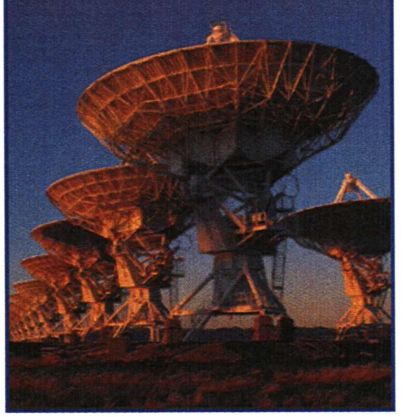
Quarterly Report

July - September 2000



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A. SCIENCE HIGHLIGHTS

Socorro

Pulsar "Lying About Its Age," VLA Study Indicates - A multi-epoch study of pulsar B1757-24 and its associated radio supernova remnant G5.4-1.2 indicates that the pulsar may be much older than indicated by the "characteristic age" based on its spin down rate. The pulsar, commonly known as "The Duck," has a calculated characteristic age of 16,000 years, but, based on a VLA proper-motion study using 1993 and 1999 images, the pulsar probably has taken about 39,000 years to move from the center of the supernova remnant to its present position. The result calls into question the determination of pulsar ages, with wide-ranging implications for the understanding of neutron stars, pulsars and even particle physics.

Investigators: B. Gaensler (MIT) and D. Frail

VLBA "Movie" Shows "Missing Link" Gas Cloud Near AGN Jet - A 16-month series of VLBA images of the jet of 3C120 shows the jet colliding with a gas cloud. The cloud is intermediate in distance from the AGN core between the close, broad-line clouds and the farther narrow-line clouds. The collision caused "flickering" in the radio emission at a specific location in the jet, leading to the conclusion that the jet changed direction. Further studies of the newly-discovered cloud could yield dynamical information important to understanding the regions near galactic supermassive black holes.

Investigators: J.-L. Gomez (Granada), A. Marscher (Boston U.), A. Alberdi (Granada), S. Jorstad (Boston U. and St. Petersburg State U., Russia), and C. Garcia-Miro (Granada).

B. MILLIMETER ARRAY PROJECT

This period has been a productive period for the ALMA project. We continue to benefit from good working relationships with our European colleagues. In each of the development areas, coordinated design efforts by each side are moving forward rapidly. This progress requires significant interaction between the groups, taking the form of both telecon and face-to-face meetings. A partial list of the meetings held during this period include:

- ALMA Weekly U.S. Division Heads Meetings
- ALMA Monthly Joint Division Head/Team Leader Meeting
  Minutes are distributed to all Division Heads and Team Leaders via email.
- ALMA Weekly AEC Telecon
- ALMA Test Interferometer Bi-Weekly Teleconferences
- ALMA Lo/Rx Meeting - weekly teleconferences
- ALMA Imaging and Calibration Meeting - weekly teleconferences
- ALMA Joint Receiver Design Group Meeting - July 25
  Minutes are available at http://www.alma.nrao.edu/committees/jrdg/index.html.
- ALMA Scientific Advisory Committee Meeting - July 10, 2000
  Minutes are available at http://www.alma.nrao.edu/committees/ASAC/index.html.
- ALMA Liaison Group - face-to-face meeting in Charlottesville, VA July 28-29, 2000
- ALMA Holography Teleconference - July 25, 2000
- ALMA Scientific Advisory Committee Teleconference - August 07
  Minutes are available at http://www.alma.nrao.edu/committees/ASAC/index.html.
- ALMA Site Development Teleconference - August 16
- ALMA Executive Committee Face-to-Face - August 24
- ALMA Joint Receiver Development Group Teleconference - August 30
  Minutes are available at http://www.alma.nrao.edu/committees/jrdg/index.html.
- ALMA Photonics Meeting - September 01
- ALMA Holography Teleconference - September 06

- ALMA Joint Receiver Development Group Face-to-Face Meeting - September 07-08
- ASAC Face-to-Face Meeting - September 09-10
- ALG Face-to-Face Meeting - September 11
- ALMA U.S. DH Face-to-Face Meeting - September 21
- ALMA Optics Workshop - September 25-29

Various reports will be posted on the ALMA web site.

Antennas

The principal task of the ALMA-U.S. antenna division has been continued management of the Vertex prototype antenna contract. As a result of a PDR Issue, the contractor made a significant change to the antenna pedestal design to bring the path length stability performance into specification. Another important contractor activity was the continued testing of approximately 40 samples of Carbon Fiber Reinforced Plastic (CFRP) in order to determine the optimum material for fabrication of the reflector backup structure.

The contractor has commenced procurement subcontracts for long-lead items including azimuth and elevation position encoders, reflector panel material and rough machining, and the mold for the CFRP reflector backup structure tooling. NRAO reviewed and approved the procurement specifications for these components. The contractor completed a new computer finite element model for the antenna including a more detailed thermal model required to refine the estimated thermal performance of the antenna. This model was provided to NRAO for checking. The design of the various platforms and access stairways on the antenna were also provided to NRAO for checking conformance with the various OSHA regulations.

Within the NRAO antenna group work continued on the design of various pieces of antenna equipment including the optical pointing telescope and the subreflector nutator. Updated versions of several antenna interface control documents (ICD), including the ICDs for the receiver, monitor and control system and transporter were in progress in collaboration with the European antenna group. Design work also progressed on the electrical infrastructure required for the ALMA Test Interferometer to be built at the VLA site.

Front-ends

The prototype helium compressor system, built in Tucson, for the Evaluation Front-end has passed a comprehensive electrical testing and is presently undergoing helium gas and oil flow rate tests. This will be the first unit to be thoroughly tested under control and monitored by a CAN bus interface to a lab computer. The compressor system has been designed to withstand the harsh environment of 40 degrees Celsius at an altitude of 5000 m. Although the Rutherford Lab is now responsible for the cryogenic systems to be used on ALMA, the problems found and solved in the development of this compressor will undoubtedly prove useful in the development of the final cryogenic system.

The optics design for the Evaluation Receivers is complete and the necessary components are being fabricated at IRAM in Grenoble as part of our collaboration. The highly specialized polarization diplexers, needed for both the evaluation receivers and the production receivers, have been produced (for the lower frequency bands) and will shortly be ready for the final drawings to be made. An optics design for the Evaluation Front-end has been set resulting in the mechanical design for the dewar proceeding at a fast pace. The stainless steel dewar drawings should be presented to the Green Bank workshop by the end the month.

The joint effort between the U.S. and its European partners to produce a design for the ALMA production receivers is progressing well. The Rutherford Laboratory in the UK has produced an initial design for the Dewar and cryogenic cooler and IRAM, in France has designed the optics for the receiver. The MPIfR in Bonn has initiated a research program involving the Gerhard Mercator University, Rutherford Laboratory, and UCK to produce high frequency photo-detectors that may be used in the later versions of the ALMA receivers.

Following a recommendation at the JRDG meeting in Cambridge, a working group was set up to produce an optical layout design for the ALMA receivers. The design documents produced by several groups were reviewed in the light of the clarification of the receiver requirements that resulted from the ASAC meeting held in Berkeley. Of particular concern were two requirements: 1) The inclusion of a cold load in the receiver dewar. The inclusion of this and the additional optics required for its implementation would have resulted in a complex receiver design that some members of the JRDG felt to be impractical. This requirement was dropped by the ASAC. 2) The polarization purity requirement.

Although this requirement is still somewhat unclear there was sufficient understanding for the working group to proceed with the optics design.

At the conclusion of the five day meeting a clear layout for the dewar and optics was achieved. Further design work has been identified and when completed a comprehensive design document will be issued. This will include the geometry, performance, and tolerances.

Wafer fabrication for the 211-275 GHz sideband-separating, balanced mixer at UVA was completed, and two wafers were delivered. Fabrication of the mounting blocks commenced. The bias circuit wiring has been installed in the dewar. Design is also complete for various parts needed to install the mixer chip in the block, including waveguide probes, DC blocking capacitors, and a transmission line signal combiner for each balanced mixer; the capacitors are complete, and the other components are being fabricated on fused quartz from Nb/Ti/Au.

The fabrication of the first 650 GHz mixer wafer continues at Stony Brook. The mixer block is being fabricated by Custom Microwave. Design work continues on other apparatus required for testing, including mirror mounts and LO couplers. W-band waveguide to be used for LO injection in overmoded configuration was gold plated and tested.

A major objective of the SIS mixer development was achieved with the successful test of a 211-275 GHz mixer with integrated preamplifier for the 4-12 GHz IF band. In this experiment, the only gain within the dewar was the preamp, so some improvement in performance is expected with a cooled postamplifier. The receiver temperature with the wideband IF was the same as that measured with the conventional 1.2 GHz IF, but the effective bandwidth was 8 GHz instead of 1 GHz; the new system thus meets the ALMA specification. The particular mixer tested with the preamp was tuned slightly below the ALMA RF band, and was not quite as good in noise performance as a typical mixer (excess of about 10K DSB); this will be corrected with a differently-tuned mixer chip.

