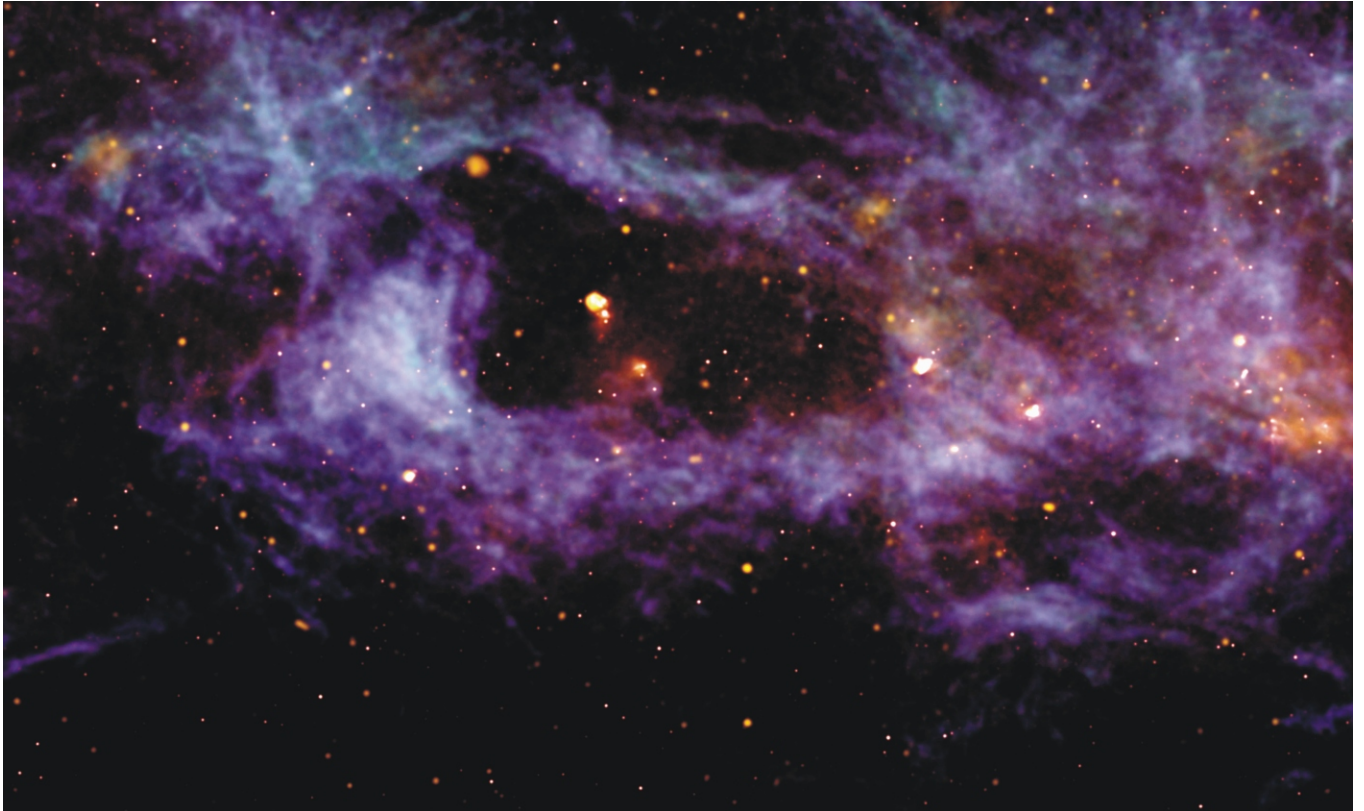


NATIONAL RADIO ASTRONOMY OBSERVATORY



Quarterly Report



January – March 2007

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Cover Image: This giant bubble in the Milky Way's dusty gas disk was sculpted by the winds and radiation force from a few dozen hot, massive stars along with shocks from supernova explosions of dying stars.

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Science and Academic Affairs

During this quarter, SAA completed a draft of a Long Term Research Staffing Plan for the NRAO and presented the plan at the February AUI Board meeting. A new program was created to increase the research activities of NRAO engineers. SAA also ran the annual Jansky Fellowship selection process and the selection of Large Proposals for all NRAO telescopes.

Within SAA there was one promotion during this period, five new hires at the postdoctoral level, and one new librarian hired to replace a retirement. The historical Archives was awarded a grant from the American Institute of Physics.

The predoctoral, co-op, visiting scientists, and summer student programs continue to remain healthy. The recently formed student internship program has been successful in attracting students and continues to grow.

Expanded Very Large Array (EVLA)

As of March 30, a total of ten antennas were in various stages of retrofit to the EVLA design. Eight antennas are used routinely for astronomical observations, one antenna is undergoing tests, and the mechanical outfitting of another antenna is nearly complete. A semi-annual update of the cost data sheets for the project's work breakdown structure showed that project contingency has improved. Actions were taken to address staffing shortages in receiver design and production. On-antenna and laboratory tests have identified thermal issues in some of the LO/IF modules as the source of instabilities in EVLA visibility phase. The 48 VDC power plant for the WIDAR correlator is being installed. A request for quotation for the 3-bit, 4Gbps digitizers is being prepared. The development and production of the 1–2 GHz and 4–8 GHz orthomode transducers has been delayed by the aforementioned manpower shortages in the front-end group. However, good progress has been made on the development of the prototype 26–40 GHz receiver. A new method for connecting the correlator's 32 stations is under consideration. The method could save about \$1M for the Canadian correlator group and will be formally reviewed for possible implementation during the next quarter. Good progress continues toward replacing the Modcomp-based VLA control system with the new EVLA monitor and control system. An alpha release of the Observation Scheduling Tool, the software used by the telescope scheduler to queue or dynamically schedule observations, is planned for this summer.

New Initiatives

The revised work plan for the U.S. Square Kilometer Array (SKA) Technology Development Project was submitted to the NSF in January 2007. Discussions continued on the U.S. and NRAO relationship to the European Framework Programme 7 initiative for the SKA. The second in a series of planning meetings was held for the tracking-station design for VSOP-2, scheduled for launch in 2012. Numerous discussions were held regarding potential operational and financial partnerships for the VLBA and other NRAO telescopes. It is expected that a proposal for the construction and operation of FASR will be submitted to the NSF in early 2008.

Green Bank Operations

Considerable work has been done at Green Bank preparing for the arrival of the plates for the Azimuth track remediation of the Green Bank Telescope (GBT). A significant milestone was reached in this project during the quarter, with the arrival of the first 24 wear and base plates for the track. The remaining plates will be delivered at the start of the next quarter, and replacement work on the track will also commence during that time.

Instrument work for this quarter involved continuing the upgrade of the C-band receiver, further investigations into the Ka-band receiver system, repairing the spectrometer LTA card, and continued work on the Penn Array. The C-band receiver will have a review during Q2, 2007, with a planned release of its improved capabilities by fall 2007. Progress was made on improvements to the Ka receiver system, which is needed to allow it to reach its full potential as a correlation receiver. Accomplishing this will also considerably improve the performance of the wideband Zspectrometer (which requires a correlation receiver to work correctly) and will pave the way for future work on any W-band receivers for the GBT. The University of Pennsylvania team achieved a breakthrough in the noise performance of the Penn Array receiver at the end of the quarter, significantly reducing the noise levels in the system and increasing the number of useful detectors very close to the full 64. If this performance can be recreated on the telescope, we expect a factor of 100 increase in mapping speed compared over last fall's engineering run. Further work will proceed over the summer, focusing on achieving the same noise performance improvement in situ on the GBT, increasing cryogenic performance on the GBT, and exhaustively characterizing currently fabricated detector arrays.

Work continued this quarter on the new dynamic scheduling system for the GBT. The overall project plans are now complete. Testing and programming has begun on the scheduling algorithms, and plans have begun for an external review of the project in the second quarter of the year.

Work on improving the performance of the telescope at high frequencies (the PTCS project) also continued through this quarter. Work was complete on upgrades to the GBT servo system to add friction compensation and acceleration feed-forward; these will improve the performance of the antenna when "nodding" between beams (e.g. for Ka- and Q-band observing) and when performing complex scan patterns such as daisy-petal scans. We also continue to work on an improved pointing model that will incorporate inclinometer data directly; this model will be used when we re-commission the GBT after the track refurbishment.

Very Large Array (VLA)

The VLA reached a milestone, with approximately 1/3 of the VLA antennas having their mechanical and electronic systems converted to EVLA capabilities. The analog link between the Pie Town VLBA station and the VLA was dismantled, marking the completion of a 5-year-long series of Pie Town link observations; we anticipate that this analog link will be replaced by a digital link after the EVLA project is completed.

Very Long Baseline Array (VLBA)

Emergency repairs were initiated and completed on a broken azimuth axle assembly at the Fort Davis station. All instrumentation tape drives were removed from the VLBA correlator, completing the VLBA conversion to the Mark 5A disk recording system. A new 22 GHz receiver retrofitted with lower-noise amplifiers was installed on the Pie Town VLBA antenna. Together with a resetting of the subreflector

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focus parameters, this improved the sensitivity of Pie Town by approximately 50 percent, considerably better than the project goal of a ~30 percent improvement.

North American ALMA Science Center (NAASC)

In Q1, 2007 major reviews of the ALMA operations plan were held by an international committee, and the NAASC plan was reviewed by an NSF committee at the end of February near NSF headquarters in Arlington, VA. February 27 and 28 saw presentations by the international operations working group, being led by the JAO and John Hibbard. The international panel presented its verbal summary to the attendees at the end of these two days. On March 1 the NAASC/NRAO staff described North American ALMA operations and the NAASC plan. The NSF panel presented their summary report to the NRAO Director and the NSF at the end of the day.

The overall reaction of both the international and North American panels was that ALMA has a more mature and better-delineated operations plan than any other ground-based observatory in history at a comparable stage of the project, and that the basic assumptions and plan are well founded and justified. Both panels congratulated the operations teams. Both panels stressed the importance of the Full Science support functions to fully enable the scientific promise of ALMA. The NSF panel emphasized that NRAO needs to be prepared for early science, to ensure that we deliver the capabilities promised at the appropriate time. They also emphasized the need for adequate user support, both in terms of software and manpower, in order to assist astronomers in the use of the new advances, and new complexities, of ALMA.

Successful completion of these reviews represents a major milestone for ALMA operations and the NAASC. Passing these reviews gives the funding agencies a road map for long-range operations funding and sets the direction for the transition from construction to operations.

Two ANASAC telecons were held to discuss project news, an ASAC update and the ASAC charges, an update on the NAASC/AOP proposal reviews, the DRSP II, and future workshops. NAASC monthly organizational meetings continued, with Canadian participation.

Planning for the next NAASC workshop “Transformational Science with ALMA: Through Disks to Stars and Planets” is proceeding; this workshop is scheduled for June 2007. There are already over 100 pre-registrants.

In February and March, alpha testing of the CASA off-line software was successfully completed by an international group including members of the NAASC. An extensive written report has been prepared by D. Shepherd. NAASC members also participated in testing of the ALMA pipeline, and a report will be prepared by C. Wilson. Members of the CASA team visited Charlottesville to discuss the simulator. A working group has been formed to consider the progress on general user-support issues and user software. This working group includes the NAASC and other divisions at NRAO, such as e2e operations.

In the coming quarter, the official reports from the international and NSF review panels of ALMA operations will be sent to the NRAO and members of the NAASC. Planning will continue on the imminent NAASC science workshop. The ANASAC will consider ASAC issues and reconsider the User grants program. Software testing by NAASC staff will continue, including work on the CASAPY ALMA simulator. Talks on ALMA will be given at U.S. institutions. The NAASC staff will visit to the Herschel and Spitzer science centers to discuss general science-center issues. A new scientific-staff hire will occur

EXECUTIVE SUMMARY

by the end of the year for participation in ALMA commissioning. ALMA-related EPO activities are discussed in the NRAO EPO section of this report. A revised WBS spreadsheet based on the NAASC plan presented to the NSF is being developed by Pilleux. Work continues on the Spectral Line Catalog, and a visit to the NAASC will be made by Lovas to work on the catalog with Remijan. The Canadian contribution to ALMA operations, and the funding options, will be discussed.

