration schedule change.

NORTH AMERICAN ALMA SCIENCE CENTER (NAASC)

NAASC highlights for this quarter include:

- Begin turno staffing of the ALMA Test Facility (ATF).
- Advertised next few NAASC positions.
- Preparations for CASA beta release (testing, release document, tutorial planning).
- Participated in ARC manager face-to-face meeting and Director's ALMA program review.
- Complete version D of the ALMA Operations Plan.
- ANASAC face-to-face meeting.
- Improvements to on-line spectral line catalog (Splatalogue).
- Submission of proposal to NSF to support UVa Microfabrication Lab (UVML).

Staffing for ALMA North American (NA) operations is ramping up. A number of new positions have been advertised at the NAASC, including two commissioning and science verification (CSV) scientists and an ALMA EPO officer. These positions will be filled over the coming 6 to 8 months. Two joint positions with the University of Virginia (UVa) will also be filled in the next few months. These are in addition to numerous positions being filled in Chile.

NAASC staff members have started the "turno" staffing at the ALMA Test Facility in Socorro. This activity involves participating in prototype antenna and software testing in order to gain familiarity with the system and train for eventual work in Chile and at the NAASC.

John Hibbard traveled to Garching to participate in the ARC managers meeting and to give a talk on the NAASC at the European "ALMA Community Days." He also traveled to Santiago to complete version D of the ALMA Operations Plan. The ARC managers will meet face-to-face quarterly. An important issue being considered is ensuring adequate user support during the early years of ALMA. Alwyn Wootten attended the annual ALMA external review in Santiago.

NAASC support and testing of ALMA software continued. Joe McMullin and Debra Shepherd traveled to ESO to give a CASA tutorial to European ARC and ARC-node members in July, in preparation for a CASA beta release planned for October. Crystal Brogan was appointed as the ALMA CASA Subsystem Scientist responsible for negotiating development goals and ensuring that the offline software meets ALMA requirements. Crystal organized many activities in preparations for the October CASA beta release, including generating a policy document, coordinating intensive testing of the pre-release software, and planning for a CASA and user-support tutorial to be held in October in Socorro. The CASA developers traveled to Charlottesville to support this effort. Testing continued on the pipeline, simulator, and Obstool.

The ANASAC held its annual face-to-face meeting in Charlottesville in August. The main issue considered was user funding associated with ALMA observing time. A letter on this issue has been written by the ANASAC and sent to the NSF and others. Andrew Baker was selected as the next ANASAC chair. We thank departing chair Jonathan Williams. The ANASAC also provided input to ASAC members for the recently submitted ASAC Report to the ALMA Board. New "Terms of Reference" were agreed to at the meeting. The NA ASAC members elected Andrew Blain as Vice Chair of the ASAC for NA at their August meeting.

3. NA ALMA Science Center

The Canadian MOU for operations is in the final stages of revision and will be completed in October 2007. Lewis Knee is leaving his position as Canadian ALMA operations representative and moving to Chile to participate in CSV activities. James di Francesco will assume the operations duties in October. We thank Lewis for his important contributions to ALMA operations planning.

The UVa Microfabrication Laboratory (UVML) receives partial support from the NAASC, and a proposal was sent to NSF to maintain this support in the coming years.

Tony Remijan, Frank Lovas (NIST), and Ciska Markwick-Kemper and others continued work on the spectral-line database "Splatalogue." By the end of the summer, Splatalogue was the most complete transition-resolved compilation of observed, measured, and calculated spectral lines. The details of the database and its use for the ALMA archive, observing-tool, and data-reduction packages will be made available by year's end, when Splatalogue will become available for use and elaboration by observatories worldwide. This group is writing a white paper summarizing ALMA's molecular-data requirements.

This quarter saw the generation of the FY 2007 Program Report, the FY 2008 Program Plan, and the FY 2008–FY 2012 Long Range Plan. NAASC staff worked with the NSF on the NAASC near-term budget projections.

NAASC Milestones July–September 2007

Milestones	Original Date	Revised Date	Date Completed
1. ANASAC face-to-face meeting	08/17/07		08/17/07
2. NAASC offline-software testing prior to beta release	08/27/07		08/30/07
3. ARC manager meeting at ESO	09/02/07		09/02/07
4. Director's ALMA program review	09/12/07		09/12/07

NAASC Milestones Beyond October 2007

Milestones	Original Date	Revised Date	Date Completed
1. MOU for UVa joint positions	10/15/07		
2. MOU for UVa Microfabrication Laboratory (UVML)	10/15/07		
3. Science center visits – Herschel	Fall 07	11/19/07	
4. CASA user-support boot camp	10/16/07		
5. New MOU with Canada for ALMA operations	9/1/07	10/30/07	
6. New NAASC science workshop 2008 – topic and SOC	09/01/07	11/02/07	
7. New ALMA EPO hire	12/01/07		
8. Two new hires for commissioning	12/30/07	04/30/07	
9. Software testing: CASA, Pipeline, Simulator, Obstool	Ongoing		
10. Talks on ALMA science and status at NA institutions	Ongoing		
11. Spectral-line catalogue—continue resolving species	Ongoing		

CENTRAL DEVELOPMENT LAB (CDL)

CDL highlights for this quarter include:

- Completed the design of ALMA band 1 (31.3–45 GHz) and band 2 (67–90 GHz) demonstration amplifiers.
- NbTiN/AlN/Nb SIS junctions, suitable for receivers operating above 700 GHz, were successfully fabricated at the University of Virginia Microfabrication Laboratory (UVML).
- A 4-element PAPER pathfinder array was deployed in Western Australia.