Work continued jointly with collaborators at the Herzberg Institute in Canada on a memo concerning the design of sideband-separating, balanced mixers using split-block hybrids and splitters as an alternative to fabricating such structures on a chip as is done for the 211-275 GHz design. A test structure for 75-110 GHz which incorporates a waveguide power divider/combiner was fabricated as a split block and successfully tested. This will be suitable for use both as a splitter for SIS mixers and as a power combiner for LO driver amplifier chips. It is suitable for scaling to at least 720 GHz. All these waveguide components have been extensively modeled and optimized using Quickwave simulation software, and the performance of the test pieces closely matches the predictions.

Further preliminary analysis of an SIS mixer capable of covering 86-116 GHz was carried out. This is an alternative to using an HFET amplifier, which although it is intrinsically single-sideband and available now with noise temperature comparable to an SIS mixer, has higher 1/f gain noise. The modeling now in progress consists in matching SIS junctions to the structure and designing a suitable waveguide probe. If this can be done satisfactorily, then the design may be completed and fabricated. The SIS mixer group wrote and submitted contributions for the Front-end section of the new ALMA Project Book.

Local Oscillator System

The ALMA baseline plan provides for a photonic reference signal that will be generated at the central station and distributed to each of the antennas by optical fiber. The major difference between this method and previous technology is that the reference can be made tunable so that the local oscillators at the antenna can be phase locked directly to the reference without extra electronics at the antenna. In addition, because widely tunable lasers are readily available, and very high frequency photomixers are being developed, the reference can now be set as high as 120 GHz. Higher frequencies are expected to be available soon. The higher reference frequencies take advantage of the fact that as much of the LO chain as possible can be in the phase-locked-loop and therefore immune to temperature effects.

For the Test Interferometer, the use of a photonic reference signal requires a frequency synthesis and distribution network at the central station. This will consist of a single master laser, and two slave lasers. The master laser is a single frequency non-tunable laser with an exceptionally narrow line width of 3 kHz. This laser serves a dual purpose: it provides LO reference signal power and it is the key component in the round-trip phase correction to the antennas. The 3 kHz line width is exceptional when one considers that the laser frequency is 193.5 THz. The short-term frequency stability is thus close to one part in 10^{11}. That indicates that the coherence length of the laser is longer than 50 km. We have used this to our advantage in developing an optical interferometer with which we have stabilized optical fiber lengths up to 25 km to within a single optical fringe (1.5 microns).

The slave lasers are then locked to the master laser in a synthesizer module. For the Test Interferometer, we are using conventional microwave harmonic mixers to do the phase locking to 120 GHz. For the ALMA array, the technique of optical phase locking using optical comb generators is being developed by our ALMA collaborators at the University of Kent at Canterbury.

The round trip phase correction for the Test Interferometer will consist of a module at the central station and one at the antenna, which will be duplicated for each antenna. Basically, the master laser signal undergoes a round-trip with a frequency shift added at the antenna, and then it is phase compared to the original signal at the central station in a photodetector / phase-detector. The output of the phase detector drives a fiber line stretcher that keep the overall fiber length locked onto an optical fringe. This technique has been successfully prototyped and design and construction of the modules for the Test Interferometer has begun.

At the antenna, the photonic LO reference is converted to a millimeter-wave signal in a high speed photomixer. A commercial chip was discovered to have exceptional performance, and it was measured and evaluated, with the result that it has not only enough RF power to serve as the LO reference, but also enough power to drive the SIS mixers directly up to at least 110 GHz (see ALMA memo #313). The measurement was done on a chip, and now the chip is being integrated into a package that will consist of a single mode fiber input and a fundamental mode millimeter-waveguide output. This work is being done in collaboration with Brian Ellison's group at Rutherford Appleton Labs.

Work was continued on the design of an integrated varistor doubler/power amplifier module to convert 25-30 GHz to 50-60 GHz power. This will be done using custom UVA diodes in the doubler section. Amplifier blocks for a 26-40 GHz power module were completed, and two such power amplifiers for use by the SIS mixer group were completed. Blocks for W-band power amplifiers were manufactured and will be sent to JPL for installation of MMIC chips.

A collaborative project with JPL was started to utilize the quick-turnaround capability of the multiplier wafer fabrication group at the University of Michigan, led by Jack East. The plan is to transfer some current JPL technology to U. Michigan, and use their foundry to test new multiplier designs without the one-year cycle time required at the JPL foundry.

Back-end Subsystem

General Microwave 0.5-4 GHz and 2-18 GHz digital attenuators were received for testing. Testing phase vs. attenuation is critical for the design. Seven responses to RFQs for a 1.5-2.5 GHz isolator for the Downconverter were received and evaluated.

A much revised and enhanced block diagram of the Downconverter bench prototype was prepared and the draft Downconverter specifications were revised.

Vendor data for improved total power tunnel diode detectors was searched, and some useful information was obtained from an engineer at a detector manufacturer. Data and application notes on sigma delta and SAR digitizers was found from Maxim and Cirrus.

The Downconverter schedule and work plans were revised with tasks updated through the bench prototype testing and part way into the field unit fabrication for the test interferometer.

The new Gore coax assemblies installed on the 8510C vector network analyzer made a huge improvement by removing all frequency glitches and instabilities compared to the old. Analysis of the vector network analyzer data on the sample General Microwave 1.5-4.0 GHz digital attenuator was completed; stability of magnitude and phase vs. temperature and bias voltage is excellent.

A new specification for the downconverter pin diode attenuators was then generated and an RFQ was issued. Analysis of the AD7731 sigma delta digitizer for the total power detector of the Downconverter is underway and an evaluation board for a 16 bit SAR digitizer will be acquired.

The layout of the clock generator PC board for the high-speed data transmission system was submitted for file check, design rule check, and price quote. After one iteration, the design passed these checks and a purchase order was issued. Parts for the board have started arriving and population and testing should occur next month.

Correlator

Work on the design of the Correlator Card is continuing. The contractor is continuing design work on the custom correlator chip. A review of progress on chip design was held at the contractors' facility. The design of the fundamental element of the correlator, namely the lag cell, has been completed and approved, using low-power standard cells. Simulations show that the chip should work up to about 170 MHz (considerably above the required 125 MHz, giving a good design margin) and dissipate about 1.5 W, which is well below the target 2.0 W. It was determined that the cost and power consumption of a version of the chip which would incorporate 8 K rather than 4 K lags would both be too high in the chosen 0.25 micron process, so the chip will have 4 K lags, which is the original specification. The remainder of the chip is now being designed, with a target of completion by the end of September 2000. We expect prototype chips in April 2001.

The FIR filter printed circuit boards were received, and a kit of parts was sent to NRAO Tucson for board population. The first board is expected back by the end of September.

The Long Term Accumulator Card, Station Card, and FIR Filter/Station test card layouts were completed and the designs were sent out for printed circuit card fabrication. Testing of these cards will probably begin in November. Work continued on the design of the Correlator Card, which is substantially done but awaits freezing of the chip design. A trial layout of the card design as it exists was done, and proved not too difficult, considering that the card will have over 6,000 nets, 73 240-pin chips, and over 1000 other components.

Computing

A Use Case working group met for a week in Grenoble and worked on top-level use cases for the ALMA array under the direction of the chair of the Science Software Requirements (SSR) committee. These initial use cases were circulated to the SSR for comment by its members. These use cases then formed the input to the Analysis and Design (A&D) group, who met the following week in Garching and continued work on their Architecture document. At present, the A&D group is concentrating on package identification and sequence diagrams.

In the ALMA Common Software (ACS) area prototyping with the ANKA system, which forms the basis of the first ACS release was undertaken to gain real-world familiarity with the underlying technology. Porting of parts of this system to VxWorks continued. Internal comments on the ACS Architecture document were sent to the document authors.

In the control software area, a revised AMBSI interface board (for device interfacing) was sent out for external manufacturing. Options for interfacing to the IF subsystem's total power detectors were investigated, and the CAN interface has been recommended. Although the interrupt rate is rather large (~2k/s) the CPU loading is only ~10 percent and saves the effort of creating a new interface. This recommendation is being studied by members of the IF, Systems, and software groups. An early draft document containing a standardized approach for "device controllers" was distributed for internal software group comments. Preliminary mount-control IDL was presented to the ACS group for consideration.

In the correlator control software area, effort was extended to make the test correlator (for the test interferometer) subscribe to the ALMA system-wide 48 ms timing pulse (the test correlator is adapted from an existing design). This requires hardware and software changes. Programming for the narrow bandwidth 100 MHz mode was undertaken. Test correlator fine delays were implemented, although final testing requires a geometric delay model server.