Central Development Laboratory (CDL)

Activities at the Central Development Laboratory this quarter included:

Device and Component Research, Development, and Production:

- The effort to develop advanced NbTiN/insulator/Nb tunnel junctions for frequencies above 700 GHz continues at the University of Virginia Microfabrication Laboratory. Six blocks for a 211–275 GHz balanced SIS mixer with a superconducting IF hybrid have been fabricated at the University of Arizona and delivered.
- The design of a new corrugated rectangular 75–110 GHz phase shifter was completed. Analysis shows a differential phase shift of $90^\circ \pm 4^\circ$ between polarizations over the band. Prototypes at 17–25 and then at 75–110 GHz will be fabricated and measured to check the design of the phase shifter, needed for generating circular polarization from linear polarization over the full waveguide band.

Instrument Development:

- A major upgrade to the Green Bank Solar Radio Burst Spectrometer (SRBS) has been completed. The system is currently in routine operation over the frequency range 15–1000 MHz.
- Work continues on the Precision Array to Probe the Epoch of Reionization (PAPER) to measure the predicted step in the cosmic background amplitude from neutral hydrogen emission at the Epoch of Reionization. An eight-element array at the Green Bank, Galford Meadow site continues to provide data for the development of wide-field imaging techniques. Initial deployment in Western Australia will begin in June 2007.
- Preliminary designs have begun and a proposal is being prepared for a small (seven or ten pixels) K-band (18–26 GHz) focal-plane-array receiver for the GBT. This will be the first heterodyne array receiver on the GBT, and it is being designed to be easily expandable to a larger K-band array (about 50 elements maximum) and to serve as a template for focal-plane arrays for other bands (e.g., $\lambda = 3$ mm). This would be a joint CDL/GB instrument development project pending the approval by the Strategic Initiative Review Committee and the Director.

Chile

Chilean labor milestones passed in this quarter include submission of labor-related documents to employees and government, completion of negotiations for implementation of local medical benefits, and hiring of management personnel for ALMA HR. Business/contracting milestones included initiation at the OSF of erection of Vertex facilities for antenna assembly as well as installation of technical equipment for communications, power generation, etc. [For simplicity and completeness, this Quarterly Report includes some ALMA construction activities reported by the organizational units (e.g., Chile Operations, the Central Development Laboratory, and the NAASC) where they are carried out. However,

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NRAO Operations is reimbursed by ALMA construction via direct charges and via the Directly Associated Costs]. Other milestones include making regular environmental reports and the starting negotiations with the University of Chile for renting space to house ALMA AIV personnel in Cerro Calán (Santiago).

End to End (E2E) Operations

The key accomplishments in Q1 2007 were (a) the continued use of the VLA data-processing pipeline, culminating in a total of nearly 24,000 new VLA images for publication to the NRAO archive and the Virtual Observatory (VO), (b) completion of data-processing tests of Common Astronomy Software Applications (CASA) package for ALMA in March, (c) transition of the Proposal Submission Tool (PST) from EVLA Computing to E2E (software is being maintained by Open Sky Software of Austin, TX), (d) participation in planning for the NRAO Web Transformation Project, a joint effort between EPO and E2E, and (e) preparation and submission of proposals to other areas of NSF to fund an NRAO pulsar archive at West Virginia University as a collaborative project.

Computer and Information Services (CIS)

In response to some widely publicized national instances of lost or stolen personnel data, a data-security policy was verbally approved by the Director's Office. There was one formal security incident during this quarter; there were no serious consequences. The security configuration of the main web server was restructured to prevent further incidents of this nature.

Education and Public Outreach (EPO)

The NRAO chaired the ALMA EPO Working Group and wrote the ALMA EPO Development Plan that was delivered in March to the ALMA Board. EPO was an active participant and presenter for the international and North American ALMA Operations reviews in Arlington, VA, February 27–March 1. EPO initiated an ALMA Project documentation program. Videography and still-photography teams in Kilgore and Houston, TX were located, contracted, and deployed to document the delivery of the unit-1 VertexRSI antenna from the factory to the Port of Houston for shipment to Chile. This work was coordinated with VertexRSI and General Dynamics. EPO initiated a search for a videography and still-photography contractor in Chile to document the arrival of the first VertexRSI antenna at Antofagasta and the Operations Support Facility in April. Long-term agreements with U.S. and Chilean contractors are being established for ALMA Project documentation. Postproduction work with the acquired raw video and images begins in early April.

The third annual AUI/NRAO Radio Astronomy Image Contest was announced at the joint meeting of the American Astronomical Society (AAS) and the American Association of Physics Teachers (AAPT) in Seattle. Based on the Awards Committee recommendation, a Third Prize has been added to the 2007 contest. EPO managed and staffed the Observatory's recently redesigned exhibits at the Seattle AAS/AAPT meeting, with assistance from scientific and management staff. EPO distributed two new press releases at this meeting and organized a Town Hall Meeting that attracted 135 attendees. The 2007 NRAO Calendar and two new color posters proved popular, especially with AAPT members. The new Observatory-wide brochure was equally popular.

The inaugural *Sister Cities* educational and cultural exchange between San Pedro de Atacama, Chile and Magdalena, NM took place January 29–February 11. Sponsored by AUI and the NRAO, this program brought two Chilean teachers and the San Pedro Mayor to New Mexico, where they participated in a wide

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range of programs, classes, community events, and field trips with students and teachers of all ages. The Magdalena school district was so impressed by their positive experience with the *Sister Cities* program that they allocated local funds so that a third teacher can join the two Magdalena teachers funded by AUI to visit San Pedro de Atacama in June and July 2007.

Four press releases were written and distributed this quarter, including two that were featured at the Seattle AAS/AAPT meeting. A. Mioduszewski and her colleagues at UNAM used high-precision VLBA distance measurements to yield new insights into star formation in our Galaxy. J. Wrobel and L. Ho (Carnegie Institute) combined the VLA, VLBA, and GBT to peer into the heart of the galaxy NGC 4395, discovering the strongest evidence yet that matter is being ejected by a medium-sized black hole. A press release described the achievement of “First Fringes” by the ALMA prototype antennas at the Antenna Test Facility in New Mexico. Another release described the *Sister Cities* program visit to New Mexico.

SCIENCE HIGHLIGHTS

Very Large Array

VLA Reveals “Smoking Gun” on Multiple-Star Formation Process - A VLA study of the multiple protostellar system L1551 IRS5 shows that the dusty disks of the two main components are aligned with each other and with the system’s larger surrounding disk. In addition, their orbital motions resemble the rotation of the larger disk. This is concluded to be a “smoking gun” in support of the disk-fragmentation model as one mechanism for the formation of multiple protostars. A third component, however, is not so aligned and may indicate an origin through capture, another postulated formation mechanism.

Investigators: J. Lim (Academia Sinica, Taiwan) and S. Takakuwa (NAOJ).

Very Long Baseline Array

VLBA Determines Distance to Star-Forming Regions With 1 Percent Precision - Multi-epoch VLBA observations of T Tauri stars in the Taurus and Rho Ophiuchi star-forming regions have produced trigonometric parallax measurements yielding the distances of these two important regions accurate to within one percent. The observations also produced measurements of proper motions of individual sources within these regions. Such measurements allow accurate determinations of such basic properties as the masses and luminosities of young stars. Because young stars tend to be surrounded by nebulosities, the radio measurements can be far more accurate than those made by the Hipparchos satellite. The results will improve our understanding of the young stars and of the 3-D structure and dynamics of the star-forming regions.

Investigators: L. Loinard, R. Torres and L. Rodriguez (UNAM); and A. Mioduszewski (NRAO).

Green Bank Telescope

First detection of an H₂CO maser flare - The H₂CO (formaldehyde) molecule is ubiquitous in molecular clouds; in a handful of star-forming regions it appears via maser emission in the 6 cm line. Observations with the GBT have detected a flare in the H₂CO maser emission from IRAS 18566+0408—a compact region with water and methanol masers and multiple molecular outflows that may harbor a massive disk. This is the first detection of an H₂CO maser flare, and its cause is not clear. The maser emission has two spectral components and both varied during the three-month flare, while keeping their original line shapes. This suggests that the burst might have been triggered by some mechanism outside the region of the masers, leading to a near-simultaneous flare in both components.

Reference: Araya et al. 2007, *ApJ*, 654, L95.

SCIENCE AND ACADEMIC AFFAIRS (SAA)

Paul Demorest and James Miller-Jones were hired as new Jansky Fellows to begin their appointments in the fall of 2007. Jansky appointments were extended to a third year for James Aguirre, Poonam Chandra, Marijke Haverkorn, David Meier, and Kristine Spekkens. The Jansky appointment for Neal Miller was extended eight months beyond the normal three-year term in recognition of his successful work and large-proposal award.

Amy Mioduszewski was promoted to Associate Scientist with an Indefinite Appointment effective February 1, 2007, acknowledging her strong scientific role in carrying out VLBA astrometry of low-mass stars in nearby star-formation regions and the important support of VLBI users she has undertaken as a member of the AIPS group. Veronica Strazzello and Maurilio Pannella were hired as NRAO research associates to work with Frazer Owen and Chris Carilli on multi-wavelength studies of extragalactic deep fields. This position is funded via Spitzer, Chandra, and Max Planck grants. Brigette Hessman was hired as an EVLA Research Associate to work at the Array Operations Center in Socorro, New Mexico.

Pre-doctoral students supported by 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 Array Operations Center and co-supervised by Prof. Ed Churchwell at the University of Wisconsin; Andrew Michael (Rochester Institute of Technology) working on multi-scale deconvolution and image reconstruction with Steven Myers at the Array Operations Center, co-supervised by Prof. Stefi Baum of the Center for Imaging Science at Rochester Institute of Technology; Esteban Araya (New Mexico Tech) working on formaldehyde maser emission in the Galaxy with Miller Goss at the Array Operations Center, co-supervised by Prof. Peter Hofner at New Mexico Tech; Chataili Parashare (University of Virginia) working on instrumentation for low-frequency radio astronomy arrays with Richard Bradley at the NRAO Technology Center, Buckner Creel (University of New Mexico) working with Mark Claussen at the Array Operations Center on VLBA astrometry of protoplanetary nebulae, co-supervised by Prof. Ylva Pihlstrom at the University of New Mexico, and Hirofumi Kawakubo (University of Michigan), working with Tim Bastian and Richard Bradley in Charlottesville and Green Bank on the development of antenna stations for low-frequency interferometric arrays, specifically for a prototype for FASR, co-supervised by Prof. Chris Ruf of the Department of Electrical Engineering and Computer Science at the University of Michigan.

Huib Intema (Leiden) worked as a graduate intern with Bill Cotton in Charlottesville on software for analysis of low-frequency observations that are severely affected by ionospheric disturbances, Claudia Cyganowski (University of Madison, Wisconsin) worked as a graduate intern with Crystal Brogan in Charlottesville on a study of the high-mass star forming region S255N. Katharine Johnston (University of St. Andrews) began working as a graduate intern with Debra Shepherd in Socorro on disk-outflow interactions in massive protostars.

Jesse Pomeroy (Electical Engineering major at South Dakota School of Mines and Technology) began working as a co-op student with Dan Merteley in Socorro in January 2007, investigating RFI at the VLA Site.

Graduate internships for summer 2007 were awarded to Katie Chynoweth (Vanderbilt University) who will work 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) who will work with Scott Ransom in

SCIENCE

2. Science and Academic Affairs (SAA)

Charlottesville on improving spectral resolution of the GBT pulsar spigot and pulsar observations with the GBT, and Paul Ries (University of Virginia) who will work with Richard Bradley in Charlottesville on measuring power patterns of low-frequency antennas using satellite down-link signals.

Visiting astronomer appointments for the summer of 2007 were awarded to Drs. Duncan Lorimer and Maura McLaughlin (West Virginia University) who will visit Green Bank for two months to work on a large-scale pulsar drift-scan survey with the GBT and a fast data-acquisition system for pulsar studies with the 140-ft telescope, Dr. Greg Taylor (University of New Mexico) who will visit Socorro for one month to work on liaison for the LWA, on the VIPS survey and preparation for GLAST, and on tests of VLBI at the VLA with the EVLA on-line system, and Dr. Laurent Loinard (UNAM-Morelia) who will visit Socorro for five weeks to work on multi-epoch VLBA observations of low-mass protostars in star-forming sites to determine their trigonometric parallaxes.