Amplifier Design and Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Evaluation of TRW Cryo-3 devices to determine noise, signal, and DC properties at cryogenic temperatures	04/01/04	ongoing	
2. Design/redesign of cryogenic amplifiers using Cryo-3 TRW devices for the EVLA, VLBA, GBT, and ALMA in the frequency range from 1 to 120 GHz	04/01/04	ongoing	

Notes:
2. The design of demonstration amplifiers for ALMA Band 1 (31.3–45 GHz) and Band 2 (67–90 GHz) receivers has been completed. A redesign of the 2–4 GHz amplifier body has been completed.

Other Project: Research on noise properties of heterostructure bipolar transistors (HBTs) continues.

Amplifier Production Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Build/upgrade/repair cryogenic amplifiers using Cryo-3 TRW devices for the EVLA covering the frequency range from 1 to 50 GHz	12/31/15		ongoing activity
2. Build/upgrade/repair cryogenic amplifiers using Cryo-3 TRW devices for the VLBA and GBT covering the frequency range from 1 to 95 GHz	ongoing		ongoing activity
3. New amplifier test system development	06/30/06	09/30/07	

Notes:
1 and 2. Four CBI Ka-band amplifiers were repaired/rebuilt and retested. A total of 36 amplifiers were shipped. All requested EVLA production is either on or ahead of schedule.

MMIC Design and Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Develop differential LNA for balanced feeds	12/01/06	04/01/08	
2. Develop integrated wideband LNA–feed package	12/01/06	04/01/08	
3. Design and test GaAs W-band (75–110 GHz) power amplifiers to improve reliability of millimeter-wave local oscillators	03/01/07	07/01/08	

4. Central Development Lab

Milestones	Original Date	Revised Date	Date Completed
4. Evaluate InP HBTs for use in cryogenic amplifiers.	06/01/08		
5. Package and test ALMA Band 10 (787–959 GHz) driver module using a MMIC VCO	07/31/07	10/31/07	
6. Test 67–95 GHz 35nm InP MMIC LNA	10/31/07		

Notes:
1 and 2. A serious design will have to wait for the appropriate MMIC wafer run to come along.
4. We have received and packaged sample devices from Northrop Grumman Space Technology (NGST) and are preparing to take cold DC measurements.
6. The design of the 67–95 GHz MMIC LNA, based on the new NGST 35 nm InP HEMT process, was completed in the second quarter of 2007. The chips are currently being fabricated at NGST.

Electromagnetic Support Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Design 18–26.5 GHz feed for the focal-plane array	11/15/07		
2. Develop dual-band 345/800 MHz feed for the	09/30/05	06/30/08	
3. Measure EVLA 12–18 GHz feed	12/31/07		
4. Prototype, fabricate, and measure a 75–110 GHz phase shifter in the 17–25 GHz band	03/31/07	12/31/07	
5. Preliminary design of polarizers for EVLA X (8–12 GHz) and Ku (12–18GHz) bands	12/31/07		

Notes:
2. Design effort on hold because of higher priorities on other projects.

Other Projects:
Measured far-field patterns of three source feeds used in holography measurement of the ALMA antennas. Measurements were done at 78.92 GHz and 104.02 GHz.

Completed EVLA Memo 112 titled, "Design, Prototyping and Measurement of EVLA S-Band Feed Horn".

Superconducting Millimeter-Wave Receiver Development Milestones

Milestones	Original Date	Revised Date	Date Completed
350 μm Receiver Technology Development			
1. Demonstrate NbTiN/insulator/Nb tunnel junction	10/01/06	12/01/07	09/17/07
Balanced SIS Mixer Development			
2. Complete first balanced SIS mixer with superconducting IF hybrid	01/01/07	delayed	
3. Complete first balanced sideband-separating mixer	10/01/07	03/01/08	

Milestones	Original Date	Revised Date	Date Completed
Other Mixer Development			
4. 385–500 GHz SIS mixer Development	09/30/05	03/01/08	

Notes:
1. NbTiN/AlN/Nb SIS junctions with good I(V) characteristics were successfully fabricated. This project is being done in collaboration with the UVa Microfabrication Laboratory.
2 and 3. Delayed until the Arizona Radio Observatory (ARO) constructs a mixer test system. Balanced-mixer development is now continuing in the 385–500 GHz band – see 4.
4. This project was on hold awaiting funds and engineering resources. It has now been restarted with support from the ARO. Balanced SIS mixers are being designed in the CDL.
2, 3, and 4. These projects are being done in conjunction with the ARO.

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

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

Note:
1. The low-frequency antenna work has been delayed until fall 2007.

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

Milestones	Original Date	Revised Date	Date Completed
1. 16-element prototype array, operating in the 100–200 MHz band in Green Bank	12/31/06	10/30/07	
2. A 4-element pathfinder array in Western Australia	07/15/07		07/31/07
3. 32-element array in Western Australia	12/15/06	09/15/08	

Electrochemistry Laboratory

The Chemistry Lab's gold-plating output (counting only large jobs) in this quarter was $30,000. Development work is progressing on electroforming techniques to be used for a large number (over 250) of waveguide components for the EVLA. Production jobs have included electroforming microwave components, internal waveguide plating, plating amplifier and mixer bodies, and the usual assortment of mounting plates, brackets, and straps. Items have been supplied to all NRAO sites and projects.

CHILE OPERATIONS

Chile Operations highlights for this quarter include:

- Completion of the study of workplace-related health and safety risks, and design of associated standing committee.
- AOS transporter hangar construction started.
- Second Vertex antenna arrives.
- First "Twin Cities" EPO cycle (San Pedro–Magdalena) completed.