In the telescope calibration area, a discussion on data formats for the test interferometer was started. The format will be FITS based and largely follow the internal structures used by the IRAM CLIC package that will perform the actual telescope calibrations. A reuse document was started to describe the capabilities of the CLIC package.

European and U.S. members attended the EIE antenna control software PDR. Work is done jointly to keep the software interfaces aligned for both antennas and somehow independent of their design. They also jointly attended a teleconference on holography for the test interferometer (the European side is providing the analysis software, and the U.S. side is producing the control and data production software).

Work on ALMA array requirements, including a feature list, will continue. Planning for a test period on the (former) NRAO 12 Meter Telescope for late this year should be finalized. Replies to comments on the ACS architecture document will be distributed, and several draft documents related to control software and telescope calibration data formats will be circulated. A simplified Control Software implementation based on ACS is going to be demonstrated

as a way to use Control software and ACS together and will be the basis for the preparation of the 12 Meter tests. Interviews for a vacant staff position in Tucson will be held. A new revision of the AMBSI will be manufactured and tested. Preliminary versions of TI ICDs for compressor, CRG and total power computer interfaces will be issued.

The NRAO group, on behalf of both partners, submitted a proposal to the University of Arizona for time to continue our software-testing program on the 12 Meter antenna. We requested eight days starting December 1. A progress meeting with EIE following the EIE control system PDR was held. The SSR committee turned their memo #293 into a requirements list document and circulated it for comment. The Use Cases generated at the Grenoble meeting were circulated for comment to the committee. Some high-level analysis and design (A&D) work (e.g., UML sequence diagrams) based on the existing use cases continued. In the Software Engineering area, the Rational Rose CASE tool installation kits were distributed to ALMA sites in both Europe and the U.S. A standard document template was prepared but not yet distributed. A paper on software development process, methodology, and tools was distributed to the whole project for comment. The ACS group distributed a pre-release of version 0.0 to NRAO/Socorro and IRAM for installation testing and demonstration purposes. Demonstrations over the web to interested parties were also carried out. The BACI component of ACS 0.0 was ported to VxWorks. A 2-day visit to the Slovenian development team of the underlying CoCoS software was carried out. Planning in earnest for the 12 Meter antenna tests commenced.

Replies to comments on the architecture document were distributed. In the Control Software area, the second revision to the AMBSI M&C interface board was evaluated, and a third revision was sent to manufacturing. The Tucson cryogenic system was given a standard M&C interface, and successfully monitored and controlled through it (including LabView based logging software for the pressure sensors). Work on design documentation for a late-year design review continued. Personnel from IRAM and NRAO determined how to split the implementation of software elements related to mount control. A scheme for automatically generating HW/M&C ICD's from a common XML source was investigated. Work towards ICD's for the 2nd LO and central reference generator was begun.

Systems

We continued to refine the interface specifications for electronic devices, with concentration on those needed for the test interferometer. A meeting was held in Socorro among engineers based there and in Tucson, covering the design of the receiver, data transmission, local oscillator, and monitor/control systems for the test interferometer and resolving various outstanding interface issues, including timing. Gie Han Tan of ESO visited Tucson and Socorro to coordinate systems engineering work between the NRAO and ESO. It was agreed that ESO will provide first drafts of the detailed construction standards for such things as electronics packaging and wiring.

We also worked with the correlator group on synchronization of the Test Correlator with the other electronics. This correlator is a clone of the GBT spectrometer, some adaptation is needed for the ALMA application.

An informal review of the plans for the holography system for antenna evaluation was held by international teleconference [1]. The PDR for this system occurred very early (April 1999, see [2]), so the recent meeting was an update. Portions of the detailed design and construction may now be done in Europe.

We continued to refine the design of the holography system and confirmed some of the choices in an international teleconference. A formal Critical Design Review is scheduled for October 10. One important decision was to generate the transmitted signal photonically: only a photomixer and horn antenna will be mounted on the tower, driven over optical fiber by one of the laser synthesizers being built as an LO reference for the astronomy receivers. (See also report under local oscillator above.) Other design choices included the selection of observing frequencies (80 and 104 GHz); methods of mitigating multipath interference; and receiver LO frequency control method.

We also contributed to the design of the optical pointing telescope by selecting the overall system configuration and participating in two local meetings. The SE group will design the control electronics for the telescope and procure a fiber optic link for the video signal.

A memo giving specifications and engineering guidelines for dc power distribution within the Test Interferometer was prepared and distributed to the appropriate engineers.

In connection with the antenna contracts, we reviewed changes to the front end interface specification; and we provided an ac power budget for the electronics.

The Project Book, for which the joint U.S.-European systems group is responsible, is becoming more complete, although material in some areas is coming in from the specialist divisions more slowly than had been anticipated.

Weekly transatlantic teleconferences are now being held between the U.S. and the European systems groups. A variety of issues is being covered, including issues of standardization of packaging of electronic modules, power supplies, and documentation. Good progress is being made, although much work in reconciling U.S. and European standards remains to be covered in this area.

[1] See minutes of teleconference at http://www.tuc.nrao.edu/~demerson/holmins7.htm .
[2] See summary of holography PDR at http://www.tuc.nrao.edu/~demerson/holopdr/holo_pdr.recm.html.

Science, Calibration, and Imaging

To spur on the imaging simulation work as a test of the competing strawperson configurations, Min Yun started some imaging simulation using UVCON in AIPS. Various procedures were corrected and problems solved after some discussion in the configuration working group. Multi-configuration imaging is identified as a potentially important additional issue for the array design and imaging. Steven Heddle (ALMA/Eu) has made significant progress in getting the AIPS-based "black box simulator". A worldwide teleconference on configuration progress will occur in late August, before the ALMA Scientific Advisory Committee meeting.

Yun discussed various options for the configuration PDR with Al Wootten. Although a detailed report will be given to the ASAC at their Berkeley meeting, it appears that the PDR should not occur before later this year.

The result which is emerging from the simulations is that pointing errors dominate differences due to choice of configuration style. This suggests that operational considerations may be of more weight in the final choice of configuration than was originally thought.

Wootten circulated a document to the ASAC summarizing thoughts of many people on the Atacama Compact Array (ACA).

A memo from Stephane Guilloteau was also circulated giving his views on the ACA. The ACA was discussed in the Imaging and Calibration Group meeting held on 18 July. Some points needing clarification were identified.

At Chajnantor, Radford conducted field work with Angel Otarola (ESO) under clear weather. He restarted the multi-wavelength submillimeter tipper after software reinstallation. At 350 μm, both tippers agree. The new tipper also shows interesting results at 260 and 200 μm, the superterahertz windows. Radford also repaired the lightning detector PC, and performed data backup and computer maintenance for other instruments. He launched daily radiosondes and verified correct operation of backup radiotheodolite. We now are obtaining reasonable data through the Chajnantor winter on the atmospheric structure, which has been lacking.

Wootten arranged for the ASAC teleconference and he and Yun participated in the ASAC teleconference on the 10th. Wootten and Yun read and commented on the draft ASAC memoranda on receiver specs and SSR group report. Of particular concern was the issue of limited capability to switch between several different bands. Wild clarified the description of this spec to our satisfaction. Wootten put together a tentative agenda for the September face-to-face meeting of the ASAC, and entered the minutes of the July meeting to the website, and arranged the August meeting, to be held the 7th.

Plans for the face-to-face ASAC meeting in Berkeley, including the agenda and reading material will be finalized by Wootten. Wootten and Butler will present a paper on ALMA capabilities for the detection of Extrasolar Planets at the IAU meeting on this subject. Wootten will also present a report on ALMA at the Observatory Reports session of Division X, as well as attend the ALMA presentation by Kawabe at a Joint Discussion on radio continuum and line observations of distant weak sources.

Definition of and imaging test for the ACA continued with several reports issued, notably the ASAC endorsement of the ACA as a desired component of the enhanced ALMA. During September, Welch produced a memo for the ASAC on the number and size of the antennas. He concluded that for the compact array to contribute a point source sensitivity matching that of the more closely spaced 12 m antennas, the necessary number of small antennas is approximately (12 DC x 6, where DC is the diameter of the compact array antenna. A 6 m antenna should provide good imaging characteristics and suitable calibration sensitivity. The ASAC concluded: "Based on studies by Guilloteau, Welch, and Morita, there is general agreement on the range of antenna number (10-16) and sizes (6-8 m) for the ACA. Generally, smaller diameters are better for imaging, as long as the minimum spacing is set by antenna size, while larger antennas are better for calibration." They called for a study of how minimum separation depends on dish size for dishes

mounted on the standard 12 m mount; a study of the effects of dish size, between 6 and 8 m dishes, and of the number and layout of dishes on imaging of several of the standard test images.