The 2007 NRAO summer-student research assistantships program recruitment process was finalized with 22 summer students; 6 at Socorro (4 REU, 1 Ugrad, 2 Grad), 5 at Green Bank (4 REU, 1 Grad), and 10 at Charlottesville-ER (7 REU, 2 Ugrad, 1 Grad).

Meetings, Conferences, and Workshops

Milestones	Original Date	Revised Date	Date Completed
1. Co-organized the 2007 NRAO Fellowship Meeting			02/05/07
2. Participate in Joint UVa/NRAO Hiring Discussions			02/26/07
3. Meeting With Science Mission Office at STScI			02/27/07
4. Set Up New Observatory Science Council			03/21/07

Promotion and Hiring of Outstanding Staff

Milestones	Original Date	Revised Date	Date Completed
1. Jansky Fellowship Selection Committee Meeting			01/04/07
2. EVLA Commissioning Scientist Search Committee	01/22/07	05/15/07	
3. Assistant Director Search Committee	05/01/07	06/15/07	
4. Create New Engineering Research Fund			03/09/07
5. Jansky Fellowship Acceptances			03/12/07
6. Set Up Tenure-Track Hiring Committee			03/12/07

Library and Archive Programs

With a grant from the American Institute of Physics, Center for the History of Physics, the Archives has begun processing, organizing, and indexing the Director's Office files of NRAO's first two Directors, Otto Struve and David Heesch, covering the years from NRAO's founding through 1978.

SCIENCE

2. Science and Academic Affairs (SAA)

Kathleen LeFebre, AOC Librarian, retired effective January 1, 2007. Holli Glassel has been hired to replace her as the new AOC Librarian. She has arranged the journals in alphabetical order and is trying to get the entire AOC circulating collection bar-coded, re-Cutted, and into the ILS. The EOS version of RAPs is now fully field-searchable, allowing regular updating of the NRAO Publication Statistics.

TELESCOPE USAGE

The NRAO telescopes were scheduled for research and for maintenance during the fourth quarter of 2006 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.

Beginning in 2005, antennas being modified for the EVLA are counted as lost for observing.

Telescope Usage (hours)			
Activity	VLA	VLBA	GBT
Scheduled Observing	1536.88	937.10	1838.00
Scheduled Maintenance and Equipment Changes	170.50	215.00	169.00
Scheduled Tests and Calibration	429.89	398.60	153.00
Time Lost	269.22	50.60	206.00
Actual Observing	1267.66	886.50	1632.00

PROJECTS

1. Expanded Very Large Array

EXPANDED VERY LARGE ARRAY

EVLA Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Implement tipping curves for opacity determination	10/16/06	01/16/07	01/09/07
2. Develop fabrication method for C-band OMT	01/10/07		01/10/07
3. Hardware acceptance tests complete on antenna 23	11/02/06	01/12/07	01/19/07
4. Project WBS cost and schedule updated	01/19/07		01/19/07
5. Antenna 23 turnover to Operations	11/03/06	01/16/07	01/22/07
6. Implement listener thread in Observation Executor	12/18/06	01/22/07	01/22/07
7. Correlator output data format defined	01/29/07		01/29/07
8. Conduct risk and contingency analysis	12/12/06	01/31/07	01/31/07
9. Select fabrication method for L-band OMT	01/31/07		01/31/07
10. Visibility data available in EVLA M&C system	02/05/07		02/05/07
11. Hardware acceptance tests complete on antenna 17	02/07/07		02/07/07
12. Antenna 17 turnover to Operations	02/08/07		02/08/07
13. Archive records written using Modcomp-independent format	03/13/06	02/15/07	02/12/07
14. GUI to hardware reset synchronization tool	01/29/07		02/13/07
15. Start EVLA conversion of antenna 19	02/13/07		02/22/07
16. Tests of Observation Executor running VLA	03/01/07		03/01/07
17. Correlator output data format finalized	03/19/07		03/19/07
18. VLA Operators able to run Modcomp replacement system	02/20/07		03/22/07
19. Earned Value progress updated	03/28/07		03/28/07
20. Provide capability for moving-source observation	12/18/06	04/03/07	
21. C-band OMT—broadband test in receiver	08/31/06	04/05/07	
22. Assemble Ka-band RF tree	02/01/07	04/05/07	
23. ESDM definition	03/12/07	04/06/07	
24. Hardware acceptance tests complete on antenna 21	04/10/07		
25. Update project risk register	04/11/07		
26. Antenna 21 turnover to Operations	04/12/07		
27. M302/3 utility module evaluated on antenna	02/28/07	04/13/07	
28. Correlator 48v DC plant installed	02/14/07	04/16/07	
29. GUI's available for initial EVLA antenna OPS checkout	06/01/06	04/16/07	
30. Final report on investigation of phase instability	04/20/07		

PROJECTS

1. Expanded Very Large Array

Milestones	Original Date	Revised Date	Date Completed
31. Develop correlator installation plan	04/23/07		
32. Assemble prototype S-band feed	03/16/07	04/23/07	
33. Start EVLA conversion of antenna 11	04/24/07		
34. Finalize production of design of C-band OMT	04/27/07		
35. Assemble prototype Ka-band receiver	02/28/07	04/27/07	
36. Install wideband C-band receiver on antenna	11/02/06	04/30/07	
37. Begin production of C-band OMT	02/28/07	05/01/07	
38. Receive "Science View" of Project Data Model from ALMA	02/16/07	05/07/07	
39. Begin lockdown of new correlator room	05/14/07		
40. Hardware acceptance tests complete on antenna 19	05/17/07		
41. Antenna 19 turnover to Operations	05/21/07		
42. First Science Advisory Group meeting for EVLA (SAGE)	05/22/07		
43. Updated High-Level Architecture	05/01/06	06/01/07	
44. Review of ASDM	02/20/07	06/01/07	
45. Prototype wideband L-band receiver assembled	06/04/07		
46. Final agreement between EVLA & ALMA on "Science view" of PDM	11/01/06	06/04/07	
47. Science-Support System software PDR	06/05/07		
48. Prototype Ka-band receiver ready for use	06/11/07		
49. Start EVLA conversion of antenna 25	06/20/07		
50. Complete tests of 2–4 GHz signal path	06/25/07		
51. Decommission Modcomp computers	06/29/07		
52. OPT outputs a VLA observe script	10/25/06	09/04/07	
53. Access to archive tool via portal	06/14/06	12/15/07	

Project Management

A semi-annual update of the cost data sheets in the project's work breakdown structure was conducted in January 2007. The update allows a comparison between the project's budget and the estimated cost to complete it. The comparison showed that with all known costs accounted for, there remained an unallocated contingency of \$4.1M. When measured as a percentage of cost to complete the project (16%), the contingency was at its highest level in the history of the project. However, the contingency has since been reduced to \$3.6M, primarily to address staffing shortages in receiver production. The estimated cost to complete the project is based on work supported by the EVLA project budget and effort contributed from the NRAO operations budget but does not include work on the correlator, which is supported by Canadian funds. The improvements in contingency have resulted from cost savings in bulk purchases of

PROJECTS

1. Expanded Very Large Array

materials and components, increased efficiency in the retrofitting of the antennas, and a better understanding of actual costs.

Steps were taken to minimize two financial risks to the project. A new method for computing contributions to the AUI IDC/Management Fee resulted in a cost to the EVLA project in FY 2006 that exceeded the budgeted amount by \$182K. [The AUI IDC/Management Fee is a two-part allocation that includes AUI Corporate Indirect Costs (IDC) and a pro-rata portion of the Management Fee. The IDC is a pre-determined rate applied to NRAO business that recovers Corporate support such as salaries, benefits, rent, travel, etc. associated with management and oversight of NRAO. The Management Fee covers those items specifically unallowable under the Cooperative Agreement (alcohol, business travel, charitable donations, etc.).] Discussions were held with the NRAO Associate Director for Administration (ADA) to devise an equitable method for distributing the costs of the IDC/Management Fee while ensuring that the existing EVLA budget was adequate to cover its share of the IDC/Management Fee. The new arrangement averts a potential risk of about \$0.8M. Also, the project had been paying the salaries of personnel in the CASA data-processing group as part of an agreement made in 2004 to compensate the NRAO operations budget for effort contributed to the project. The agreement was scheduled to end in September 2007, when all CASA salaries were to be transferred to the operations budget. Discussions were held with the ADA to verify that the salary transfer would indeed occur, thus avoiding a risk to the project of about \$2M.

Systems Integration

The testing of Antenna 23 was completed, and the electronics outfitting and testing of Antenna 17 was completed. Both antennas were returned to the array for astronomical observations. The electronics outfitting of Antenna 19 will commence in April 2007.

Work is progressing on improving the phase performance of the electronics system. Phase instabilities have been tracked down mainly to the thermal behavior of two or three of the LO/IF modules. We are currently running tests to examine the behavior of these modules and to evaluate the effects of changes as we make them. This has included the development of a test fixture to simulate the elevation movement of the antenna and its effect on the electronics.

In addition to regular antenna outfitting, the systems integration team has expended considerable effort over the last quarter to streamline the antenna retrofit process and to improve the serviceability of the electronics hardware through the life of the system. This has included considerable documentation of cable harnesses, labeling of racks and cables, and modularizing cables and assemblies for easier installation and maintenance.

Antennas

The mechanical outfitting of Antenna 21 was completed in February 2007, and the mechanical outfitting of Antenna 19 will be complete in April. The fabrication of mechanical components for the next three EVLA antennas is ongoing. The designs of insulation for the feed tower and feed horns are complete.

PROJECTS

1. Expanded Very Large Array

The fiberglass lamination of L-band (1–2 GHz) feed horns 1 through 18 is complete. The lamination of horn 19 is in progress. All but one of the C-band (4–8 GHz) feed horns are assembled and stored in the cold storage warehouse. The remaining C-band horn is being used for receiver tests in the Array Operations Center. The fabrication of the first S-band (2–4 GHz) feed horn is in progress. The S-band circular to rectangular transitions have been designed and requisitioned.

Civil Construction

The 48 VDC power plant for the correlator was delivered to the VLA site in early March 2007, and site personnel have nearly completed its installation. The startup of the power plant will occur in April. The next step will be working on the equipment racks and cabling for the correlator, networking, and back-end computing. At this time, control and alarm wiring will be installed from the air conditioning equipment, fire-suppression system panel, and the operations area to the correlator's power-control computer. The new correlator room will be ready well in advance of the arrival of the prototype and production correlators.

Training on the operation of the HVAC system in the new shielded room for the correlator was completed in March 2007.

The installation of an uninterruptible power supply for the EVLA operations area is scheduled for June 2007.

Local Oscillator (LO) System

All LO modules are in full production. A quality control program was started to ensure that every module produced meets standards for workmanship and quality. The documentation for the modules is behind schedule and will be the focus of engineering support for the remainder of the fiscal year. The round-trip-phase meters are being tested on the array.

The following list summarizes the completion status for LO module production. In general, LO module production is keeping pace with or ahead of the antenna retrofitting schedule.

- Synthesizer Reference Generator (L300) – 40%
- 12–20 GHz Synthesizer (L301) – 40%
- 10.8–14.8 GHz Synthesizer (L302) – 25%
- LO Reference Receiver (L304) – 47%
- Reference Generator (L305) – 38%
- Central Reference Generator (L350) – 75%
- Master Offset Generator (L351) – 50%
- Round-Trip-Phase Measurement (L352) – 25%
- LO Transmitter (L353) – 31%
- LO Driver (L354) – 100%

Each LO module will still need some level of retrofits, mostly owing to upgraded hardware and RFI requirements.

PROJECTS

1. Expanded Very Large Array

Fiber Optics

Modules for the Digital Transmission System (DTS), formatter, and de-formatter continue to be built to meet the antenna outfitting schedule. Fiber optic pads at each antenna location need to be installed so that an EVLA antenna can be connected to the optical fiber data-transmission system. Of the 72 pads on the array, 56 have been installed. A request for quotation for the 3-bit, 4Gsps digitizers is being prepared.

Intermediate Frequency (IF) System

All IF modules are in full production. The baseband converter still lacks the equalizer filters, but the latest equalizer design meets specification and will start to be incorporated in the third quarter of CY 2007.

The following list summarizes the completion status for IF module production.