Local Labor Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Elaboration of workplace risk assessment	Q3 2007		09/27/07
2. Health and Safety Joint committee design[1]	Q3 2007		09/27/07

Business/Contracting Milestones

Milestones	Original Date	Revised Date	Date Completed
1. AOS transporter hangar construction starts	05/02/07	09/20/07	09/20/07
2. ALMA camp enlargement (32 new rooms)	03/13/07	06/01/07	07/03/07
3. ALMA camp enlargement stages 3 and 4 contract, now at NSF for approval	09/21/07		
4. Antenna vendors camp extension contract	09/13/07		09/13/07
5. Security services at ALMA facilities contract awarded, being submitting to NSF for approval[1]	08/01/07		
6. Contract for one extra foundation at the site erection facility	09/28/07	Q4 2007	
7. Internal fiscal audit of Chile office by NRAO			08/07
8. Training of Chile staff on NRAO's online procurement process			08/07

Notes:
1. Long-term contract (three years).

Chile Antenna Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Second Vertex antenna arrives	09/28/07		09/24/07
2. Structural reinforcement of Vertex hangar			09/30/07

5. Chile Operations

Chile EPO Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Twin-Cities Magdalena delegation visits San Pedro			07/15/07
2. "Star Party" in San Pedro			07/03/07
3. The NRAO organizes coordination meetings with local astronomers			09/07
4. Participation in national e-science congress			09/12/07

Other Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Environmental reporting to CONAMA[1]	Monthly		Monthly
2. Environmental reporting to CONAMA[1]	Biyearly		07/30/07
3. Annual payment of mining rights.	Yearly		09/10/07

Notes:
1. Monthly and bi-yearly reports are sent to CONAMA.

END TO END (E2E) OPERATIONS

End to End (E2E) Operations highlights for this quarter include:

- NRAO Interactive Services (http://my.nrao.edu) introduced to the user community.
- Common Astronomy Software Applications (CASA) prepped for beta release in October.
- Proposal submission capabilities upgraded to include proposal handling functionality.
- Alpha site for new NRAO web completed in conjunction with EPO.

In Q3 2007, NRAO Interactive Services was introduced at http://my.nrao.edu, the proposal submission utilities were upgraded, and the Common Astronomy Software Applications (CASA) data-reduction package was prepared for its beta release at the beginning of Q4.

The key technical accomplishments of End to End Operations in Q3 2007 were: a) the continued use and refinement of the VLA data-processing pipeline, culminating in over 50,000 new VLA images (covering more than 9000 sky positions) that are being published to the NRAO archive and the Virtual Observatory (VO) in late October, b) final development for the beta version of CASA in preparation for the beta release, which was delayed by two weeks into the beginning of October, c) the first proposal deadline in which the upgraded Proposal Submission Tool (PST) was accessed through the new NRAO Interactive Services Portal at http://my.nrao.edu and maintained by E2E (using service provided by Open Sky Software of Austin, TX), d) completion of an alpha site for the revised NRAO web in partnership with EPO, and e) additional accomplishments in support of Archive 2.0, the project to advance the contents and interfaces for the NRAO data repositories.

The technical accomplishments of the Archive v2.0 development team are: a) various bug fixes in the query tool, b) optimizations for queries, especially those which could take a very long time or virtually hang, c) a structure for easy access to GBT data, d) integration of Google-like searching capabilities, e) an updated database schema for indexing the archive, f) improvements to metadata integrity, and g) a new search-tool web template based on NRAO Interactive Services.

In the area of NRAO participation in the National Virtual Observatory (NVO), the first of the second-generation VO data access interfaces (for spectra), development of which was conducted by an international team led by NRAO over a period of more than two years, was approved as an IVOA standard. Development is underway for similar-second generation IVOA protocols for catalog and image access.

Two proposals for external funding were submitted this quarter. In July the NRAO collaborated with the Pittsburgh Supercomputer Center (PSC), the University of Virginia (UVa) Center for Computational Science, and the UVa Department of Astronomy on a proposal titled "Collaborative Research: Origins of Solar Systems—Experiment, Theory, and Computation at the Petascale." This effort would provide algorithm development support to the NRAO, including professional consultation from PSC and graduate-student support from the UVa Center for Computational Science. This five-year project is valued at $1.1M. E2E also participated in a proposal led by North Carolina A&T State University (NCAT) on "Partnerships for Astronomy and Astrophysics Research and Education (PAARE) at NCAT", a program to encourage the full participation of minority candidates at all stages of their education in progressive opportunities in radio astronomy.

6. END TO END Operations

Management & Administration Activities

Milestones	Original Date	Revised Date	Date Completed
1. Determine feasibility of partnership for NSF PAARE diversity program	07/15/07		07/15/07
2. Create NRAO alpha web-site specifications with EPO; meet with NRAO webmasters and outside designers	08/03/07		08/01/07
3. **External funding:** If feasible, work with NCAT/NCSSM to prepare computational-science diversity program proposal for NRAO	08/03/07		08/01/07
4. **External funding:** Prepare proposal for Community-Based Data Interoperability Networks	08/23/07	cancelled(*)	
5. **External funding:** Prepare proposal for Cyberinfrastructure Training	08/27/07	cancelled(*)	
6. Participate in EVLA Advisory Committee meeting	09/06/07		09/06/07
7. Complete first E2E strategic planning session	09/15/07	12/01/07	
8. Release http://my.nrao.edu dashboard for astronomers; begin receiving NRAO proposals using new interface	09/15/07		09/14/07
9. **External funding:** Prepare proposal for CreativeIT program.	09/21/07	cancelled(*)	
10. Complete specifications for Strategic Decision Support System (a management dashboard)	09/30/07	12/01/07	
11. First draft of E2E Strategic Plan complete	09/30/07	12/31/07	

(*) Preparing a proposal requires that a) the solicitation aligns with current NRAO priorities and b) that PIs and Co-Is can be effectively engaged from NRAO staff and collaborating institutions. When both of these conditions are not met, the milestone is cancelled.