Personnel

At the end of the quarter, 59.3 full-time equivalent staff were assigned to the ALMA Project at NRAO.

C. GREEN BANK TELESCOPE

Project Summary

Most of the structural work on the GBT is now complete, and work emphasis has shifted to outfitting the telescope, testing the telescope servo system, and formalizing the details of project completion.

First light was detected with the Green Bank Telescope on August 22, 2000, at approximately 7:00 p.m. The telescope was used to observe a continuum source, 1140+223, and a pulsar, PSR B1133+16, at a frequency of 403 MHz. An observation of another pulsar, PSR B0329+54, was made during the GBT dedication ceremony on August 25.

Over the last quarter, the NRAO staff in Green Bank has been working to outfit the GBT. The large L-band and S-band feed horns were installed in the turret of the receiver room. The NRAO azimuth cable wrap was installed in the pintle bearing room, and the optical fiber cable that carries IF and computer signals between the telescope and the electronics room was pulled through the wrap to the receiver room. Connectors have been installed on the large number of multimode fibers in the cable. All required cabling has been installed in the prime focus area. With the exception of a few tubing runs at the lower feed arm, the installation of cryogenic helium lines is complete. The termination of the 2,209 actuator cables in the actuator control room is complete. The connectors on the 61 wet actuator cables have been replaced. The installation of 2,209 surface retroreflectors is complete with the exception of 50 retroreflectors at the antenna vertex. Control panels for two laser rangefinders on the lower feed arm have been installed.

COMSAT, which is now a subsidiary of Lockheed Martin, completed the photogrammetry of the telescope's primary reflector. The photogrammetry results showed that all but about one percent of the surface actuators were set to specification. This remarkably good news meant that the surface was properly set in general and that additional photogrammetry runs would not be necessary. The photogrammetry results were also used to make the final alignment of the receiver room and to position the subreflector.

A "pinging" noise occurs in the azimuth wheels when the telescope is rotated in azimuth. The noise seems to originate in the wheel bearings. An inspection of the bearings in wheel number 9 revealed rust on some of the bearing rollers. The rust is attributed to water leaking through the bearing seal. The pinging noise and rust are thought to be unrelated. Currently, there is no consensus on what causes the noise.

Lockheed Martin inspected all azimuth wheel bearings to determine the extent of the rust problem. Of the 32 azimuth wheel bearings (there are two bearings in each of 16 azimuth wheels), nine failed the inspection. These bearings will be replaced. Lockheed Martin is preparing a plan for bearing replacement. The problems with the azimuth wheels will not jeopardize the short term operation of the telescope.

In July and August, the GBT servo system was thoroughly and rigorously tested according to an acceptance procedure. The azimuth and elevation drives, in addition to the subreflector and prime focus actuators, were exercised during the tests. Motion of the elevation gear segments was discovered during the servo tests. The elevation bullgear is now being realigned. To avoid motion of the segments in the future, the keys between segments are being trimmed, and the segments are being pressed closer together. The segments will be held in place by stops welded at either end of the bullgear. It is possible that a metal grout may need to be installed along the gear segments to secure them in place.

Tests of the elevation encoder showed that apparent errors in encoder readings were caused by thermal expansion of the encoder mount. With the telescope position fixed in azimuth and elevation, the encoder reading changes substantially at sunrise when sunlight shines on the encoder mount. The encoder readings also vary with ambient temperature. Lockheed Martin has agreed to build a more massive mount for the encoder and to enclose it with a small shelter. Work is underway to determine why the azimuth encoder readings also show a dependence upon ambient temperature.

The conditions for the acceptance of the GBT have been outlined in a Final Acceptance Test Procedure. Approximately half of the items listed in the procedure have been satisfactorily completed. The completed items include the proper installation and alignment of the pintle bearing and azimuth wheels, the proper installation of the azimuth track, the proper alignment of the primary reflector RF axis, the proper alignment of the surface actuators, the proper manufacture of the surface panels, and the proper installation and alignment of the azimuth and elevation encoders. The satisfactory completion of most of the remaining items in the procedure depends upon the outcome of the servo tests.

On August 22, Lockheed Martin and NRAO agreed to the terms of modified final acceptance of the GBT. One of the main purposes of modified final acceptance is to describe how the problems with the azimuth wheel bearings can be addressed so that Lockheed Martin can complete the project and NRAO can begin the formal outfitting and commissioning of the telescope this year. In addition to the plan for the inspection and repair of the azimuth wheel bearings, the terms of the acceptance agreement describe how "punch list" items will be addressed in the acceptance of the telescope, and how the retainage for the project will be distributed at acceptance.

NRAO and Lockheed Martin completed the terms of modified final acceptance of the GBT on September 28. Any items that were considered potential acceptance issues have been identified in a punch list. NRAO has retained sufficient funds to insure that Lockheed Martin completes the items on the punch list. Starting October 2, NRAO will have control of the telescope. The GBT will be placed in the access position for the month of October so that NRAO can complete its outfitting chores. In the evening, Lockheed Martin will continue with the alignment of the elevation bull gear. Any liability issues connected with their use of the telescope will be covered by their insurance. The one year warranty on the telescope will start on November 1.

Project Budget
(as of August 31, 2000)

The remaining money to be spent in the Electronics and Monitor and Control budgets is earmarked for an array of computer disks (RAID) and a data access workstation. The remaining money to be spent in the Surface and Pointing budget is for the wiring of the feed arm lasers.

Category	Allocation ($k)	Expended ($k)	Balance ($k)
Antenna	9	13	(4)
Electronics	30	17	13
Surface/Pointing	74	49	25
Monitor/Control	56	0	56
Project Management	153	98	55
Total	322	177	145

Project Major Milestones

Milestone	Original Date	Revised Date	Completed09-30-00
Complete act. cable test 2	05-31-00	07-14-00	07-14-00
Complete ACR outfitting	06-01-00	11-15-00	
Install L & S-band feeds	06-15-00	08-09-00	08-09-00
Measure all Rx feeds	07-03-00	11-03-00	
Assemble all cryo. comp.	07-14-00	11-15-00	
Feed arm servo tests	06-30-00	08-31-00	08-31-00
Az/El servo tests	08-18-00	08-31-00	08-31-00
Reroute GBT road	06-30-00	07-07-00	07-07-00
Terminate optical fibers	07-28-00	10-29-00	
Install weather station 2	08-18-00	10-31-00	
Install surface retros	08-14-00	09-15-00	09-15-00
Install feedarm lasers	09-15-00	12-15-00	
Install low freq. receivers	09-30-00	10-20-00	
Install high freq. receivers	09-30-00	11-08-00	
Install LO & IF racks	09-30-00	10-02-00	10-02-00
Antenna acceptance	09-30-00	09-28-00	09-28-00
Install servo room racks	10-05-00	10-05-00	10-05-00
Install perimeter fence	11-17-00	12-30-00	
Complete Q-band tertiary	04-15-00	06-30-01	
Measure az. track profile	09-15-99	12-31-00	

GBT Software

General

We are presently working on a Proposal Submission Tool (PST) to be based on the Phase I Tool (PIT) written to handle the scientific proposals for observations with Gemini. There are several advantages to using such a tool: much of the basic development has already been done; we can rely on them for support; they need third party users to exercise their tool; and scientists will have one fewer proposal submission schemes to learn. The tool will allow observers to include files created with different document processing systems with their proposals. Technically, PST is a Java application which will be downloaded from a server, and run locally on an observer's PC or Unix workstation. It will be deployed on October 1—the date of the publication of the request for proposals for the first peer-reviewed science projects on the GBT. It has been checked for operation on Unix (Solaris and RedHat Linux) and Windows.

Monitor and Control

Clearly the most important achievement of the GBT Monitor and Control (M&C) group was to carry out the first observations with the GBT on August 22, 2000, of the radio galaxy 1140+223 and the pulsar PSR B1133+16. In addition, the pulsar B0329+54 was tracked before and during the formal dedication of the GBT on August 25, 2000.

With the exception of one back-end (the spectrometer), the M&C system has a complete set of software to control all of the GBT instrumentation needed for commissioning and science observing. This has now been consolidated as release 3.1. During the weeks prior to the dismantling of the mockup, extensive tests were done to guarantee the reliability of the installation. These included many overnight observing runs using the GBT antenna simulator, but also using a complete signal path from a front-end receiver and producing engineering FITS data files.