- 4P IF Converter (T301) – 10%,
- LSC IF Converter (T302) – 31%,
- UX IF Converter (T303) – 31%,
- IF Downconverter (T304/T305) – 29%.

The 4P IF Converter, relevant only for the low-frequency VLA bands, was deliberately delayed in order to focus on the other EVLA hardware, but its production now will catch up rapidly. As with the LO modules, each IF module will still need some level of retrofits for hardware upgrades and RFI requirements.

Front End

Antenna 17, the eighth EVLA antenna to be upgraded, had its interim 1–2 GHz, 4–8 GHz, 8–12 GHz, and 18–26 GHz receivers installed during the period from late December 2006 through February 2007. Antenna 21, the next in line for an upgrade, has been outfitted with new electronics racks and cable trays. Its interim 8–12 GHz and 18–26 GHz receivers were installed in February and March, respectively. Problems with microphonics in the 1–2 GHz receiver for antenna 21 delayed its installation to late March. Meanwhile, Antenna 19 was stripped of its old receiver systems and electronics in preparation for its upgrade.

Owing to the departure of one of our key microwave engineers, a number of development and evaluation tasks related to the 1–2 GHz and 4–8 GHz wideband OMTs have been adversely affected. The quad-ridge fins on one of the prototype 1–2 GHz OMTs have been copper plated, but cryogenic tests in the prototype 1–2 GHz receiver (currently on antenna 14) have yet to be performed to determine if the sensitivity degradation can be reduced. The contract for the first two test articles of the production version of the 1–2 GHz OMT has been released. The housing will be cast by a contractor while the throat section will be electroformed by NRAO. Delivery is expected in May.

Four of the old A-Rack C-band polarizers have been modified by the cryogenics group and the VLA machine shop so that they can fit inside the new EVLA 4–8 GHz dewar. These 4.5–5.0 GHz narrowband units will be used until the design of the wideband 4–8 GHz OMT is complete. The fin spacing and probe length of the 4–8 GHz OMT have yet to be finalized, but the method and details for the mass-production

PROJECTS

1. Expanded Very Large Array

of these units is more or less complete. Problems with finalizing the EVLA card-cage design for mass production have delayed the delivery of the 4–8 GHz interim receivers slated for Antennas 23 and 21.

Machining and wire bonding issues with the 40–50 GHz MMIC post-amplifiers delayed the delivery of several 40–50 GHz receivers. These problems have been solved, and the receiver for antenna 26 is undergoing its final series of tests in the laboratory (after eliminating a number of large resonant spikes in the pass band) and will be installed in early April, quickly followed by those for Antennas 23 and 17.

Good progress has been made on the 26–40 GHz prototype receiver. All of the machined components for the dewar are complete, and the RF tree is currently in the process of being assembled. This effort has been aided greatly by Green Bank engineers who gave us some of their spare waveguide components, including the OMT, phase-shifter, circular-to-square, and 45 degree twist sections. The first cooled tests will occur in late April.

Correlator

The correlator development team in Penticton and Socorro has been in the thick of major prototype testing and debugging for the entire quarter. On the Station Board, effort concentrated on ensuring that all of the high-speed data paths on the board are working and have the desired signal integrity. This effort has been successful, and now efforts are focused on testing Station Board functions and making the minor design changes required before the next prototype is fabricated. On the Baseline Board, effort has concentrated on testing the correlator chip ASIC. Socketing of the 672-pin BGA chip on the board has not worked out as planned, so chips that passed standalone full-speed tests were soldered onto the board with some, but not complete, success. Nevertheless, the major functions on the board have been tested successfully, and the ASIC has passed significant and exhaustive, although not final, tests. Since the first prototype board has not been fully populated with ASICs, final testing of the ASICs and the board must wait until the second-stage prototypes on which ASICs will be soldered on all sites.

Software development has focused on supporting hardware testing. Software developers quickly respond to implement changes and fixes. Graphical user interfaces and underlying driver software are invaluable to setting up and running tests of this system.

Recently, a new and optimized method for connecting the correlator for 32 stations has been proposed. In this method, the number of interconnect cables is reduced by a factor of three, eight racks are eliminated, and 32 fewer Baseline Boards are needed. The total savings could be as high as \$1 million, thus relieving some budget pressure on the correlator. Fewer cables and boards also mean improved system reliability. Additionally, and importantly, this allows the correlator to more seamlessly and logically trade off bandwidth for number of channels, for example. Preliminary interconnect drawings for this new connection scheme have been distributed. The impact on software is virtually nil, and only the Baseline Board needs some re-wiring of its high-speed input section (while maintaining backwards compatibility), something that has already begun in anticipation of a successful review. The schedule impact to implement the proposed changes would be a two-month delay in the delivery of the correlator. The Station Board and the basic rack design are unchanged. This proposed change will be formally reviewed this summer before it is accepted.

Monitor and Control

Retirement of the Modcomp computers remained the primary focus of the EVLA Monitor and Control (M&C) effort during the first quarter of CY 2007. A number of issues remain to be solved before

PROJECTS

1. Expanded Very Large Array

operation of a Modcomp-free system becomes the rule rather than the exception. Handling of the VLA correlator is being refined, and, while the system now writes valid archive records, it sometimes takes too long to get organized. However, exclusive operation of the VLA-EVLA hybrid array by the EVLA M&C System, with no assistance from the Modcomp-based VLA Control system, now occurs on a regular basis, with one day per week given over to testing and debugging the Modcomp-free system. Time and attention are also being given to the long list of tools and utilities that need to be in place when the Modcomp computers are retired. Prototypes have been demonstrated for several of the tools. Foundation-level capabilities upon which other tools will be built are being put into place.

An item of rising prominence for the EVLA M&C System is the anticipated arrival of the prototype correlator in March 2008. Progress has been made in defining and implementing the output (binary) format of the prototype correlator and in defining the format of the archive records (binary data + meta-data) that will be written to the archive. A first draft of a document that attempts to list all of the software needed for the prototype correlator has been created and is being circulated.

Science Support Systems

Software development for Science Support Systems continues to progress. All major elements of the software's High Level Architecture are implemented except for the description of the hardware setup. Significant progress was made on the "Science View" of the hardware setup. This will allow the EVLA to describe the details of its hardware setup in terms that non-expert astronomers can understand, and will also allow the EVLA to share concepts and code with ALMA.

The software tool that manages catalogs of sources, including calibrator catalogs, was updated significantly, and its interaction with the EVLA Observation Preparation Tool (OPT) was made seamless. This is a big improvement over previous implementations. Both the VLA and VLBA calibrator catalogs are now available in this tool with a variety of simple query functions. In the next quarter, we will be extending the available catalogs to include high-frequency catalogs and making the calibrator catalogs available to the astronomical community via standard web queries.

The EVLA Observation Scheduling Tool (OST) now more closely resembles what the operators want and need. An alpha release of the OST will occur before the retirement of the Modcomps this summer.

PROJECTS

2. New Initiatives

NEW INITIATIVES

Square Kilometer Array (SKA)

Discussions were held regarding the content of the U.S. Technology Development Project (TDP) for the SKA. These resulted in revisions to the work plan and submission of the revised SKA TDP work plan to the National Science Foundation in late January. Similar discussions, and a face-to-face meeting in Bonn, were held regarding the European proposal for SKA infrastructure development funding from the Framework Programme 7 initiative. The U.S. delegation to this meeting included representatives of Cornell and the NRAO, who had been briefed regarding NSF preferences prior to the Bonn meeting. NRAO participated in review-committee meetings for the NASA Deep Space Network “Analysis of Alternatives” (including a large number of ~12m antennas as the preferred alternative) and the Mileura Widefield Array; both of these initiatives potentially impact the scientific and technical development of the SKA.

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 instrument is under development by a consortium involving the NRAO and a number of university partners, including NJIT, Berkeley, the University of Michigan, the University of Maryland, and Caltech. The consortium is being organized under management by AUI. It is expected that a proposal for the construction and operation of FASR will be submitted to the NSF in early 2008. The NRAO will be the managing partner of the construction project. A standalone observatory under AUI will take responsibility for FASR operations. The FASR project represents a new model for cooperation between a national facility and university partners on a new scientific facility

VLBI Space Observatory Programme-2 (VSOP-2)

A technical meeting was held in February 2007 in Madrid. This meeting focused on the development of a common tracking-station design for the VSOP-2 mission. Representatives of the NRAO attended to discuss the requirements of the VLBA telescopes and correlator as well as a potential Green Bank tracking station. A subsequent meeting will be held in Sagami-hara, Japan in mid-April.

External Partnerships

A partnership with the Max Planck Institut für Radioastronomie (MPIfR) is expected to result in the implementation of higher-sensitivity 22 GHz receiving systems on the VLBA. The first such system was installed at the Pie Town VLBA antenna in February. A Memorandum of Understanding (MOU) regarding the 22 GHz implementation and operational cooperation is well advanced and expected to be signed during this quarter. The NRAO also has negotiated a collaborative observing agreement with the Gamma-ray Large Area Space Telescope (GLAST) that enables a single proposal to the GLAST mission to result in the U.S. individual investigators receiving both funding from GLAST and observing time from the NRAO. The MOU covering this agreement also is expected to be signed during the 2nd quarter. Discussions with other potential VLBA partners, in response to the NSF Senior Review recommendation to find funding from outside sources, are in progress.

PROJECTS

2. *New Initiatives*

New Initiatives Office Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Attend VSOP-2 Tracking Station Meeting	04/18/07		
2. Attend U.S. SKA Consortium Meeting	05/11/07		
3. Final Signatures on GLAST Collaboration MOU	05/31/07		
4. Final Signatures on MPIfR Cooperation MOU	06/22/07		

OPERATIONS

1. Green Bank Operations

GREEN BANK OPERATIONS

Green Bank highlights include:

- The first 24 wear and base plates for the GBT azimuth-track upgrade arrived in Green Bank.
- The noise performance of the $\lambda = 3$ mm Penn Array receiver was significantly improved, and the number of good detectors has nearly reached the goal of 64. The array mapping speed should be a factor of 100 higher than during last fall's engineering run.
- Algorithms for dynamically scheduling the GBT are being developed and tested.
- The GBT serve system was upgraded to improve tracking and permit complex scan patterns such as daisy petals.

Green Bank Site Milestones

As the 2007 fiscal year began on October 1, 2006 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.

GBT Milestones for FY 2007

Milestones	Original Date	Revised Date	Date Completed
Azimuth Track Refurbishment			
1. First 24 wear and base plates manufactured	01/31/07	03/01/07	03/13/07
2. Next 24 wear and base plates manufactured	03/30/07	04/02/07	
3. All components on site	03/30/07	04/05/07	
4. Refurbishment starts	04/30/07		
5. Refurbishment complete	08/31/07		
6. Telescope performance restored	08/31/07		
Caltech Continuum Backend (CCB)			
1. Project Complete	10/01/06	01/26/07	01/26/07 ^{Note 1}
C-band Receiver Upgrade			
1. Design Review	04/24/07		
2. Upgrade Complete	02/15/07	07/31/07 ^{Note 2}	
3. Commissioning Complete	03/01/07	09/30/07 ^{Note 2}	
Dynamic Scheduling			
1. Test Phase I Complete	04/31/07	09/30/07 ^{Note 3}	
2. Proposal Review	06/01/07		
3. Stage I tools complete, dynamic scheduling commences	02/01/08	06/01/08 ^{Note 3}	
4. Stage II tools complete	02/01/09	06/01/09 ^{Note 3}	
FPGA development Project ^{Note 4}			
1. First version of the data distribution (iBob) and analog-to-digital modules produced and documented	06/01/07		

OPERATIONS

1. Green Bank Operations

Penn Array Receiver ^{Note5}			
1. Document commissioning results	12/31/06	03/31/07	03/31/07
2. Verify improved noise & cryogenic performance on the GBT	08/30/07		
PTCS			
1. Trajectory Generation and Servo Improvements complete	12/31/06	04/30/07 ^{Note}	
2. PLC interlock system installed	08/31/07		
3. Small-scale surface errors characterized	08/31/07		
4. Laser rangefinder Vesion 2 development complete	09/31/07		
Spectrometer LTA Upgrade			
1. LTA upgrade complete	10/01/07 ^{Note 7}	07/15/07	
Zpectrometer ^{Note8}			
1. Science validation complete	06/01/08		

Notes:

1. The CCB is a University Collaboration with the California Institute of Technology. The first CCB unit was completed on schedule for use with the Ka-band receiver. Completion of the 2nd and 3rd units was delayed by work on the Spectrometer LTA cards.
2. The C-band completion date moved to accommodate Penn Array work. Work will be completed during summer shutdown.
3. Dynamic scheduling work was pushed back by work on the high frequency receivers.
4. The FPGA Development Project is a University Collaboration with the University of Cincinnati.
5. The Penn Array is a University Collaboration with the University of Pennsylvania. Penn Array Receiver progress has been slowed by difficulties in fabricating the detector array.
6. Only slow-speed tracking improvements were done.
7. The LTA card will be repaired and not upgraded. Completion time has been moved up accordingly.
8. The Zpectrometer is a University Collaboration with Andy Harris at University of Maryland.