Algorithm Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Complete plan for a strategic organizational initiative to revitalize algorithm development at the NRAO	06/07/07		06/07/07
2. Relationship established with PSC to help the NRAO with its algorithm-development efforts	06/30/07		06/30/07
3. **External funding:** Submit proposal to NSF OCI for petascale applications, with UVa and PSC	07/23/07		07/23/07
4. Create project charter for algorithm development	09/30/07	12/31/07	
5. Hold first NRAO Algorithm R&D Symposium	11/30/07	11/30/08	

6. END TO END Operations

NRAO Participation in the National Virtual Observatory (NVO) Project

Milestones	Original Date	Revised Date	Date Completed
1. Summer 2007 NVO team meeting (Tody/Radziwill)	07/31/07		07/31/07
2. IVOA interoperability workshop (Cambridge UK)	09/27/07		09/27/07
3. SSA V1.0 becomes IVOA Recommendation			09/27/07
4. Spectrum DM becomes IVOA Recommendation			09/27/07
5. Cone search V1.0 becomes IVOA Recommendation			09/27/07
6. Concept and data model for handling time-series data	05/01/07	09/25/07	09/28/07
7. Table access protocol (TAP) design analysis	09/10/07		09/24/07
8. Metadata information schema proposal for TAP	10/31/07		
9. TAP prototype including simple query functionality	11/05/07		
10. DALServer updated to latest SSA standard (V1.02)	11/05/07		
11. SSA V1.1 working draft including Grid functionality	09/15/07	01/31/08	
12. Revised SIA V1.0 specification for PR	08/15/07	02/15/08	
13. Initial working draft and prototyping for SIA V2	09/15/07	03/15/08	
14. High-level plan for NRAO data center in place	06/31/07	deferred(*)	
15. Updated data-processing framework architecture	01/31/08		
16. Integration of CLI capability into VOClient	02/15/08		
17. Draft Applications Messaging specification	10/25/07	03/15/08	
18. IVOA interoperability workshop (Trieste)	05/12/08		
19. 2008 NVO summer school	09/15/08		

(*) Partnership arrangements with National Center for Supercomputer Applications (NCSA) currently being actively explored, which impact the architecture of a data center for NRAO.

NRAO Archive Infrastructure & Interfaces

Milestones	Original Date	Revised Date	Date Completed
1. Devise archive index schema and replication schema	04/30/07	02/15/08	
2. Set up rsync between GB and CV to archive GBT data	03/31/07	07/31/07	07/06/07
3. Generate index files for trimester 07A GBT data	08/31/07		06/31/07
4. Develop database schema for the archive index files	06/31/07	08/01/07	
5. Release Archive v2.0 Beta	10/26/07		
6. Complete Archive v2.0 Beta, production release of Archive v2.0	12/31/07		
7. Develop search parameters for advanced searches of single-dish spectral-line data.	06/31/07		06/08/07

6. END TO END Operations

Milestones	Original Date	Revised Date	Date Completed
8. Generate automated script to load the index-file data into the archive index database	06/31/07		06/01/07
9. Develop pipeline to generate calibrated SDFITS data.	12/31/07		
10. Develop pipeline to generate preliminary calibrated, averaged dataset	12/31/07		
11. Install the Spectral Line Search Engine (SLiSE) to query the single-dish spectra database	12/31/07		
12. Include 12 m and 140 ft data in the production single-dish archive node (requires capability to reduce data)	12/31/08		

NRAO Proposal Infrastructure & Interfaces

Milestones	Original Date	Revised Date	Date Completed
1. Complete PST performance improvements	05/20/07	08/01/07	8/21/07
2. Conduct user acceptance testing for upgraded PST	08/15/07	08/31/07	8/31/07
3. Test user acceptance of Proposal Handling System	09/15/07		09/21/07
4. Release PST upgrade; begin receiving new proposals	09/15/07		09/14/07
5. Successful management of October 2007 NRAO proposal deadline with upgraded software	10/01/07		
6. Prepare specifications for February 2008 additions	11/23/07		
7. Revisions available for user-acceptance testing	01/04/08		

Data Processing (CASA/GBTIDL) Milestones

Milestones	Original Date	Revised Date	Date Completed
1. CASA Alpha Release Patch 1	06/15/07		07/05/07
2. CASA ALMA ARC Tutorials (ESO Garching)	07/09/07		07/09/07
3. CASA Alpha Release Patch 2	08/15/07		08/15/07
4. CASA Beta Release Scheduled	09/30/07	10/15/07	
5. Release CASA Beta Helpdesk	11/01/07		
6. Complete Beta Update 0.5 (bug fixes)	11/15/07		
7. Complete Beta Update 1.0 (bug fixes)	12/31/07		
8. Evaluate effectiveness of CASA Beta Helpdesk and global issue resolution process	12/31/07		
9. Plan for first public release, including dates, complete	03/31/08		

6. END TO END Operations

NRAO Pipeline Infrastructure & Interfaces

Milestones	Original Date	Revised Date	Date Completed
1. Develop plan for common VLA/Chandra sources	12/31/06	12/15/07	
2. Explore possibility of common NRAO/HST sources	12/31/06	12/15/07	
3. Explore possibility of common NRAO/Spitzer sources	12/31/06	12/15/07	
4. Bind AIPS pipeline to live VLA observations	05/31/07	*	
5. Identify and recruit data analyst	03/31/08		
6. Second half of VLA archive processed via pipeline	06/30/08	06/30/09	

Notes: * – Deferred indefinitely.

COMPUTER AND INFORMATION SERVICES (CIS)

Computer and Information Services (CIS) highlights for this quarter include:

- A new webmaster team has been appointed. These people will support further content development by other groups and work to increase the reliability of the web service.
- The last Ethernet switch from the previous generation of network equipment in Green Bank was replaced. This was the network switch on the GBT itself.