The GBT integration tests exposed limitations with the computers used to support the ongoing observations. In particular, we are becoming limited by CPU speed and memory. Fortunately in a distributed system such as M&C, the tasks can be run on any computer. We therefore made a major effort to enable all M&C software, especially the CPU and memory-intensive tasks, to run on commodity PC hardware using Linux. Most of the major changes to enable M&C to run on a non-network-order ("Little Endian") computer have been done over the last two years, and the last remaining changes are now complete. All of the permanently running programs ("daemons") of the M&C system can now be executed on a Linux PC.

It seems that our tests of the Posicast trajectory preprocessor on the GBT will probably be the first use of this type of vibration-cancellation technique with a large radio antenna. Tests showed that for steps of several degrees the preprocessor trajectories excited significantly smaller amounts of vibration than did trajectories produced by the basic servo system. This is very encouraging. However, for short trajectories, (a few tenths of a second), the acceleration profiles failed to dampen vibrations. This is due an algorithmic error, which is now understood, and which will have to be addressed before the commissioning observations begin in November, 2000.

Telescope Operations

Development of checklists and documentation for specific operations outfitting procedures, antenna stow procedures, site personnel log for access to the GBT, and general site access requirements were completed in the third quarter. Development of operational procedures will continue on into the last quarter of 2000.

The final version of the COMSAT documentation was delivered to the NRAO at the end of September. Operations evaluation for the completeness of this documentation and preliminary incorporation of this material into the GBT operations system will begin during the last quarter of 2000.

Documentation for HVAC familiarization and the GBT man lifts were completed in the third quarter. Documentation for mechanical familiarization and antenna control were started. Other areas of procedure documentation and checklist will be started in the last quarter, as time permits.

The GBT telephone and video specifications were also updated.

GBT Preventative Maintenance

Completed during the third quarter of 2000:

- A preliminary list of special tools and heavy equipment needed for GBT maintenance.
- A detailed plan for the maintenance use of the COMSAT warehouse.
- A preliminary inspection plan (for welds, caulking, and structure). Major effort will begin during the last quarter on the investigation of a contract for structural inspections.

GBT Operator Training

Operator familiarization training on GBT HVAC, and OCU/PMU training on the 20 m (similar to the GBT) were completed. Training on the GBT electrical began in the last part of the quarter. The remaining training on the electrical will be completed by the end of 2000. Training on the GBT control, servo, and cryo systems will begin during the next quarter.

A comprehensive review of the training program was completed. Implementation of some of the training in this plan may begin in the last quarter however it will be predicated on available resources.

Safety training including lock out/tag out and materials handling was completed. Safety training will continue into the next quarter.

Some preliminary familiarization of Glish and AIPS++ was begun and will continue into the last quarter.

D. CHARLOTTESVILLE ELECTRONICS

Amplifier Design and Development

The amplifier group has continued to support the ALMA project with manpower and construction assistance in the SIS-integrated amplifier development effort, and with additional technical support to ALMA in the construction of bias power supplies and the use of cryogenic test fixtures. Technicians within the amplifier group have made a number of modifications and improvements to the Apple II-based noise measurement systems.

New development work was focused on refining the 8-18 GHz design, and the evaluation of a small set of 200 micron TRW devices in 3-13 GHz service. Results have been encouraging, achieving significantly lower noise temperatures than previously seen with 300 micron devices.

Amplifier Production

A total of 21 amplifiers was completed during the quarter. Production included: six C-band, six K-band, two K_a-band, three Q-band, and four 8-18 GHz amplifiers. The C-band amplifiers are being used as IF amplifiers by various members of the millimeter-wave community. One of the 8-18 GHz amplifiers went to JPL for use in a radio astronomy educational outreach program, in cooperation with the Apple Valley schools. The remaining amplifiers are used in various NRAO upgrade projects.

Superconducting (SIS) Millimeter-Wave Mixer Development

SIS Mixer Development

The University of Virginia (UVA) has delivered the first wafer of 211-275 GHz integrated balanced sideband-separating mixers for ALMA. The mixer block for initial testing with an L-band IF has been completed, and first tests will be made shortly. This mixer block differs from previous NRAO SIS mixer blocks in that it contains bias circuits for the four component mixers. After testing with an L-band IF, these chips will be tested with the 4-12 GHz IF preamplifiers now being developed. For the higher IF, it is important to have a very short connection between the mixer and the preamp, and this is more easily accomplished if the mixer bias circuits are located inside the amplifier body. It is considered important during the development phase to have the mixer and preamplifiers detachable so each can be measured separately.

SUNY/Stony Brook has solved the alignment problems that crippled their new E-beam lithography system earlier this year, and delivered a wafer of the new 602-720 GHz mixers. However, the I(V) characteristics are poor, with high leakage current which will give poor mixing performance. This is not typical—previous batches of junctions of similar size on both Si and fused quartz have had excellent characteristics—and they are now studying the cause of the problem. The mixer chips, despite their poor I-V curves, will be useful in characterizing the passive components of the design. The mixer blocks with integrated scalar feed horns have been delivered by Custom Microwave, Inc. This single-ended mixer will serve as a building block for balanced and sideband-separating mixers for ALMA. The existing 200-300 GHz Infrared Laboratories test dewar has been modified and will be used to test the 602-720 GHz SIS mixers.

We have been asked by the ALMA Science Group to assess the feasibility of a Band 3 (86-116 GHz) SIS mixer. The primary driver for this is concern about the 1/f gain fluctuations of millimeter-wave HFET receivers. The goals are: 1) carry out a thorough study on the feasibility of balanced sideband-separating mixers with integrated IF amplifiers meeting the ALMA specifications, 2) develop and evaluate a fully-integrated (MMIC) fixed-tuned waveguide mixer for this band and use it as a building block in a balanced and sideband separating mixer, and 3) provide technical and budgetary information gathered in this study to ALMA management and scientific advisory committee as a basis for choosing SIS or HFET receivers for this band. We have studied the major options in designing a Band 3 SIS mixer and have chosen a design similar to the proven NRAO type 373 (200-270 GHz) mixer, which satisfies the requirement for low IF parasitic capacitance and inductance. An additional RF matching circuit has been incorporated to increase the RF bandwidth. Initial circuit analysis using MMICAD shows that it is possible to design a coupling network to provide good matching between the waveguide probe and the array's optimum source admittance over the entire ALMA Band 3 frequency range.

SIS Mixer Testing

Software upgrades during the quarter allow automated mixer noise temperature measurements as a function of intermediate frequency. Two types of noise temperature measurements are now available: precision measurements, which use a power meter, and real-time measurements, which use a square law detector. The real time measurements allow the operator to view estimated receiver noise temperature across the entire 4-12 GHz IF band, which is useful for manual tuning.

The measurement system hardware and software were upgraded to use four existing mixer bias supplies for the balanced sideband-separating mixer measurements.

The design and coding of the new, simplified user interface was completed during the quarter. This new software also stores data in a server-based database, and the design and coding of that subsystem have also been completed. Significant software reuse was obtained by developing software components for server-based database access and specialized grids to display relevant mixer data. Additional coding of the measurement software will be completed in the next quarter and the new system will be used for routine mixer testing.

Stability problems with the existing mixer bias supplies were investigated during the last quarter and traced to insufficient phase margin in the bias feedback loop. A lead-lag circuit was designed and tested which eliminates the instabilities.

A system to provide computer control of LO levels was also completed during the quarter and will be integrated into the overall test system during the next quarter.

Broadband IF Development

Development of the integrated 4-12 GHz IF preamplifier continued during this quarter. Three amplifier bodies were made with a better isolated mixer bias-T which minimizes the interaction of the bias-T with the rest of the amplifier circuit. Upon connecting the bias-T to the amplifier circuit, the performance of the amplifier did not change appreciably (as it had with the previous design).

The preamp/bias-T was attached to a specially modified type 373 (210-270 GHz) single-ended mixer. The first results of the integration are very encouraging—the receiver noise temperature with the integrated mixer/amplifier was found to be as good as or better than with the standard L-band IF (1.5 GHz). We are now testing the preamp with other mixer chips to see how reproducible these results are.

Publications

S. M. X. Claude, C. T. Cunningham, A. R. Kerr, and S.-K. Pan, "Design of a Sideband-Separating Balanced SIS Mixer Based on Waveguide Hybrids," ALMA Memo No. 316, 20 September 2000, available at *http://www.alma.nrao.edu/memos/html-memos/alma316/memo316.pdf.*

Electromagnetic Support

GBT

Measurements were completed on the 290-395 MHz short backfire antenna feed. Return loss is better than -13.5 dB for one polarization and better than -15.0 dB for the other. The far-field pattern level varies between -9.0 dB and -13.5 dB at the edge of the main reflector within the frequency band. The patterns are circularly symmetric up to about 370 MHz.