OPERATIONS

2. NEW MEXICO OPERATIONS

NEW MEXICO OPERATIONS

New Mexico highlights include:

- About 1/3 of the VLA antennas have their mechanical and electronic systems upgraded to EVLA capabilities.
- The VLBA conversion from instrumentation tapes to the Mark 5A disk recording was completed.
- The Pie Town antenna was equipped with a new 22 GHz receiver and the subreflector was adjusted to increase sensitivity by 50%, well above the project goal of 30%.

VLA and VLBA Milestones

Management and Scientific Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Decommission final tape drives on VLBA correlator	12/31/06	01/05/07	01/05/07
2. Return EVLA antenna 23 to operational VLA	12/31/06	01/16/07	01/22/07
3. VLA-VLBA Proposal Deadline	02/01/07		02/01/07
4. Return EVLA antenna 17 to operational VLA	02/28/07	02/08/07	02/08/07
5. Install lower-noise 22 GHz receiver at VLBA-PT	02/28/07	02/15/07	02/15/07
6. Proposal Selection Committee w/ five outside members	04/04/07		
7. Return EVLA antenna 21 to operational VLA	04/15/07	04/12/07	
8. First shared-risk science with EVLA 5 GHz tuning	04/30/07		
9. Return EVLA antenna 19 to operational VLA	06/15/07	05/21/07	
10. VLA-VLBA Proposal and Large Proposal Deadline	06/01/07		
11. Retire VLA Modcomp Computers	03/31/06	06/29/07	
12. First shared-risk science with EVLA 22 GHz tuning	04/30/07	09/10/07	
13. Remove St. Croix from VLBA for rust repair	09/15/07		
14. CASA beta release	09/28/07		
15. VLA-VLBA Proposal Deadline	10/01/07		
16. Return St. Croix to VLBA after rust repair	12/15/07		
17. First shared-risk science with EVLA 1.2–2 GHz	12/31/07		
18. Complete 22 GHz low-noise retrofit of VLBA	02/28/08		

Notes:

11. This item was delayed into 2007 to enable personnel resources to be spent on EVLA Monitor/control software development.

12. First 22 GHz science with wider tuning capabilities was deferred owing to a lack of proposals for this capability with the relatively small number of EVLA antennas available. The first scientific proposals for this capability now have been accepted for the second trimester of 2007.

16. We anticipate the first science with wider-band tuning for 1.4 GHz will be proposed and accepted for the VLA B configuration in the last trimester of 2007.

OPERATIONS

2. NEW MEXICO OPERATIONS

Computer Infrastructure Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Bring up EVLA Antenna 21 Network	02/07/07		02/01/07
2. Complete AOC network renumbering	12/15/06	01/15/07	02/15/07
3. Bring up EVLA Antenna 19 Network	03/15/07		03/15/07
4. Install 64 bit 8-processor development system	03/15/07		03/15/07
5. Bring up EVLA Antenna 11 Network	04/15/07		
6. Install new central Network Appliance file server	12/31/06	04/30/07	
7. Demo platform-independent calendaring system	05/15/07		
8. Establish network tunnel to DRAO	08/31/06	05/31/07	
9. Establish network tunnel to ESO	09/30/06	05/31/07	

Notes:

6. Order delayed, received better pricing by waiting, delivery set for 4/1/07
8. Requires further cooperation from DRAO, under way
9. Requires further cooperation from ESO

Electronics Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Install 17 MARK V playback units in Operations	01/05/07		01/05/07
2. Remove all recorders from Socorro Operations	01/05/07		01/05/07
3. Disassemble analog Pie Town Link	09/28/07		02/15/07
4. Install K-Band Sensitivity Upgrade Pie Town VLBA	02/15/07		02/15/07
5. Repair VLA M8 power supplies for FRM system	03/27/07		03/27/07
6. Develop Plan for PT VLBA Maser #10	03/19/07		03/01/07
7. Revise White Sands RFI MOU	10/20/07		03/01/07
8. Install K-Band Sensitivity Upgrade LA VLBA	04/03/07		
9. Install repaired Q-Band FD VLBA	04/18/07		
10. Scheduled Maintenance Visit Ft Davis VLBA	05/07/07		
11. Install K-Band Sensitivity Upgrade FD VLBA	06/03/07		
12. Scheduled Maintenance Visit Brewster VLBA	07/31/07		
13. Install K-Band Sensitivity Upgrade KP VLBA	08/03/07		
14. Pickup refurbished Maser #13 from Sigma Tau	09/20/07		
15. Scheduled Maintenance Visit Owens Valley VLBA	09/26/07	05/15/08	
16. Complete a VLA prototype ACU system	07/20/07	08/01/08	

Notes:

15. The St. Croix corrosion-control visit, scheduled from September 2007 to December 2007, will delay the Owens Valley maintenance visits until May 2008.
16. This task was transferred to the new Servo group leader in December 2006. The EVLA project and the VLA and VLBA maintenance tasks all have higher priority to than a new ACU system. We hope to have a working prototype in August 2008.

OPERATIONS

2. NEW MEXICO OPERATIONS

Engineering Services Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Fort Davis VLBA Axle Repair	01/05/07		01/05/07
2. Complete DnC array reconfiguration	01/26/07		01/18/07
3. Complete D array reconfiguration	02/16/07		02/13/07
4. Repair 3 intersections (AW6, AW5, BW9)	05/30/07		
5. Complete A array reconfiguration	06/12/07		
6. Hancock VLBA Foundation and Subreflector Repair	07/30/07		
7. Complete BnA array reconfiguration	09/21/07		
8. Complete B array reconfiguration	10/12/07		
9. Replace 4,000 Ties	11/30/07		
10. St. Croix Antenna Painting	12/15/07		

OPERATIONS

3. NA ALMA Science Center

NA ALMA SCIENCE CENTER

NAASC highlights include:

- The ALMA operations plan passed major reviews by the NSF and by an international committee. Successful completion of these reviews gives the funding agencies a road map for long-range operations funding and the transition from construction to operations.
- The NAASC workshop “Transformational Science with ALMA: Through Disks to Stars and Planets” was organized and will take place in June.
- The CASA off-line software successfully completed alpha testing.

NAASC Milestones

Milestones	Original Date	Revised Date	Date Completed
1. ALMA Operations plan sent to external reviewers	01/31/07	02/08/07	02/08/07
2. NSF panel ALMA site visit	01/26/07		01/26/07
3. NSF Review of NAASC Plan	03/01/07		03/01/07
4. International review of AOP at NSF Headquarters	02/27/07		02/27/07
5. Respond to NSF budget questions	03/21/07		03/21/07
6. ALMA external software testing – Pipeline	01/18/07	03/01/07	03/15/07
7. ALMA external software testing – CASA	10/30/06	03/05/07	03/05/07
8. Transfer AOP document and budget to JAO/Smeback	04/02/07		
9. Respond to NSF panel report	04/27/07		
10. Spectral-line catalogue—organize working group, first meeting in Charlottesville, Spring 07	04/05/07		
11. 2nd NAASC workshop – Protoplanetary Disks	06/22/07		
12. Spectral-line catalogue—continue resolving species	Ongoing		
13. Science center visits to Herschel, SSC	05/30/07		
14. Software testing: CASA, Pipeline, Simulator	On-going		
15. New hire for commissioning	12/07		

OPERATIONS

4. Central Development Lab

CENTRAL DEVELOPMENT LAB

CDL highlights include:

- Six blocks for a 211–275 GHz balanced SIS mixer were delivered.
- A new corrugated rectangular 75–110 GHz phase shifter was designed.
- The Green Bank Solar Radio Burst Spectrometer was upgraded and operates routinely over the frequency range 15–1000 MHz.
- Design work began on a K-band focal-plane array receiver for the GBT.

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 EVLA, VLBA, GBT, and ALMA in the frequency range from 1 to 120 GHz	04/01/04	ongoing	

Notes:

2. The development of demonstration amplifiers for ALMA band-1 and band-2 receivers is in progress.

Other Projects:

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 EVLA covering frequency range from 1 to 50 GHz	12/31/05		ongoing activity
2. Build/upgrade/repair cryogenic amplifiers using Cryo-3 TRW devices for VLBA and GBT covering frequency range from 1 to 95 GHz	ongoing		ongoing activity
3. New amplifier test system development	06/30/06	6/30/07	

Notes:

1 and 2. First-quarter production totaled 38 new and upgraded amplifiers, including L (1–2 GHz), S (2–4 GHz), C (4–8 GHz), K (18–26 GHz), and Q (40–50 GHz) band units primarily for EVLA receivers. All requested EVLA production is either on or ahead of schedule.

3. The PC/LabVIEW-based noise-measurement system is operational, and all routine LNA measurements and performance documentation are now being performed with this system. We have been allocated a block of programmer's time over the next several months to implement user-interface enhancements to the system.

Other Projects:

The Chemistry Lab plated approximately 60 grams of gold, representing an actual gold cost of about \$1200 and an estimated commercial value of \$18,000. Jobs have included electroforming of microwave

OPERATIONS

4. Central Development Lab

components, internal waveguide plating, plating of amplifier and mixer bodies, and the usual assortment of mounting plates, brackets, and straps. Items have been supplied to all NRAO sites and projects.

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	04/01/08	
4. Package and test ALMA band 10 (787–959 GHz) driver module using MMIC VCO	7/31/07		
5. Design ALMA band 2 (67–90 GHz) LNA MMIC using NGST 35nm InP HEMT process	5/31/07		
6. Design K-band (18–26 GHz) LNA MMIC using NGST 35nm InP HEMT process	5/31/07		

Notes:

1. Extensive effort has been put into designing this MMIC. Some progress has been made, but the combination of specs on input impedance, noise temperature, and dynamic range are proving to be most challenging. A serious design will have to wait for the appropriate MMIC wafer run to come along.
2. Have begun exploring ways of more closely integrating LNAs with feeds and OMTs for lower noise.
3. Wafer probe test results with the revised MMPA75B are good. The BAE foundry is now dicing the first samples of the band 3 (92–108 GHz) amplifiers and will be tested in package. The 70 nm GaAs wafer run is scheduled to begin by the end of May.
4. Collaboration is continuing with Dr. Chiong from ASIAA Institute in Taiwan, who was at the NRAO for a 12 month visiting appointment. The MMIC VCOs designed by Dr. Chiong during his stay at the NRAO were fabricated and samples delivered to the NRAO for on-wafer testing. Using this MMIC VCO, an all-MMIC LO driver has been designed to fit into a 0.75" x 0.90" x 1.03" package containing the VCO, warm multipliers, amplifiers, mixers, and filters needed to drive the cold frequency multipliers for band 10. This block has been machined and will be assembled this coming quarter.
5. and 6. Received model of 35nm InP HEMT for new NGST 35nm InP HEMT process. We have been asked to contribute designs for the next run of this process. We have begun looking at the model data given and converting the s-parameters to a circuit model and converting the frequency-dependent noise parameters to a temperature-dependent (Pospieszalski) noise model. Preliminary designs of amplifiers using this device have begun.

Other Projects:

A paper was presented at the 18th International Symposium on Space Terahertz Technology on local-oscillator sideband noise in single-ended mixers. The research presented was based on the R&D for the ALMA local-oscillator system, and the findings will be used in the design of the ALMA band-10 local oscillator. The written paper for the conference proceedings will be finished and submitted this quarter.