Observatory-wide Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Appointment of webmasters (c)	07/31/07		07/31/07
2. Annual system-administrator conference in Green Bank (b)	08/23/07		08/23/07
3. Acquisition of modern network switch for the GBT (d)	09/15/07		09/15/07
4. Deployment of new GBT network infrastructure (d)	09/30/07		09/28/07
5. Upgrade link between UVa and NRAO–CV to 1 Gbps (d)	01/31/07	06/30/08	
6. New VPN concentrator available (d)	09/30/07	11/30/07	
7. Web reliability initiative (c)	12/31/07		
8. Replace wide-bed printers	12/31/07		
9. Annual system-administrator conference in CV (b)	04/30/08		
10. Deploy Microsoft Office 2007 (b)	05/31/08		
11. Web content management overhaul (c)	05/31/08		
12. Begin deployment of new Linux (RHEL5) (b)	05/31/08		

Notes:
5. This will be installed by the University of Virginia as soon as the requisite components are available.
6. The equipment was ordered and delivered and has been deployed for test use. It has not been released for general use.
(a) Security
(b) Common Computing Environments
(c) World-wide web infrastructure
(d) Telecommunications

Charlottesville Computing Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Order for new computer-room power conditioning	09/30/07	11/30/07	
2. Upgrade Exchange server	03/31/08		

Notes:
1. Funds to make this purchase were not fully available at the end of the fiscal year. Partial funding has been carried over to fiscal year 2008 to complete the acquisition.

EDUCATION AND PUBLIC OUTREACH (EPO)

Education and Public Outreach (EPO) highlights for this quarter include:

- *Pulsar Search Collaboratory* awarded to NRAO–WVU by the NSF ITEST program.
- REU/RET proposal submitted to NSF AST.
- 3rd annual AUI / NRAO Image Contest submissions received and prizes awarded.
- GLOBE education program debuted.
- New Mexico teachers visited Chile via the Sister Cities program.
- Web site renovation progress through alpha demo.
- Two new staff members joined the EPO team.

The National Science Foundation Information Technology Experiences for Students and Teachers (NSF–ITEST) program awarded full funding ($893K) to the joint NRAO–West Virginia University *Pulsar Search Collaboratory* (PSC) proposal submitted last May. Through this innovative PSC program, teachers and students will assist a worldwide team of astronomers in discovering new pulsars. The project will introduce students to computational mathematics and distributed computing applications, while engaging them in authentic scientific research. The long-term goal is to integrate PSC tools and data into the National Virtual Observatory, making it possible for a broad cross-section of students and teachers from across the nation, and especially under-represented groups, to learn about current astronomy practice, actively participate in scientific research, and work with established scientists.

EPO wrote the RET sections for the proposal submitted on September 13 to NSF AST that seeks renewal of the NRAO REU/RET program for FY 2009–2013.

NSF AST visited Green Bank and Socorro in late July and early August as part of an "EPO Inventory" that was conducted at each of the NSF astronomy facilities by T. Bosler and B. Patten.

Fourteen images were submitted by the September 7 deadline for the 3rd annual AUI/NRAO Image Contest. The awards committee judged the submissions in mid September, awarding First, Second, and Third prizes, and four honorable mentions. Each of these images will appear in the NRAO 2008 Calendar.

High school teacher Amy McCarty participated in the NRAO RET program, collaborating with D.J. Pisano on a research project titled "Comparison of VLA and GBT observations of HI in Galaxies," searching for signatures of diffuse, extended gas associated with these galaxies. Ms. McCarty teaches Algebra and Physics at the rural Altavista Combined School in Altavista, VA.

Three-day intensive residential Chautauqua programs took place in Green Bank and Socorro this summer, continuing a 20-year NRAO tradition of serving undergraduate science faculty. The weeklong Education Research in Radio Astronomy (ERIRA) workshop also returned this summer to Green Bank. ERIRA is a cooperative effort of the NRAO, the University of Chicago, and University of North Carolina that provides tours and observing projects for high school and undergraduate students. The West Virginia Governor's School for Math and Science was hosted in Green Bank, providing an in-depth research experience for sixty rising eighth graders, encouraging their interest in STEM (Science, Technology, Engineering, and Mathematics) careers. A one-week, NASA-funded teacher institute was held in July, this program's fifth year, and the 21st consecutive year of K–12 teacher professional development at the NRAO. The *StarQuest* star party continued as an annual Green Bank event with 160+ attendees. GLOBE (Global Learning and Observations to Benefit the Environment) is a worldwide hands-on, K–12 school-based science and education program that debuted this summer at Green Bank. GLOBE students,

teachers, and scientists collaborate on inquiry-based investigations of the environment and contribute scientific measurements to an international database.

Contracts for the creation of two "alpha–1" demonstration sites for the new NRAO web site were completed. A more detailed "alpha–2" demonstration-site specification was developed and a contract was awarded for completion this fall. The science/observer and EPO web sites are the highest priorities.

The "Sister Cities" program continued as fifth-grade teacher Jim Sauer and second-grade teacher Sandra Montoya of Magdalena, NM arrived in San Pedro de Atacama, Chile on July 1. During their two-week visit, they joined classrooms in San Pedro and the rural elementary school in Toconao. They collaborated with Chilean teachers at each site, comparing education strategies and obstacles to instruction. They also worked with students from the Liceo tourism program and in the English classes.

Six press releases were written and distributed. An August 23 release that described the discovery of evidence for a 280 Mpc cosmic void found by L. Rudnick et al (University of Minnesota) in the NVSS generated very strong media interest and set records for visits and downloads at the NRAO web site.

Judy Stanley joined the NRAO EPO team on July 27, taking up her position as NM Education Officer and replacing Robyn Harrison. Ms. Stanley worked most recently at the University of New Mexico LodeStar Astronomy Center in Albuquerque where she was the Outreach Site Coordinator and Director of Education. Taylor Johnson joined EPO on October 1 as our WWW Content Specialist and Senior Web Designer. Taylor has more than a dozen years experience in web development and graphic design, including a wide and relevant range of web content, tools, technologies, and standards.