General

Design of a quadrature hybrid branch coupler in the 75-110 GHz range was completed. The design goal was to obtain an amplitude imbalance of less than 1 dB and phase imbalance of less than a degree. Three designs of the coupler with 6 branches have been finalized to cover the following frequency ranges: (i) 75-106.9 GHz, (ii) 78-108.6 GHz and (iii) 79.5-110 GHz. Return loss is better than -20 dB for all three designs. These designs can be scaled up to the 211-275 GHz band. The designs were optimized using MMICAD and then refined with QuickWave-3D software.

Spectrometers/Correlators

During this quarter, most of the time was spent working on the design of the ALMA correlator with only a very small amount of time spent in support of the GBT spectrometer. Some support of the ALMA test correlator (GBT clone) was also required.

During the quarter a prototype ALMA correlator filter card was received from a PCB vendor. This card has been sent out for final-parts assembly.

Other printed circuit cards sent out for prototype PCB manufacturing include the LTA, the station card, and a test fixture card.

Design of the test fixture was completed to the point of motherboard PCB layout.

The design of the ALMA correlator card continued with detailed design of the card FPGAs taking most of the time. This card cannot go through PCB layout until final pinouts of the correlator chip are known, but a trial layout for the card was performed to see how difficult it would be.

The 4096-lag ALMA correlator chip design was mostly completed by the vendor during this quarter and functional simulation was begun.

Accomplishments of the correlator group during the quarter include:

1. Completion of a prototype filter PCB.
2. Completion of the LTA, the station card, and the test fixture card layouts and submission of a purchase request for prototype PCBs of all three cards.
3. Participation in the first functional simulation of the ALMA correlator chip.
4. Obtained auto- and cross-spectra on all modes except one from the test correlator.
5. Began writing software for the Infineon microprocessor which will be used on the ALMA correlator control cards.

Goals for the next quarter include:

1. Start initial testing of the filter card (but without the test fixture).
2. Start testing of the station card (without the test fixture).
3. Build the filter card/station card test fixture. Start checkout of this fixture.
4. Start testing of the LTA card.
5. Start simulation of the correlator chip in Charlottesville using software purchased for this purpose.

ALMA LO Source

The purpose of this project is to develop a series of electronically-tunable, phase-locked sources operating near 100 GHz. These sources will be used to drive millimeter- and submillimeter-wave frequency multipliers that produce the first-LO signal for the ALMA receivers.

During this quarter a computer-based controller for the phase-locked source was developed. Issues regarding the integration of the source with other ALMA LO subsystems were also investigated. Work continues on the development of integrated amplifier/multiplier components.

Measurements of the phase noise characteristics of LO multiplier chains and their components were performed and are described in ALMA Memo No. 311.

ALMA Frequency Multipliers

The purpose of this project is to develop millimeter- and submillimeter-wave frequency multipliers for use in laboratory experiments and receiver systems associated with ALMA. A series of multipliers using varactor and varistor circuits operating in the 50 to 950 GHz range are being developed. We have an ongoing contract with the Semiconductor Device Laboratory at the University of Virginia (UVA) to support semiconductor device research.

Work continues on the development of integrated capacitors. A series of measurements were conducted at a frequency near 100 GHz to evaluate special capacitor test structures. These measurements revealed that the dielectric material, Chemical Vapor Deposition (CVD) grown silicon dioxide, is extremely lossy and not suitable for frequency multiplier applications. Similar tests are currently being conducted on silicon nitride and sputtered silicon dioxide

capacitors for comparison. The design of the 81/243 GHz tripler is on hold pending the outcome of these capacitor measurements.

A collaboration with JPL and the University of Michigan for the development and fabrication of monolithic frequency multipliers, primarily for the submillimeter ALMA bands, is currently being finalized. The goal of this collaboration is to provide a second source of diodes needed for ALMA, provide access to additional fabrication processes not available at UVA allowing more complex and physically integrated multiplier designs, and significantly reduce the semiconductor processing time needed for both ALMA and HIFI/FIRST devices. This collaboration will begin sometime next quarter.

Also in collaboration with the UVA group, we have successfully molded a polyurethane (PUR) replica of the 55/110 GHz doubler. The poor adhesion of the metal to the plastic in the deep narrow channels of the waveguide circuits continues to be a problem that we are aggressively addressing. Sputtering continues to be the most promising approach. Experiments involving several different sputtering techniques are planned for the next quarter.

Fully-Sampled, Focal Plane Array Feed

The purpose of this long-term development project is to explore the technical challenges associated with the development of a radio "camera" for imaging applications on single-dish telescopes. The camera consists of a two-dimensional array of receiving elements located on the telescope's focal plane. These elements sample the focal plane electromagnetic field distribution, yielding complex signals that are processed using both analog and digital techniques to synthesize the desired number of telescope beams. We are currently working on the third generation of the 19-element proof-of-concept system.

During this quarter we began a series of measurements in the Green Bank anechoic chamber on the several modified designs of the sinuous antenna elements in an attempt to understand the mechanism responsible for the fluctuations in the feed point impedance with frequency. Preliminary results have shown that the structure's abrupt outer edge is contributing significantly to this fluctuation, but additional measurements with improved calibration procedures will be necessary to obtain an accurate value of the impedance. Work will continue on this important measurement throughout the next quarter.

Advanced Radio Frequency Interference Canceling System

The purpose of this long-term development project is to apply modern digital signal processing technology to the ever-growing problem of radio interference. Modern adaptive signal canceling methods are currently being analyzed and applied to system-noise-limited measurements of very weak cosmic signals. Our long-term goal is to develop a RFI excision system that is integrated with the GBT back-end electronics and is capable of canceling interference from both terrestrial and satellite sources, thus opening new spectral windows for astrochemistry and highly red-shifted HI measurements. We are currently in the first phase of our proof-of-concept system.

The NSF MRI proposal for the development of a complete adaptive RFI canceling instrument for the GBT was funded and task planning has begun. Several science-based RFI-canceling projects have been identified and a development strategy was addressed. This work is also being coordinated with the efforts at BYU through a series of teleconferences.

During this quarter we continued to make improvements to the current hardware-based, proof-of-concept system. The various component modifications have been completed and the system is currently being reassembled in preparation for a series of laboratory measurements in Green Bank next quarter to explore adaptive filter coefficient stability, attenuation versus interference-to-noise ratio, injected noise spectral properties, and broadband noise cancellation.

Work continues on the development of a fast, clean analog-to-digital converter. The converter, which consists of two complex sampling channels (80 MS/sec each) has been built and passed initial tests. A special interface board to a PC, DSP evaluation board, and a commercial DSP-based signal processing board is currently under development.

Meetings

Members of the CDL attended the following meetings this quarter:
NASA Peer Review Meeting, Washington, DC, July 19, 2000 (Bradley).

ALMA Receiver Meeting, Cambridge, UK, September 6-8, 2000 (Webber).
Applied Superconductivity Conference, Virginia Beach, VA, September 17-22, 2000 (Kerr, Pan).
ALMA SIS Working Group, Virginia Beach, VA, September 18, 2000 (Kerr, Pan).
NRAO Scientific Staff Retreat Meeting, Socorro, NM, September 18-20, 2000 (Webber, Lauria).

E. GREEN BANK ENGINEERING

GBT Spectrometer

Software development continues. The basic modes of operation defined by the GBT science workshop report will be finished and tested by November 3. Other modes will follow along after that. Each mode will be tested as it is completed, and added to the spectrometer capability list Pulsar modes are projected to be complete by the end of March 2001.

Cross-talk in the sample distributor cards was traced to very long wire runs and fast edges in some control signals. The chip generating the fast edges was replaced with a corresponding part from a slower logic family, and the problem went away in all cards.

Enhancements to the system to allow better isolation of faults and integration of software have been designed. One such modification will equip all LTAs with LEDs to indicate the status of various key bits on the cards. Another modification will buffer key signals on the VME interface board and bring them out to front panel test points for easy access with a logic analyzer or scope. These modifications are in process at this time, and are on hold due to a lack of technician manpower.

Spurious components of the sampling clock cause ghosts of the input signal to appear at frequency offsets corresponding to the difference between the sampling clock and the spurious component. Detailed measurements of spurious components of the 100 MHz and 1600 MHz sampling clocks were made during this quarter. A variety of spurs were found. Some were caused by the maser reference signal, some by the system power supply, and others by cross-products of the previous two. Attenuation of some spurs by about 35 db is required to meet the 50 dbc spec imposed by Fisher. To date, the power supply spurs have been reduced 20 db using additional filtering. An analysis of the phase-locked-loop has been made, and it appears that additional attenuation can be achieved by drastically reducing the loop bandwidth. A test fixture is presently being constructed to try this.

Other GBT Back-ends

The Spectral Processor is ready for use. It is being used this quarter for debugging and RFI measurements.

The Digital Continuum Receiver has been in regular use in the GBT Mockup to test receivers and other equipment for gain stability, temperature stability, etc. It is ready for general use.