OPERATIONS

4. Central Development Lab

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	06/01/07	
Balanced SIS Mixer Development			
2. Complete first balanced SIS mixer with superconducting IF hybrid	01/01/07	07/01/07	
3. Complete first balanced sideband-separating mixer	10/01/07	03/01/08	
Other Mixer Development			
4. 385–500 GHz SIS mixer Development	09/30/05	12/31/07	
5. Measure IF characteristics of a diffusion-cooled HEB mixer	06/30/06		

Notes:

1. This project is being done with the University of Virginia Microfabrication Laboratory
3. This project is the next step towards the ultimate low-noise SIS receiver. It builds on 2, above, to make a balanced sideband-separating SIS mixer with very low noise and low LO power requirement. Such mixers will be essential for future coherent mm/sub-mm focal-plane and beam-forming array receivers.
4. This project is on hold awaiting funds and engineering resources.

Other Projects:

Very-Low-Loss Passive Front End Components: Recently, there has been interest in using high-temperature superconducting (HTS) circuits in two applications: (i) very high-Q band-stop filters for interference excision on the GBT, and (ii) to lower the loss of the feed and polarizer or 90-degree hybrid at the input of receivers on the VLA. It seems likely, however, that un-plated copper conductors can be as effective as HTS in these applications except, perhaps, for interference filters that require very high-Q resonators. It is well known that the resistivity of copper decreases by more than an order of magnitude from room temperature to ~ 30 K. We have measured samples of the copper on Duroid and Cuflon circuit board and find a DC resistance ratio of ~ 50 between room temperature and 4 K. Using the simple skin-loss formula, that would be expected to give a factor of ~ 7 reduction in loss at microwave frequencies. If it is possible to reduce conductor loss in the front end by this amount, the input loss will be reduced to essentially that of the connectors. An experiment is currently being designed to measure the loss of copper, aluminum, and gold-plated copper circuits at room temperature and cold.

Electromagnetic Support Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Design of EVLA 12–18 GHz feed	09/30/04	06/30/07	
2. Develop dual band 345/800 MHz feed for the GBT	09/30/05	09/30/07	
3. Measure EVLA 2–4 GHz feed	03/31/07	07/31/07	
4. Prototype, fabricate, and measure a 75–110 GHz phase shifter at 17–25 GHz band	03/31/07	09/30/07	

OPERATIONS

4. Central Development Lab

Notes:

3. Rectangular to circular transitions for the 1.9–2.6 GHz and 2.6–4.0 GHz bands required for testing the feed have been designed. Fabrication is in progress.

4. The first design of a corrugated rectangular K-band prototype phase shifter, which is a scaled version of the W-band phase shifter, did not meet the specifications over the intended 17.0–25.0 GHz (75–110 GHz) band. The W-band phase shifter of this design has corrugations with slot width of 0.009” on one set of walls. A new W-band design with slot width of 0.005” was completed. Analysis with Microwave Studio shows a differential phase shift of $90^\circ \pm 4^\circ$ over the 75–110 GHz band. Prototypes at K-band and W-band will be fabricated and measured to check the design.

Other Projects:

VSWR measurements were performed on the production feeds for the EVLA Ka-band (26–40 GHz) front ends. The return loss is better than –25 dB on all the 27 feeds that were measured.

A paper titled “A New Broadband Short-Backfire Antenna as a Prime Focus Feed: Single and Dual Band” was submitted and has been accepted for presentation at the IEEE AP-S International Symposium 2007 at Honolulu, HI in June 2007.

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	
2. 80–300 MHz, dual polarization, log-periodic on 45-foot telescope, new digital spectrometer	09/30/05	11/05/06	01/19/07
3. 300–2500 MHz, dual polarization, 45-foot telescope with log-periodic feed, new digital spectrometer	09/30/05	11/05/06	01/19/07

Notes:

1. The low-frequency antenna work has been delayed until spring 2007.

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

Milestones	Original Date	Revised Date	Date Completed
1. Major upgrade to instrumentation subsystems	07/15/07		
2. 16-element prototype array, operating in the 100–200 MHz band in Green Bank	12/31/06	09/30/07	
3. A 4-element path-finding array in Western Australia	07/15/07		
4. 32-element array in Western Australia	12/15/06	12/31/07	

Notes:

4. The size of the Western Australia array has been increased to 32 elements. Deployment has been rescheduled for December 2007.

OPERATIONS

4. Central Development Lab

Frequency-Agile Solar Radiotelescope (FASR) Development Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Reference Instrument including engineering design document	06/16/06	04/15/07	

OPERATIONS

5. Chile Operations

CHILE OPERATIONS

Chile Operations highlights include:

- Implementation of local medical benefits.
- Hiring an ALMA HR manager, recruitment officer, and staff.
- Installation of equipment and shipment of first antenna components.

Local Labor Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Internal Regulations document submitted to employees			01/02/07
2. Internal Regulations document submitted to local authorities			02/01/07
3. Medical benefits negotiation with AURA and Carnegie completed. Submitted to ALMA HR Council.			02/21/07
4. Hiring of Replacement ALMA HR Manager			03/05/07
5. Hiring of ALMA Recruitment Officer			03/05/07
6. Hiring of NRAO Chile Office staff			01/08/07
7. Hiring of NRAO Chile Office staff			01/08/07

Notes:

6. NRAO Chile Office Administrative assistant: Carola Lara.
7. NRAO IT Administrator person: Rafael Ovando.

Business/Contracting Milestones

Milestones	Original Date	Revised Date	Date Completed
1. ALMA Contractors Camp Enlargement, approved by NSF	03/13/07		03/13/07
2. Vertex Site Erection Facility building steel structure erected	05/10/07		
3. Contract for handymen with Sodexo	01/19/07		01/19/07
4. Close negotiations with Universidad de Chile to rent facilities for ALMA AIV in Santiago.			
5. Equipments installation in AOS TB (HVAC, fire extinguishing, oxygen generator, power generators).			03/30/07
6. Microwave link installation between OSF and AOS. Phone system and internet service for AOS.			03/15/07
7. Emergency telephone equipment on road between OSF and AOS (Pampa La Bola).			02/07/07
8. Additional power generator installation in OSF for Vertex and Melco facilities.			03/23/07
9. Shipment of first antenna components.	02/08/07		02/28/07

OPERATIONS

5. Chile Operations

Other Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Environmental reporting to CONAMA	Monthly		Monthly
2. Environmental reporting to CONAMA	Biyearly		Biyearly
3. Annual payment of concession, Region II and CONICYT	Yearly		01/04/07
4. Execution of special fauna monitoring established in Resolución 049 (EIA's approval).	03/07		03/07
5. Annual payment of mining rights.			03/29/07
6. Face to Face IPT Meeting	03/10/07		03/10/07

Notes:

1. Monthly reports are sent to CONAMA;
2. Biyearly reports are sent to CONAMA.

OPERATIONS

6. E2E Operations

E2E OPERATIONS

E2E operations highlights include:

- Production of nearly 24,000 new VLA images by the data-processing pipeline for publication in the NRAO Archive and the Virtual Observatory.
- Successful completion of data-processing tests of CASA for ALMA.
- Transition of the Proposal Submission Tool to E2E operations.

Management & Administration Activities

Milestones	Original Date	Revised Date	Date Completed
1. Prepare proposal for computational-science REUs	04/30/07		
2. Oversight for March 2006 external CASA tests	03/09/07		03/09/07
3. Begin regular biweekly E2E email communications	04/30/07		
4. Begin regular biweekly E2E in-person meetings	04/02/07		04/02/07
5. Finalization of CASA beta plan	04/17/07		
6. Preparation of demos for Users Committee	05/17/07		

NRAO Participation in the National Virtual Observatory (NVO) Project

Milestones	Original Date	Revised Date	Date Completed
1. Conduct fall 2006 joint meeting of NRAO/NVO	12/31/06		01/31/07
2. Scalable data analysis framework functional prototype	02/15/07		02/15/07
3. Initial working draft SIA V2 document	05/01/07		
4. Initial working draft table-access protocol document	05/01/07		
5. Concept for handling SEDs and spectral aggregates	05/01/07		
6. IVOA interoperability meeting (China)	05/14/07		
7. High-level plan for NRAO data center in place	06/31/07		

NRAO Archive Infrastructure & Interfaces

Milestones	Original Date	Revised Date	Date Completed
1. Document role of archive facilities in the NRAO Integrated Science Center vision, including envisioned physical and application architectures	09/30/06	02/28/07	03/31/07
2. Complete VO-Google Pre-prototype	12/31/06	1/31/07	01/31/07
3. Complete VO-Google Beta	04/15/07	5/15/07	
4. Devise archive-index schema and replication scheme; resolve data integrity issues in current NRAO archive	04/30/07	08/15/07	
5. Determine release date for Archive v2.0	03/15/07	05/15/07	

OPERATIONS

6. E2E Operations

Milestones	Original Date	Revised Date	Date Completed
6. Complete transfer of historical VLBA tape archive	12/31/06	12/31/07	
7. Complete transfer of 3 TByte historical GBT science data	12/31/06	12/31/07	
8. Complete transfer of Tucson 12m data	12/31/07		
9. Complete transfer of GB 140ft data	12/31/07		

NRAO Proposal Infrastructure & Interfaces

Milestones	Original Date	Revised Date	Date Completed
1. Effect transition of NRAO PST & Database to e2e Ops	12/31/06	02/15/07	02/15/07
2. Complete PST performance improvements	05/20/07		
3. Successful maintenance of PST in first e2e-managed proposal deadline period	06/01/07		

Data Processing (CASA/GBTIDL) Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Conduct external ALMA CASA Tests	03/09/07		03/09/07
2. Prepare detailed schedule for September CASA beta	03/31/07	04/09/07	04/09/07

NRAO Pipeline Infrastructure & Interfaces

Milestones	Original Date	Revised Date	Date Completed
1. Summary statistics and report on existing VLA/VLBA pipeline in AIPS	09/30/06	11/15/06	02/15/07
2. First half of VLA archive processed via pipeline	06/30/07		
3. Second half of VLA archive processed via pipeline	06/30/08		
4. Develop plan for common VLA/Chandra sources	12/31/06	08/15/07	
5. Explore possibility of common NRAO/HST sources	12/31/06	08/15/07	
6. Explore possibility of common NRAO/Spitzer sources	12/31/06	08/15/07	
7. Process in place for a data analyst to pipeline and archive straightforward VLA/VLBA observations within two weeks of data availability	01/31/07		01/01/07
8. Bind AIPS pipeline to live VLA observations	05/31/07	08/15/07	
9. Feedback from researchers regarding utility of pipelined products available and disseminated	06/30/07		

OPERATIONS

7. Computer and Information Services

COMPUTER AND INFORMATION SERVICES

Observatory-wide Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Upgrade link between UVa and NRAO-CV to 1 Gbps ¹ (d)	01/31/07	04/30/07	
2. Formal approval of data security policy (a)	02/28/07	04/30/07	

Notes:

1. This will be installed by UVa as soon as the requisite components are available.
 - (a) Security
 - (b) Common Computing Environments
 - (c) World-wide web infrastructure
 - (d) Telecommunications

Charlottesville Computing Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Install service-interruption notification utility	01/15/07		01/15/07
2. Hire new Windows system administrator	03/31/07		03/19/07
3. Upgrade Exchange Server ²	03/31/07	04/15/07	

Notes:

2. Delayed slightly by lack of staffing. This is now proceeding well with the new hire.

OPERATIONS

8. Education and Public Outreach

EDUCATION AND PUBLIC OUTREACH

EPO highlights include:

- EPO wrote the ALMA EPO development plan that was reviewed by the NSF in Arlington.
- EPO initiated an ALMA Project video and still-photography documentation program.
- A *Sister Cities* educational and cultural exchange was initiated between San Pedro de Atacama, Chile and Magdalena, NM.

Publications Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Announce 3 rd annual AUI/NRAO Image Contest	01/10/07		01/10/07
2. 3 rd annual AUI/NRAO Image Contest website on-line	02/14/07		02/15/07
3. Select images for two new large-format color posters	03/09/07		03/12/07
4. April Newsletter delivered to printer	03/20/07		03/19/07
5. Deliver two new posters to printer	04/13/07		
6. Printer delivers posters	05/04/07	05/18/07	
7. 3 rd annual AUI/NRAO Image Contest deadline	09/07/07		

Notes:

1. A more active campaign to encourage submissions is planned, especially at the May 27 – 31 American Astronomical Society meeting. The April and July 2007 NRAO Newsletters will include a color flyer describing the Contest. EPO personnel will also actively solicit submissions via personal contacts.
3. The images selected are prize winners from the 2nd Annual Radio Astronomy Image Contest: (a) Supernova 1993J and Its Fourier Transform by M. Bietenholz; and (b) The HI Nearby Galaxy Survey (THINGS) by F. Walter et al.
4. A total of 2,255 printed copies of the April 2007 NRAO Newsletter were distributed. Electronic notification of the NRAO Newsletter's availability is operational for those subscribers who choose it.
6. Revised date based on experience in late 2006.