Publications / Documentation Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Publish July 2007 NRAO Newsletter	07/11/07		07/11/07
2. 3rd annual AUI/NRAO Image Contest deadline	09/07/07		09/07/07
3. Award Image Contest prizes	10/01/07		09/25/07
4. Publish October 2007 NRAO Newsletter	10/01/07		
5. Complete publications revisions for AAS mtg	12/15/07		

Online Outreach Milestones

Milestones	Original Date	Revised Date	Date Completed
1. WWW Project Plan complete	05/09/07		05/09/07
2. Initial design options due from three contractors	05/14/07	06/11/07	06/11/07
3. Review & down-select to best design options	05/25/07	06/12/07	06/12/07
4. Contractors complete alpha-1 demo site	09/21/07		09/15/07
5. Contractor completes alpha-2 demo site	11/07	12/04/07	

8. Education and Public Outreach

Scientific Community Outreach Milestones

Milestones	Original Date	Revised Date	Date Completed
1. NRAO–NAIC Single Dish Summer School (GB)	07/08–15/07		07/08–15/07
2. VSOP-2 Planning Meeting (GB)	08/29–30/07		08/29–30/07

Education Programs

Milestones	Event Date
1. Sister Cities program: San Pedro de Atacama (Chile)	06/30–07/14/07
2. Society of Amateur Radio Astronomers (GB)	07/01–03/07
3. Green Bank StarQuest IV (GB)	07/04–07/07
4. Chautauqua 2007 (SOC)	07/11–13/07
5. NASA/NRAO Joint Institute (GB)	07/15–20/07
6. Globe Workshop (GB)	07/22–27/07
7. 3rd Annual Governor's School for Math & Science (GB)	07/29–08/11/07
8. Catch the Wave Camp: GEAR UP (GB)	cancelled

EPO Community & Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. EPO WWW Content Specialist selection complete	12/15/06	09/15/07	09/12/07
2. NSF EPO Inventory visit (SOC)	07/26–27/07		07/26–27/07
3. NM Education Officer selection complete	07/27/07		07/21/07
4. NSF EPO Inventory visit (GB)	08/07		07/18/07
5. ASP EPO meeting (Chicago)	09/05–07/07		09/05–07/07
6. ALMA EPO Program Officer selection complete	09/28/07	01/08	

ADMINISTRATION

Environment, Safety, and Security (ES&S)

ALMA

Work this quarter with ALMA included participation in design reviews, readiness review, and documentation reviews. Work included the following:

- Reviewed Vertex hazard-analysis submittals as prepared by General Dynamics.
- Reviewed the Front-End Support Structure (FESS) Hazard Analysis.
- Reviewed the safety concerns related to transporter damping issues with the Antenna IPT.
- Reviewed the Site Erection Facility structural requirements for stability and facility safety.
- Participated in the Front End mockup acceptance process in Charlottesville.
- Reviewed the Band 3 and Band 6 design-review hazard analysis.
- Worked with the ATF team in transition from SEI management.
- Completed the Preliminary Hazard Analysis and Declaration of Incorporation with the Computing IPT for the AMBSI II board.

NRAO–New Mexico

We began to provide additional ES&S support to the VLBA sites. ES&S was actively involved in multiple safety-training sessions for the VLBA site technicians. Additionally, ES&S monitored the safety requirements for the ultra-high-pressure paint removal and repainting efforts at the St. Croix VLBA site.

NRAO–Green Bank

The GBT track effort was completed with no reported accidents or injuries to NRAO staff. Also this quarter, the site-wide annual sprinkler inspection was completed. ES&S coordinated with Green Bank management to complete the physical security audit.

NRAO–Charlottesville

This quarter the findings of the OSHA compliance inspection were addressed, and non-conforming items were remedied. The physical security audit was competed in Charlottesville this quarter. ES&S coordinated with NTC management to dispose of the hazardous waste chemicals from the chemistry lab that had accumulated over the past few years.

Future Efforts

In the next quarter, ES&S will continue to coordinate the installation of card access to the secure servers in Green Bank. ES&S will also present the plans for NRAO Emergency Preparedness efforts.

HUMAN RESOURCES

Diversity Program

Diversity Program highlights for this quarter include:

- Female (F) and Minority (M) staffing
  - Joint tenured scientist in Charlottesville (M/M)
  - Scientific Associate III in Green Bank (F/M)
  - Engineering co-op student in Socorro (F/M)
  - Engineering co-op student in Green Bank (F/M)
  - Summer intern in Green Bank (F)
- Completed NRAO's Diversity Plan
  - Submitted to NSF in July
- Diversity Hiring Initiatives
  - Began advertising engineering jobs on the Society for Women Engineers online recruitment Board.
    - Have previously utilized AASWomen online service, etc.
  - *Diversity/Careers in Engineering & Information Technology* interviewed Jim Firmani regarding NRAO's diversity hiring initiatives for its October/November *Diversity in Action* feature article.
- Developing a supervisor training program that covers basic employment law, managing difficult employees, writing effective performance evaluations and diversity matters.
  - Delivery is targeted for 1st quarter 2008.
- With guidance from the NRAO Diversity Committee, Human Resources is developing a diversity awareness training program for all employees.
  - The development process will be discussed at the Diversity Committee's meeting in October.
  - Delivery is targeted for 1st quarter 2008

Partnership for Astronomy and Astrophysics Research and Education at North Carolina A&T State University (PAARE-NCAT)

- Proposal submitted to NSF PAARE grant program
  - North Carolina A&T is PI
  - Radziwill / NRAO is Co-I
- Providing expertise in astronomy, astrophysics, computational science, space science and atmospheric physics.
- Built on the strong capabilities of its supporting partners:
  - Florida Institute of Technology (FIT),
  - University of North Carolina at Greensboro (UNCG), and
  - National Radio Astronomy Observatory (NRAO).
- Collectively managing programs targeting the full pipeline of candidates for research careers in astronomy and astrophysics (K12 through PhD employment), these institutions are uniquely positioned to facilitate progressive opportunities, particularly for minorities.