It has been decided that we wish to do holography from the Gregorian focus, as well as from the prime focus. A Gregorian feed was designed, fabricated, and tested. The system is ready to go on the telescope.

The GBT VLBA terminal remains to be integrated into the system, and work is proceeding on this.

GBT Fiber IF System

The IF Rack was finished this quarter. It is undergoing tests in the GBT Mockup with the remainder of the IF system. This will continue until we break down the mockup to move the racks to the telescope.

GBT Servo System

The GBT servo system was tested this quarter. Aside from punch-list items, the servo meets the specifications. Tests are continuing as the telescope is completed.

GBT Receivers

The GBT Gregorian receivers are all complete, with the exception of the Q-band receiver. All the receivers have been refurbished and await installation in the GBT.

GBT Active Surface

The Active Surface software is in good shape. Some work remains in the interface between the Active Surface and the Metrology systems to allow calibration of the actuator using rangefinder data.

The major activity underway this quarter was testing and repairing failed actuator cables, and installing the active surface hardware.

The active surface room has been populated with all the controls for the actuators, and the process of connecting the actuators to the control panels has been completed. Power supply and communications wiring is in progress now.

System integration and testing should be completed in the fourth quarter of this year.

Q-band Receiver

Testing and characterization of the receiver has been done over the last quarter. Some additional testing and optimization will continue over the next quarter.

GBT Cryogenics

Work the past quarter resulted in all tubing runs being completed. Compressor construction has begun, and will continue for the next month. The system will be used to cool the receivers this quarter.

GBT Outfitting

The outfitting of the antenna has begun. The cables for the networks, telephone, intercoms, and other NRAO systems are in hand, and ready for installation at our first opportunity. Detailed plans have been made for these installation jobs, some of which have been done prior to the acceptance of the telescope.

Outfitting the receiver room, the active surface room, and the servo room will begin upon acceptance of the telescope from COMSAT.

OVLBI

This quarter we completed a number of repairs to the OVLBI tracking station.

Test equipment for troubleshooting the station was defined and some was purchased. This will help in increasing the station's reliability record, and reduce time to repair.

Plans for the next quarter are to work on increasing reliability and decreasing the time to repair the station. This process is helped along by the increasing experience of the OVLBI engineering and technician staff.

20 Meter

The 20 Meter was shut down this quarter.

85-3 and the Green Bank Interferometer

The control system on the Interferometer and 85-3 has been upgraded to use the GBT YGOR control system. This system shares a common software architecture and hardware platform with the GBT. 85-3 has been running this software for several weeks. The interferometer has been running now for a month, and performance is good. There is an occasional problem in the data acquisition software, and in the Glish interface. The system is scheduled to be shut down mid-October indefinitely, pending additional funding.

General Site Support

Engineering support was provided to the Astronomy Education Center project for RFI suppression issues. Engineering was supplied to the Interference Protection Group for an RFI monitoring station.

F. SOCORRO ENGINEERING

Electronics

Preventive Maintenance Program

Some significant or at least illustrative maintenance activities are listed below.

The estimated cost of repairing hydrogen maser #11 which failed last quarter has now tripled to $150,000 so that purchase of a replacement seems the only viable option. We anticipate reclaiming the pieces for spares and possibly for initiating a repair capability in-house. Maser #4, which was repaired earlier this year but failed anew, remains at the factory awaiting further repair. As a result of the two failures, the observatory has no spare masers.

Delivery of an amplifier for installation of solar calibration on a new Q band receiver is now delayed until next quarter. The solar calibration procedure has been simplified through the combination of the measurement and control computers into a single laptop, but questions remain about the utility of the data produced. A review of the procedure to insure that the most useful calibration data are produced is a goal for the 4th quarter.

The thorough audits of the VLA "wye" monitor system and the on-line alarms have led to improved interpretation of alarm conditions and a list of tasks to clarify alarm causes and responses. For instance, VLA antenna power failures are most often caused by lightning-induced glitches in the fire alarm reporting. Work is scheduled for the 4th Quarter to separately identify a glitch-induced power failure from a bonafide fire report.

High system temperatures were noted on new wideband K band receivers at the VLA during certain atmospheric conditions. The problems were at first thought to be caused by condensation of moisture introduced through tiny weep holes in the feeds, but installation of a static dry air system has not solved the problem. Further investigation may point toward the need of a dynamic dry air system for the feeds which would require special funding. Since the problem occurs only infrequently and then seasonally, the response has been given a lower priority than other work.

A laptop test unit was devised to test the VLA Antenna Control Unit (ACU) to replace a cumbersome and failing test unit provided for the array 20 years ago. Further work is planned which will combine the ACU test laptop with a separate laptop used for testing servo performance.

The new systems controller for the VLA correlator has been successfully tested in several modes and is nearing an important milestone in its development, the "self test," a key requirement for correlator operation. The goal is to complete self test operation by year's end.

Final checkout of a spare L28 module for the VLA was completed, a critical step because that timing module was until now a "single point of failure" for the VLA.

Failure rate of the head position control modules for the VLBA tape drives was reduced through selection of a higher voltage drive resistor. The shuttling fixture used to configure new and repaired heads was restored to working order. A study of head stack failures uncovered a missed measurement in head alignment; with confidence restored in the triple cap design, additional headstacks have been placed on order. Finally, new tape offset parameters have proven repeatable and reliable; the offsets will help with interdrive compatibility, especially where speeds are changed.

To routinely provide observing schedule information to outside agencies for use in frequency coordination, a new computer program was built to extract pertinent data from existing databases. What took several days to compile in the past now can be generated automatically.

Installation of the wideband IF filters at the VLA has brought attention to T2-to-T2 modem flatness, equalization issues, and DC offsets in the back-end synchronous detectors. All 3 problems areas are being addressed during maintenance time.

The Atmospheric Phase Interferometer (API) for the VLA is being completely rebuilt by a Tech student. The hope is to provide a stable instrument for use during A array.

Projects

VLBA PT Link

The essential goal for 2000 is to provide the link to Pie Town for observing at high resolution during the VLA "A" configuration in October 2000. Work accomplished this quarter to meet the goal includes construction and checkout of additional spares and the design, construction, and installation of a circuit to permit delay of a "data invalid" correlator condition which had been compromising a significant amount of data before the correction.

New Receivers

An essential goal is to assemble and install an additional six Q-band receivers and four low noise K-band receivers on the VLA in 2000. One of each type of receiver was installed this quarter leaving three Q-band receivers and two K-band receivers for installation in the fourth quarter. Repair work on existing receivers has delayed the construction schedule this quarter, but we hope the hiring of two new specialists for the Front End Group will permit us to meet both maintenance and construction goals.

An additional essential goal is to install two new W-band receivers on the VLBA for a total of six functional receivers by year's end. W-band receiver #3 was successfully rebuilt this quarter with new MAP amplifiers and the redesigned "Y" coupler. Both #3 and a new W-band receiver #5 show dramatic improvements in temperature performance with system temperatures approaching the individual amplifier performances. Some problem areas addressed this quarter were soldering defects in a transition piece, a weak joint in a transition piece, using higher amplifier bias voltages to compensate for low output from the doubler, a polarizer repair, a leaking hermetically-sealed connector, and a failed amplifier. All F117 modules will have to be re-modified to provide the higher bias voltages now required. Receiver #3 has been shipped to Kitt Peak and #5 to Owens Valley for the CMVA run in October. Receiver #6 is scheduled to be shipped to Kitt Peak in the next quarter.

Upgrade for the Pulsar High Time Resolution Processor (HTRP)

A NM Tech project, the HTRP upgrade has been supported by NRAO in part. Two "on-sky" tests of the pulsar system this quarter have proved the prototypes; pulsar measurements were actually performed successfully in the second test. As a result, release of the 200 MHz FADC for printed circuit board construction is expected early next quarter. The design of an updated VME timing card is complete and parts on order. Construction of both FADC and VME boards next quarter is expected to complete NRAO's participation in the construction of the project.

VLA Expansion Project (EVLA)

Measurements of RF emissions from correlator and sampler modules at Green Bank and CV will help prepare an appropriate response to anticipated RFI from EVLA modules. The RFI Environmental Monitoring System was placed into use, currently monitoring 1 - 2 GHz at the VLA.

Initial "handshake" problems between a VME controller and the VLA serial line controller were identified and corrected this quarter. The two-port serial line controller (SLC) is now available for development of software control modules for the VLA, a first step in replacement of the Modcomps.

An EVLA system block diagram under preparation now includes more detailed diagrams for the top level drawing, 1st LO generator, 2nd LO Synthesizer, Offset/Fringe Generator (DDS), and the Digital IF Fiber link (digital and optic boards).