World Wide Web Milestones

Milestones	Original Date	Revised Date	Date Completed
1. EPO WWW Content Specialist selection	12/15/06	06/01/07	
2. WWW design RFQ / SoW distributed	04/03/07		
3. WWW Transformation Project Plan complete	05/09/07		

Notes:

1. A disappointing candidate pool will require a second advertising campaign and delay this hire into late spring 2007. A contractor will be hired to perform the EPO web-site design work that this position would have otherwise initiated this winter.
2. Four contractors have been identified.

OPERATIONS

8. Education and Public Outreach

ALMA EPO Milestones

Milestones	Original Date	Revised Date	Date Completed
1. ALMA EPO WG reviews 1 st draft ALMA EPO Development Plan	01/18/07		01/18/07
2. Sister Cities Program: Magdalena, NM	01/28– 02/09/07		01/28– 02/09/07
3. ALMA EPO WG reviews 2 nd draft ALMA EPO Development Plan	02/22/07		02/22/07
4. EPO briefing for international ALMA Operations review	02/27/07		02/27/07
5. EPO briefing for NA ALMA Operations review	03/01/07		03/01/07
6. Submit rev 1.0 ALMA EPO Development Plan to ALMA Board	03/15/07		03/15/07
7. Submit rev 1.0 ALMA EPO Policies & Procedures to ALMA Board	03/15/07	06/15/07	
8. ALMA Board presentation re EPO	03/28/07		03/28/07
9. Begin documenting unit-1 VertexRSI antenna delivery from factory	03/13/07	03/15/07	on-going
10. Select video/stills contractor for Chile	04/20/07		
11. Ship arrives at Antofagasta with unit-1		04/22/07	
12. Complete post-production on unit-1 video for AAS video trailer	05/23/07		
13. Array Operations Site (AOS) Technical Building dedication	06/15/07		
14. Sister Cities Program: San Pedro de Atacama, Chile	06/25– 07/06/07	06/30– 07/13/07	

Notes:

2. Additional details are given in the EPO section of the April 2007 NRAO Newsletter.
- 3 and 6. NRAO EPO (M. Adams) led the preparation of the ALMA EPO Development Plan.
7. ESO Public Affairs Dept. (H. Boffin) led the preparation of the ALMA EPO Policies & Procedures document. The first draft was not available to the ALMA EPO Working Group until March 8, so the submission to the ALMA Board was delayed until June 2007.
8. NRAO EPO (M. Adams) prepared the presentation that ALMA Director Massimo Tarenghi gave to the ALMA Board at their March 2007 meeting in Japan.
9. Unit-1 began its trip to Chile two days later than the date initially estimated by VertexRSI. NRAO EPO engaged a local videography / still photography contractor in Kilgore, TX strongly recommended by General Dynamics to document the transport of the unit-1 VertexRSI antenna in and out of the factory. A second videography / still photography contractor, based in Houston, was engaged by EPO to record unit-1 antenna transport events near and at the Port of Houston.
11. The ship and unit-1 departed the Port of Houston on April 4.
13. Includes video link to all NRAO facilities.
14. These dates shifted slightly to accommodate teacher schedules.

OPERATIONS

8. Education and Public Outreach

Astronomical Community Milestones

Milestones	Original Date	Revised Date	Date Completed
1. NRAO Town Hall at winter AAS meeting	01/08/07		01/08/07
2. Complete brochure revisions for summer AAS meeting	04/27/07		
3. Summer AAS meeting / exhibition	05/27–31/07		

Community Relations & Management EPO Milestones

Milestones	Original Date	Revised Date	Date Completed
1. Submit Pulsar Search Collaboratory project preliminary proposal to NSF	01/05/07		01/05/07
2. Royal Astronomical Society - Victoria Centre talk	01/10/07		01/10/07
3. Hertzberg Institute of Astrophysics talk	01/10/07		01/10/07
4. Royal Astronomical Society - Okanagan Centre talk	01/11/07		01/11/07
5. DRAO - Penticton talk	01/12/07		01/12/07
6. GB Science Center marketing panel review	02/09/07		02/09/07
7. Virginia Piedmont Regional Science Fair	03/08/07		03/08/07
8. Shenandoah Valley Stargazers talk	03/16/07	03/23/07	03/23/07
9. Submit Pulsar Search Collaboratory project full proposal to NSF	05/10/07		
10. NRAO Users Committee (Charlottesville)	05/17–18/07		
11. NRAO 50 th Anniversary Symposium (Charlottesville)	06/18–21/07		
12. ASP EPO meeting (Chicago)	09/05–07/07		
13. Communicating Astronomy to the Public (Athens)	10/07–11/07		
14. Green Bank Community Open House	10/21/07		

Notes:

1. Approval has been received for full proposal submission for this joint project with our colleagues at West Virginia University.
- 2 and 4. Post-AAS meeting talks by M. Adams: “Three Radio Astronomy Futures: ALMA, EVLA, SKA.”
- 3 and 5. Post-AAS meeting talks by M. Adams: “Communicating the NRAO Mission and Science”
7. AUI/NRAO sponsored the Physics & Astronomy category for this Charlottesville-area middle and high school regional science fair. NRAO EPO and scientific staff volunteered as judges.
8. M. Adams invited talk, “Three Radio Astronomy Futures: ALMA, EVLA, SKA,” delayed one week by bad weather.
13. Sponsored by Commission 55, this meeting will define the International Year of Astronomy – 2009 program for the IAU.

OPERATIONS

8. Education and Public Outreach

Custom School & Civic Group Program Milestones

Milestones	Event Date
1. Bethany College (VLA)	01/17/07
2. Boy Scout Troop 117 (GBT)	01/20/07
3. University of New Mexico (VLA)	02/09/07
4. Clarksburg Scout Group (GBT)	02/10/07
5. Fox Chapel (GBT)	02/17/07
6. Engineering Week student group (VLA)	02/18/07
7. University of New Mexico (VLA)	02/18/07
8. Science Olympics, San Jon Schools (VLA)	02/22/07
9. West Stanley High School (GBT)	02/22–24/07
10. Providence Day School (GBT)	03/01–04/07
11. Colorado Spring School (VLA)	03/06/07
12. Pomona College (VLA)	03/09/07
13. Villanova Astronomical Society (GBT)	03/16–17/07
14. Ohio State University (GBT)	03/18/07
15. Lynchburg College (GBT)	03/22/07
16. Gallop Junior High School (VLA)	03/22/07
17. Linwood Holton Governor's School (GBT)	03/23–24/07
18. Morehead University (GBT)	03/30/07
19. IEEE (VLA)	03/30/07
20. Easton Area High School (GBT)	03/31–04/01/07
21. Beaver County Christian School (GBT)	04/04/07
22. Guided Public Tours (VLA)	04/07/07
23. Bosque School (VLA)	04/09/07
24. Grosse Point North High School (GBT)	04/10–12/07
25. Bosque School (VLA)	04/11/07
26. Bosque School (VLA)	04/12/07
27. Glenville State College (GBT)	04/12–14/07
28. Truth or Consequences Middle School (VLA)	04/13/07
29. Truth or Consequences & Sierra Elementary schools (VLA)	04/14/07
30. Rio Rancho High School Astronomy Club (VLA)	04/14/07
31. Texas Tech University (VLA)	04/14/07
32. Zuni High School (VLA)	04/19/07
33. Trinity Christian School (GBT)	04/19/07
34. James Madison University (GBT)	04/20–22/07
35. Santa Fe Elderhostel (VLA)	04/20/07
36. El Paso Service Club (VLA)	04/21/07
37. Weirton St Paul (5 th grade) (GBT)	04/22/07

OPERATIONS

8. Education and Public Outreach

Milestones	Event Date
38. Newburgh Free Academy (GBT)	04/25–27/07
39. Cub Scout Pack 440 (GBT)	04/28/07
40. American Astronomical Society (GBT)	04/28/07
41. Fox Chapel (GBT)	04/29/07
42. Bosque School (VLA)	05/01/07
43. Bosque School (VLA)	05/03/07
44. Rio Rancho Middle School Gifted Program (VLA)	05/03/07
45. Madison Middle School (GBT)	05/04–05/07
46. Cross Lanes Christian School (GBT)	05/10/07
47. Cottonwood School (VLA)	05/11/07
48. Black Diamond Girl Scout Troop 2262 & 2032 (GBT)	05/12/07
49. Boy Scout Troop 14 (GBT)	05/18/07
50. Reinhardt College (GBT)	05/13–19/07
51. Fort Gay Middle School (GBT)	05/23–24/07
52. Boy Scout Troop 78 (GBT)	05/25–26/07
53. AUI Board (GBT)	06/16/07
54. 50 th Anniversary Conference Site Tour (GBT)	06/22/07
55. National Science Camp (GBT)	06/29/07

Formal Education & Conference Program Milestones

Milestones	Event Date
1. Chautauqua 2007	06/03–08/07
2. ERIRA	06/10–16/07
3. National Youth Science Camp staff training	06/17–21/07
4. Green Bank StarQuest IV	07/04–07/07
5. NASA/NRAO Joint Institute	07/15–20/07
6. Globe Workshop	07/22–27/07
7. 3 rd Annual Governor's School for Math & Science	07/29–08/11/07

MANAGEMENT

1. Administration

ADMINISTRATION

Environment, Safety, and Security (ES&S)

On the ALMA Project, ES&S participated in the first acceptance process for back-end racks shipped to Chile. In New Mexico, ES&S completed the fieldwork for the site-wide asbestos survey. In Green Bank, ES&S efforts are increasing as the GBT track replacement project is developing. In Charlottesville, the card-access system was brought online with the fire-suppression system anticipated next quarter.

ALMA

Work on the ALMA project included participation in multiple design reviews including the AEM Consortium antenna design review, the transporter design review, the nutator systems readiness review, and the Band 9 Safety Documentation review. During the quarter, ES&S visited the Vertex facility in Kilgore, Texas to review and resolve antenna safety discrepancies identified in the previous quarter. In March, ES&S participated in the face-to-face meetings for the ALMA Integrated Project Teams. During these meetings, the first coordinated efforts for the acceptance process were implemented for back-end items shipped to Chile.

NRAO-New Mexico

In New Mexico, ES&S completed the field work for the site-wide asbestos survey for the VLA. The sampling-results report is anticipated next quarter. The U.S. Department of Transportation Drug and Alcohol Testing Program manual was completely implemented for commercial drivers. At the AOC the floor striping is still pending and under discussion with local management. At the VLA, the new waste-oil storage tank arrived and installation is pending completion of concrete foundation work. ES&S continued to support the Antenna Test Facility by providing training services and support on preparation of a front-end safe-handling presentation. ES&S completed the 2008 renewal application paperwork for the Emergency Medical Services (EMS) first responders as well as the EMS fund act paperwork for state funding. ES&S participated in the inspection for EVLA Antenna 21 as it came out of major overhaul, and this quarter completed the VLA-site emergency lighting, emergency shower, eye wash, and the emergency exit sign inspection for the VLA site.

NRAO-Green Bank

In Green Bank, the Science Center fire alarm system is now functioning correctly. The new 300 gallon double-walled steel waste-oil tank has arrived. Installation of the new tank is pending a new concrete pad. The semi-annual cafeteria inspection was completed with no significant violations documented. In Green Bank, ES&S is actively involved in the GBT track-replacement program and is participating in the track-replacement scheduling meetings, reviewing contractor safety plans, and assisting in development of safety guidelines for GB personnel and visitors during the track project. Also, this quarter, ES&S has been involved with oversight of the site wastewater treatment plant. First-quarter sampling results were within accepted guidelines for the NRAO permit to operate and discharge through the state of West Virginia. The development of the GBT fire-suppression system project has been deferred until the track project is underway.