Personnel

NEW HIRES

Donahue, Patrick	Contracts and Procurement Manager	08/27/07
Miller-Jones, James	Jansky Fellow	09/04/07
Hesman, Brigette	NRAO Postdoc	07/02/07
Stanley, Judith	Public Education Officer	07/23/07
Coutts, Gordon M	Electronics Engineer II	08/15/07
Sexton, Robert	Electronics Engineer II	09/10/07
Rochford, James	Software Engineer II	09/10/07
Long, Jeffrey	Systems Administrator II	07/16/07
DuPlain, Ronald	Software Engineer III	08/21/07

TERMINATIONS

Lynch, Ryan	Research Assistant	08/24/07
Ries, Paul	Intern	08/17/07
Otarola, Angel	Electronics Engineer II	08/31/07
Cai, Chunai	Software Engineer II	07/31/07
Dressle, Justin	Software Engineer III	08/03/07

PROMOTIONS

Langley, Christopher	Division Head, ALMA IPT Back-End IPT	07/15/07
Ford, Ephraim	Electronics Engineer I	08/01/07
Duvall, Eugene	Electronics Engineer II	08/01/07
Pilleux, Mauricio	ALMA Deputy Project Manager (Technical)	08/01/07

TRANSFERS

Brisken, Walter	Associate Scientist/RE	08/01/07
Navarro, Claudio	ALMA Supply Chain Management Specialist	07/20/07

BUDGET

For the fiscal year ending September 30, 2007, NRAO Operations received a total of $50,700k (including $5,835k for EVLA) in new funding. This figure is $40k less than the initial expectation of $50,740k owing to costs associated with NSF travel and support of various reviews during the fiscal year, and offset by a $15k increment to support the single-dish summer school. When combined with prior-year commitments and prior-year carryover, the NRAO Operations total budget authority for FY 2007, less EVLA, was $51,361.3k.

Overall the NRAO Operations budget is approximately 13.8% underspent through the end of the fiscal year. The following is a brief explanation of the WBS level 1 elements that are under/over spent in excess of 10%.

- ALMA Operations - Significant underspending occurred in the materials and services expense category as a function of the advance funding for future Chile Operations.

- Observatory Management - Underspending occurred thanks to better-than-forecast claims-benefits experience, common-cost recovery, and directly associated costs.

3. Budget

NRAO Operations Expenses and Commitments FY 2007 Year to Date (October 1, 2006 to September 30, 2007) in $000								Percent of fiscal year	100.0%
WBS Level 1	Salaries & Benefits	Materials & Services	Travel	Revenue or Cost Recovery	Total	Linear Spending	Actual Exp + Comm	Actual Percent Expended & Committed	Annualized Variance
Observatory Management	4,928.2	3,574.9	294.5	-150.0	8,647.6	8,647.6	6,438.6	74.5%	25.5%
Education and Public Outreach	520.4	248.3	20.6	-125.0	664.3	664.3	706.7	106.4%	-6.4%
Central Development Lab	1,501.6	256.7	30.0		1,788.3	1,788.3	1,674.7	93.6%	6.4%
Green Bank Operations	8,660.9	2,743.4	143.2	-455.6	11,091.9	11,091.9	10,347.6	93.3%	6.7%
New Mexico Operations	13,044.7	4,788.9	210.2	-80.0	17,963.9	17,963.9	17,719.2	98.6%	1.4%
ALMA Operations	892.3	4,776.0	74.6		5,743.0	5,743.0	2,180.4	38.0%	62.0%
Computer and Information Services	872.9	648.6	25.0		1,546.5	1,546.5	1,483.9	96.0%	4.0%
Science and Academic Affairs	2,076.8	1,521.3	317.8		3,915.9	3,915.9	3,719.1	95.0%	5.0%
NRAO Operations totals	32,497.9	18,558.1	1,115.9	-810.6	51,361.2	51,361.2	44,270.2	86.2%	13.8%

Acronyms and Abbreviations

Acronym	Definition
AAS	American Astronomical Society
ACU	Antenna Control Unit
AIPS	Astronomical Image Processing System
ALMA	Atacama Large Millimeter Array
AlN	Aluminum Nitride
AMBSI	ALMA Monitor/control Bus Standard Interface
ANASAC	ALMA North American Scientific Advisory Committee
AOC	Array Operations Center (Socorro, NM)
AOS	Array Operations Site (ALMA)
API	Atmospheric Phase Interferometer
ARC	ALMA Regional Center
ARO	Arizona Radio Observatory
ASAC	ALMA Scientific Advisory Committee
ASP	Astronomical Society of the Pacific
ATCA	Australia Telescope Compact Array
ATF	ALMA Test Facility
AUI	Associated Universities, Incorporated
BGA	Ball-Grid Array
C band	4–8 GHz
CalDM	Calibration Data Model
CASA	Common Astronomy Software Applications
CBI	Cosmic Background Imager
CDL	Central Development Laboratory (Charlottesville, VA)
CICADA	Configurable Instrument Collaboration for Agile Data Acquisition
CIS	Computer and Information Services
CLI	Command-Line Interface
CMB	Cosmic Microwave Background
CONAMA	Chilean National Environmental Commission
COTS	Common Off-The-Shelf
CSV	Commissioning and Science Verification (ALMA)
CV	Charlottesville
CY	Calendar Year
DC	Direct Current
DAL	Data Access Language
DDS	Direct Digital Synthesizer
DM	Data Model
DRAO	Dominion Radio Astrophysical Observatory
E2E	End-to-End
EPO	Education and Public Outreach
ERIRA	Education Research in Radio Astronomy
ES&S	Environment, Safety, and Security (NRAO)
ESO	European Southern Observatory
EVLA	Expanded Very Large Array
FASR	Frequency-Agile Solar Radiotelescope