MANAGEMENT

1. Administration

NRAO-Charlottesville

This quarter, the NTC fire-detection and alarm systems and the card-access system were installed. Access cards were distributed and the system is on-line and functional. The NTC system is identical to the Edgemont Road access control system and allows staff to access both buildings with a single card. The fire-detection and alarm system has a few minor punchlist items remaining including employee training. Final testing and acceptance of the completed fire system is anticipated next quarter. Also, an OSHA-type inspection was performed by ES&S staff this quarter at the NTC facility.

Future Efforts

In the next quarter, the site safety representatives will pursue the further development of the GBT fire-suppression system with Green Bank staff, will complete the OSHA inspection at Charlottesville, and will begin development of the arc flash electrical-safety program.

MANAGEMENT

2. Program Management Office

PROGRAM MANAGEMENT OFFICE

By the beginning of this quarter, most of the initial modules of the Web-Based Business Services (WBBS) were completed and in use by NRAO staff. Since delivery of the WBBS was a primary activity of the Program Management Office, we took this milestone as an opportunity to assess the goals and deliverables of the PMO. While retaining the long-term objectives of the PMO, we determined that we could lower costs by closing the PMO as a standalone office and consolidating its activities within existing management and administrative groups. The following reorganization was completed on 31 January 2007:

- The Administration Group, under the supervision of the Associate Director for Administration (G. Clark), is now responsible for
 - The Management and Information Services (MIS) Group
 - Ongoing maintenance, operation, and future upgrades of the Web Based Business Services system
 - Implementation of the Electronic Timecard (ETK) project
 - GPRA reporting
- The Deputy Director / Operations Office is responsible for Operations Milestone Tracking and Performance Evaluation
- The ALMA Project Office is wholly responsible for staff assigned to the ALMA NA Project (business manager, controller, schedulers) who were previously in a matrix-management arrangement with the PMO.

MANAGEMENT

3. Personnel

PERSONNEL

NEW HIRES

Kennon Chambers	Facilities Engineer I	03/05/07
James Firmani	Human Resources Manager	02/26/07
Julienne Harnett	Scientific Associate II	01/02/07
Erin Mastrantonio	Research Assistant	01/08/07
Daniel J. Pisano	Research Associate	01/02/07
Jesse Pomeroy	Co-op Student	01/08/07
Paul Ruffle	Scientific Associate II	01/10/07

TERMINATIONS

David Hubbard	Head of Observatory Program Office	01/30/07
Jennifer Katz	Research Assistant	01/19/07
Paul Rhodes	Technical Manager, Senior	01/31/07

PROMOTIONS

Amy Mioduszewski	Assistant Scientist/CIS to Associate Scientist/CIS	02/01/07
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STATUS CHANGES

Robert D'Angio	Human Resources Manager to Senior HR Consultant	01/01/07
John Payne	Scientist/Research Engineer to Adjunct Scientist	01/01/07
Barry Turner	Astronomer to Adjunct Scientist	01/01/07
Qi Feng Yin	Scientist/Astronomer to Adjunct Scientist	01/01/07

MANAGEMENT

4. Budget

BUDGET

The NRAO Operations is forecast to receive \$50,740k (including \$6,010k for EVLA) in new funding this fiscal year. When combined with prior year commitments and prior year carryover, the NRAO Operations total, less EVLA, is \$51,486k. As of March 31, \$25,370k has been received. Overall the NRAO Operations budget is approximately 9.3% (annualized) underspent midway through the fiscal year based on annualized, linear spend profile. Comparisons against a linear spend profile are used only as a first order measure. Actual spending can be expected to deviate from linear owing to seasonal hiring, temporary vacancies, large capital expenditures, and a variety of other causes. The following is a brief explanation of the WBS level 1 elements that are under or over spent in excess of 10%.

Central Development Lab. Underspending by approximately 17.6% (annualized) is occurring in the several expense elements. Labor is running Hiring of a new technician for the Amplifier group was delayed and more labor has been attributed to the ALMA construction project than was originally planned. Spending is expected to be more closely aligned with the linear spend rate when some facilities upgrades are undertaken later in the fiscal year as well as the purchase of equipment in support of the 350 micron mixer development project.

Green Bank Operations. Expenditures are lagging the linear spend rate in the salaries and benefits expense element due in part due to the upcoming seasonal hiring of GBT painters, maintenance trainees, and other temporary employees this summer. Materials expense is also underspent due to funds not yet expended for the Green Bank track repair project.

ALMA Operations. Significant underspending is occurring in the materials and services expense category due in large part to the advance funding for Chile Operations. It is expected that up to \$3.2M will be available to carry forward into FY 2008.

MANAGEMENT

4. Budget

NRAO Operations Expenses and Commitments FY 2007 Year to Date (October 1, 2006 to March 31, 2007)								Percent of fiscal year	50.0%
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	\$4,785,965	\$3,532,817	\$564,435	(\$150,000)	\$8,733,217	\$4,366,608	\$4,505,539	51.6%	-3.2%
Education and Public Outreach	\$520,430	\$248,290	\$20,600	(\$125,000)	\$664,320	\$332,160	\$364,284	54.8%	-9.7%
Central Development Lab	\$1,501,583	\$256,745	\$30,000		\$1,788,328	\$894,164	\$736,410	41.2%	17.6%
Green Bank Operations	\$8,637,891	\$2,997,892	\$143,220	(\$455,600)	\$11,323,403	\$5,661,701	\$5,025,060	44.4%	11.2%
New Mexico Operations	\$13,284,015	\$4,495,931	\$173,200	(\$80,000)	\$17,873,146	\$8,936,573	\$9,268,933	51.9%	-3.7%
ALMA Operations	\$892,348	\$4,776,003	\$74,640		\$5,742,991	\$2,871,495	\$889,045	15.5%	69.0%
Computer and Information Services	\$867,399	\$635,200	\$25,000		\$1,527,599	\$763,800	\$798,706	52.3%	-4.6%
Science and Academic Affairs	\$2,191,782	\$1,316,603	\$324,780		\$3,833,165	\$1,916,583	\$1,768,325	46.1%	7.7%
NRAO Operations totals	\$32,681,413	\$18,259,481	\$1,355,875	(\$810,600)	\$51,486,169	\$25,743,085	\$23,356,302	45.4%	9.3%

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
AAPT	American Association of Physics Teachers
AAS	American Astronomical Society
ACU	Antenna Control Unit
ADA	Associate Director for Administration
AEM	consortium manufacturing the European ALMA antennas
AIPS	Astronomical Image Processing System
AIV	Assembly, Integration, and Verification
ALMA	Atacama Large Millimeter Array
ANASAC	ALMA North American Scientific Advisory Committee
AOC	Array Operations Center (Socorro, NM)
AOP	Array Operations Plan
AOS	Array Operations Site (ALMA)
ASAC	ALMA Scientific Advisory Committee
ASIC	Application-Specific Integrated Circuit
ASDM	ALMA Science Data Model
ASP	Astronomical Society of the Pacific
AUI	Associated Universities, Incorporated
AURA	Association of Universities for Research in Astronomy
BAE	British Aerospace Engineering
BGA	Ball Grid Array
C-band	4–8 GHz
CASA	Common Astronomy Software Applications
CASAPY	CASA with Python interface
CCB	Caltech Continuum Backend (GBT)
CDL	Central Development Laboratory (Charlottesville, VA)
CIS	Computer and Information Services
CONAMA	Chilean National Environmental Commission
CONICYT	Comisión Nacional de Investigación Científica y Tecnológica de Chile
CV	Charlottesville
CY	Calendar Year
DRAO	Dominion Radio Astrophysical Observatory
DRSP II	Design Science Reference Plan, Version 2 (ALMA)
DTS	Digital Transmission System
e2e	End-to-End
EIA	Environmental Impact Assessment
EMS	Emergency Medical Services
EOS	Electronic Online Systems
EPO	Education and Public Outreach
ES&S	Environment, Safety, and Security (NRAO)
ESDM	EVLA Science Data Model
ESO	European Southern Observatory
EVLA	Expanded Very Large Array
FASR	Frequency-Agile Solar Radiotelescope
FD	Fort Davis (VLBA station)
FPGA	Field-Programmable Gate Array

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
FRM	Focus and Rotation Mechanism
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
GHz	Gigahertz
GLAST	Gamma-ray Large-Area Space Telescope
Gsps	Giga samples per second
GUI	Graphical User Interface
HBT	Heterostructure Bipolar Transistor
HEB	Hot-Electron Bolometer
HEMT	High-Electron-Mobility Transistor
HI	Neutral hydrogen
HR	Human Resources
HST	Hubble Space Telescope
HTS	High-Temperature Superconducting
HVAC	Heating, Ventilation, and Air Conditioning
IAU	International Astronomical Union
IDC	Indirect Cost rate
IDL	Interactive Data Language
IF	Intermediate Frequency
ILS	Integrated Library System
InP	Indium Phosphide
IPT	Integrated Product Team
IR	Infrared
IRAS	Infrared Astronomy Satellite
IT	Information Technology
IVOA	International Virtual Observatory Alliance
JAO	Joint ALMA Office
K	Kelvins (temperature)
K-band	18–26.5 GHz
Ka-band	26.5–40 GHz
KP	Kitt Peak (VLBA station)
Ku-band	12–18 GHz
L-band	1–2 GHz
LNA	Low-Noise Amplifier
LO	Local Oscillator
LTA	Long-Term Accumulator (GBT spectrometer)
LWA	Long-Wavelength Array
M&C	Monitor and Control
Mbps	Mega bits per second
MHz	Megahertz

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
mm	millimeter
MMIC	Monolithic Microwave Integrated Circuit
MOU	Memorandum of Understanding
MPIfR	Max Planck Institut für Radioastronomie
µm	micrometer
NA	North American / Not Applicable / Not Available
NAASC	North American ALMA Science Center
NAOJ	National Astronomical Observatory of Japan
NASA	National Aeronautics and Space Administration
Nb	Niobium
NbTiN	Niobium Titanium Nitride
NGST	Northrop Grumman Space Technology
nm	nanometer
NRAO	National Radio Astronomy Observatory
NSF	National Science Foundation
NTC	NRAO Technology Center (Charlottesville)
NVO	National Virtual Observatory
OMT	Orthomode Transducer
OPS	Operations
OPT	Observation Preparation Tool
OSHA	Occupational Safety and Health Administration
OSF	Operations Support Facility (ALMA)
OST	Observation Scheduling Tool
P-band	327 MHz
PAPER	Precision Array to Probe the Epoch of Reionization
PC	Personal Computer
PDM	Project Data Model
PDR	Preliminary Design Review
PLC	Programmable Logic Controller
PMO	Program Management Office
PST	Proposal Submission Tool
PT	Pie Town (VLBA station)
PTCS	Precision Telescope Control System
Q	Quarter
Q-band	40–50 GHz
R&D	Research and Development
RAP	Radio Astronomy Preprints
REU	Research Experiences for Undergraduates (NSF program)
RF	Radio Frequency
RFI	Radio-Frequency Interference
RFQ	Request For Quotation
S-band	2–4 GHz
SAA	Science and Academic Affairs (NRAO division)
SAGE	Science Advisory Group for the EVLA
SED	Spectral Energy Distribution

APPENDIX

Acronyms and Abbreviations

Acronym	Definition
SIA	Simple Image Access
SIS	Superconductor–Insulator–Superconductor
SKA	Square Kilometre Array
SoW	Statement of Work
SRBS	Solar Radio-Burst Spectrometer (Green Bank)
SSC	Spitzer Science Center
STScI	Space Telescope Science Institute
TB	Technical Building (ALMA)
TDP	Technology Development Project (SKA)
TRW	TRW Corporation
U-band	12–18 GHz
UNAM	Universidad Nacional Autonoma de Mexico
UVa	University of Virginia
VCO	Voltage-Controlled Oscillator
VDC	Volts, Direct Current
VIPS	VLBA Imaging and Polarization Survey
VLA	Very Large Array
VLBA	Very Long Baseline Array
VLBI	Very Long Baseline Interferometry
VO	Virtual Observatory
VSOP	VLBI Space Observatory Program
VSOP-2	VSOP successor
W-band	68–117 GHz
WBS	Work Breakdown Structure
WG	Working Group
WIDAR	Wideband Digital Interferometric Architecture (EVLA correlator)
WWW	World-Wide Web
X-band	8–12 GHz