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
FPGA	Field-Programmable Gate Array
FY	Fiscal Year
GaAs	Gallium Arsenide
GB	Green Bank
GB/SRBS	Green Bank Solar Radio Burst Spectrometer
Gbps	Giga bits per second
GBT	Green Bank Telescope
GBTIDL	GBT Interactive Data Language
GC	Galactic Center
GEAR UP	Gaining Early Awareness and Readiness for Undergraduate Programs
GHz	Gigahertz
GLAST	Gamma-ray Large-Area Space Telescope
GLOBE	Global Learning and Observations to Benefit the Environment
Gsps	Giga samples per second
HBT	Heterostructure Bipolar Transistor
HEMT	High-Electron-Mobility Transistor
HSA	High-Sensitivity Array
HST	Hubble Space Telescope
IDL	Interactive Data Language
IF	Intermediate Frequency
InP	Indium Phosphide
IPT	Integrated Product Team
IRC	Instrument Remote Control
ISSC	International SKA Steering Committee
IT	Information Technology
ITEST	Information Technology Experiences for Students and Teachers (NSF)
IVOA	International Virtual Observatory Alliance
JWST	James Webb Space Telescope
K	Kelvins (temperature)
K band	18–26.5 GHz
Ka band	26.5–40 GHz
Ku band	12–18 GHz
L band	1–2 GHz
LMT	Large Millimeter-wave Telescope
LNA	Low-Noise Amplifier
LO	Local Oscillator
LTA	Long-Term Accumulator (GBT spectrometer)
M&C	Monitor and Control
MHz	Megahertz
MK	Mauna Kea (VLBA station)
mm	millimeter
MMIC	Monolithic Microwave Integrated Circuit
MoO	Mission of Opportunity (NASA)
MOU	Memorandum of Understanding
Mpc	Megaparsec
MPIfR	Max Planck Institut fűr Radioastronomie

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
MSI	Mikro Systems, Inc.
μm	micrometer
MUSTANG	Multiplexed Squid TES Array at Ninety GHz (GBT "Penn Array" receiver)
NA	North American
NAASC	North American ALMA Science Center
NAIC	National Astronomy and Ionosphere Center
NASA	National Aeronautics and Space Administration
Nb	Niobium
NbTiN	Niobium Titanium Nitride
NCAT	North Carolina A&T State University
NCSSM	North Carolina School of Science and Mathematics
NGST	Northrop Grumman Space Technology
NIST	National Institute of Standards and Technology
NJIT	New Jersey Institute of Technology
nm	nanometer
NRAO	National Radio Astronomy Observatory
NSF	National Science Foundation
NTC	NRAO Technology Center (Charlottesville)
NVO	National Virtual Observatory
NVSS	NRAO VLA Sky Survey
OCI	Office of Cyber Infrastructure (NSF)
OMT	Orthomode Transducer
OOF	Out Of Focus (holography)
OPT	Observation Preparation Tool
OSHA	Occupational Safety and Health Administration
OSF	Operations Support Facility (ALMA)
P band	327 MHz
PAARE	Partnerships in Astronomy & Astrophysics Research and Education (NSF)
PAPER	Precision Array to Probe the Epoch of Reionization
PC	Personal Computer
PDR	Preliminary Design Review
PFM	Pointing–Focus Model
PLC	Programmable Logic Controller
PR	Proposed Recommendation
PSC	Pittsburgh Supercomputer Center, Pulsar Search Collaboratory
PST	Proposal Submission Tool
PTCS	Precision Telescope Control System (GBT)
Q	Quarter
Q band	40–50 GHz
R&D	Research and Development
RCT	Resource Catalog Tool
RE	Research Engineer
RET	Research Experiences for Teaches (NSF program)
REU	Research Experiences for Undergraduates (NSF program)
RF	Radio Frequency
RFI	Radio-Frequency Interference

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
RFQ	Request For Quotation
rsync	program that synchronizes remote data sets
RTP	Round-Trip Phase
S band	2–4 GHz
SAA	Science and Academic Affairs (NRAO office)
SCT	Source Catalog Tool
SDD	Software Development Division
SDM	Science Data Model
SDFITS	Single-Dish Flexible Image Transport System
SEI	Stockholm Environmental Institute
SIA	Simple Image Access
SIS	Superconductor–Insulator–Superconductor
SKA	Square Kilometre Array
SLiSE	Spectral-Line Search Engine
SoW	Statement of Work
SRBS	Solar Radio-Burst Spectrometer (Green Bank)
STEM	Science, Technology, Engineering, and Mathematics
SSA	Simple Spectral Access
SSC	Spitzer Science Center
SSS	Science Support Systems
TAP	Table Access Protocol
TBD	To Be Determined
TRW	TRW Corporation
U band	12–18 GHz
UVa	University of Virginia
UVML	University of Virginia Microfabrication Laboratory
VCO	Voltage-Controlled Oscillator
VLA	Very Large Array
VLBA	Very Long Baseline Array
VLBI	Very Long Baseline Interferometry
VO	Virtual Observatory
VPN	Virtual Private Network
VSOP-2	VLBI Space Observatory Program successor
W band	68–117 GHz
WBS	Work Breakdown Structure
WG	Working Group
WIDAR	Wideband Digital Interferometric Architecture (EVLA correlator)
WMAP	Wilkinson Microwave Anisotropy Probe
WVU	West Virginia University
WWW	World-Wide Web
X band	8–12 GHz