An important goal for 2000 loosely connected to EVLA is to extend the existing 200 MHz VLA IF to 300 MHz by means of wider front end filters. Only 2 antennas remain to be modified to complete the hardware phase of the project.

K-band Water Vapor Radiometer (WVR)

The test stand was updated with a new computer to permit a faster sampling rate, among other things. A new precision voltage source proved that the existing voltage-to-frequency converter used with the instrument should have sufficient stability after all. Maintenance of existing receivers will preempt any further work on this project for the time being.

VLBA Panel Adjustments

An essential goal and auxiliary project for the VLBA W-band receiver installation is adjustment of the VLBA main reflector panels. To that end, a low cost microwave holography panel measurement system has been devised using a small (30" - 40") reference reflector antenna. The antenna was mounted on the VLBAPT antenna this quarter and used to receive a beacon from a geostationary earth satellite. A back-end data acquisition system was completed to correlate the reference and VLBA antenna signals for the holography measurement. A full-up test of the system is now scheduled for the 4th Quarter.

High Density Recording Rates

To improve the SNR of faint objects, formatter expansions at the Fort Davis, North Liberty, Los Alamos, and Mauna Kea were completed this quarter for a total of 7 modified sites. Two more sites are scheduled for completion by the end of the year; St. Croix will not receive the modification. The hardware modification will permit use of a 512 Mbps recording rate by using two tape recorders simultaneously, once software and operational issues are resolved.

Engineering Services

Operation and Maintenance

Array reconfiguration to the D-array was accomplished along with the overhauls of Antenna 11 and Antenna 25. During the overhauls, ES Division retrofitted the access platforms for the pedestal room a/c unit; installed EL hardstops; modified EL encoder mount and added an encoder weather enclosure; relocated AZ limit switches; installed feedcone segments and new receiver mounts; and, enlarged holes on transporter lift pads. Elevation cable wrap modifications to improve disconnection of power and control cabling at the elevation axis were installed. VLA encoders were disassembled and rebuilt, then bench tested to meet original specification. Antenna Pad Mounting Plates on AN-2 and AN-3 were realigned to facilitate the placement of antennas on these foundations.

Successful Tiger Team visits to Kitt Peak and Fort Davis were made in July and August respectively. Installations of VLBA apex handrails, Elevation hardstops, rotation of AZ bearings and several other maintenance tasks were completed. EL platform extension and AZ bearing rotation projects were finished this quarter with the Fort Davis visit. Trips were made to North Liberty, Kitt Peak and Owens Valley to install 3mm receiver mounting hardware. 3mm receivers will be installed as they become available.

Mechanical

Antenna Mechanics

In addition to two VLBA tiger team visits (KP & FD) and two major overhauls to VLA Antennas (#11 & #25), the mechanics continue fabricating and painting the VLA and VLBA Apex Handrails. Apex Handrails are installed on Antennas 1, 9-12, 15-17, 21, 3-5, 18, 19, 24-28, KP, NL, FD, and PT. The Fall Arrest system is still awaiting approval by the Safety Office. Approval is expected next quarter and Fall Arrest system installation will begin. The new VLA antenna dish access "Hatch Ladder Grab Bar," which makes climbing into the antenna dish easier and safer, has been approved. The new hatch bar has been installed in Antennas 11, 17, 2, and 25. This task has been incorporated into the VLA antenna major overhaul. Dish panels were readjusted on Antennas 17 and 23. Scheduled antenna preventive maintenance tasks on FRMs, bearings and gears were completed in both the azimuth and elevation axis'. One AZ VLBA drive wheel assembly was repaired in preparation for the next replacement when necessary.

Painting on Antenna 17 was completed this quarter, bringing the total to two painted antennas for this year thus far. Spot paint repairs were made to Antennas 23, 16, 7, 20, and 22. Enough paint was saved through a change in painting techniques on Antenna 17, that one additional antenna can be painted this year. The third antenna to be painted is Antenna 6. Antenna 6 is currently being water blasted in preparation for painting and should be finished next quarter. The paint crew temporarily broke from antenna painting in order to paint the Control Building stairways and the balcony. Paint Booth operations continue to paint all antenna fabricated parts such as apex handrails, junction boxes, feed towers and VLBA platform extensions.

Post reconfiguration transporter maintenance was completed. A Vickers hydraulic pump tester was finished, which revealed that the majority of the main hydraulic pumps perform poorly. With six pumps total (three on each transporter) only two tested good, one tested borderline and the remaining showed poor performance. Maintenance efforts are under

way to make improvements to the pumps. Additionally, maintenance was required on Transporter #1 Detroit and Onan generators, which resulted in replacement of a generator, regulator, and a fuel cut-off switch.

Electrical

Servo

Corrective and preventive maintenance of antenna servo systems continue. Minor changes to the new encoder upgrade were made and major components have been ordered. Encoder schematics are finalized and the encoder design is published on the web for other observatories. Encoder boards have been finalized and their fabrication ordered. In-house assembly of encoder boards is expected to begin in the 4th quarter. Encoder overhauls consisting of bearing replacement and realignment continues during regular antenna overhauls. Additionally, to improve pointing error, a new alignment procedure during encoder antenna installation is being carried out. In conjunction with Electronics Division, the Servo Shop finished building a new Antenna Control Test Unit (ACTU) which will test the antenna servo control system and will record servo test data.

HVAC

Corrective and preventive measures continue while upgrades to VLBA contempo HVAC units come to an end with Fort Davis. For the sake of uniformity, several VLBA sites will still need minor component changes. Final documentation and schematics of as-built HVAC systems is underway and is expected to be completed in the next quarter. Several Control Building chiller problems associated with recovery from power outages have been addressed.

Electrical

Several preventive maintenance tasks were completed this quarter, including monthly inspections of antennas, HVAC and electrical systems, and lighting PMs. ALMA work is underway. Office spaces have been rewired and all ALMA site electrical material has been ordered. Antenna site electrical work will begin in the 4th quarter. The Electrical Group has provided antenna move support Generator operation, Lightning Protection System PMs and several maintenance tasks were completed. New procedures for VLA generator operation have been implemented. These new procedures, in general, call for automatic startup of generators during power outages. The existing power/phase loss detection equipment will determine when the generators should start up. Generator governor controls have been upgraded, making transfers to and from utility much smoother than before. Site lighting diagrams have been received and upgraded.

Site & Wye

Grounds

Waveguide Lightning Protection System repairs are at a standstill due to higher priority work and equipment failures. The steering on the old Huber grader is broken and there are no longer parts available. East arm Lightning Protection System (LPS) is complete. A grader has been borrowed and LPS repairs are expected to be complete in the 4th quarter. Herbicide for brush and weed control was applied to all D and A array stations prior to the antenna moves. Routine landfill and roads maintenance was performed and anode beds were watered and maintained as scheduled.

Carpentry

The Control Building stairways have been restored and the Carpentry Shop has built two new offices at the CB Annex. Three other offices were modified and restored for use by ALMA personnel. A total of five offices will be available for use by ALMA personnel in the CB Annex. In preparation for ALMA construction crew use, VSQ #3 patio and walkway have been repaired.

Track

Track has been leveled and aligned from CN-9 through BN-5 and from BW-5 through BW-6. Bad tie clusters were replaced on the west arm from BW-6 through AW-9. The track pre-move inspection is complete for the Antenna A-array reconfiguration. The newly acquired Jackson Track Tamper was used to level track on the west arm. Minor "lining" problems with the tamper are being worked out. Once these problems are taken care of, the tamper will be used to line and level track. Use of this machine in leveling has already saved many man hours on track work.

Vehicles

Vehicle PMs and repairs are continuing as needed. Jackson Tamper repairs were made to the newly acquired tamper and spare parts were ordered. The yellow MC-9 bus began "making oil," so the engine was pulled. The heads were removed for repairs (at a cost of $1800) and have been returned. The mechanics are in the process of re-assembling the engine for installation. The blue MC-9 is now leaking coolant from both radiators. Cost of each is approximately $1K. One mechanic and two others traveled to California for a bus inspection of two buses that were found on surplus screener. The surplus buses were rejected due to excessive wear and tear.

Engineering

Machine Shop

Components for three (#23-25) Q-Band receivers were fabricated and eight Q-Band feed mount gimbals (#15-22) were finished in the Machine Shop. K-Band feed mount gimbals (#21-28) and W-Band Front Ends parts (#5-6) were also fabricated. Additionally, the Machine Shop resurfaced a VLA armature, repaired recorder head blocks, fabricated model 22 cold head first stage disp caps, fabricated RFI tower J-box mounting brackets, modified 86 GHz card cage backs and handles, fabricated a 2 cm holography receiver mount, tachometer testing brackets, and W-Band short loads Numerous other miscellaneous parts were made as well. The Machine Shop also was used extensively for emergency repairs of equipment and tools used on the site.

Drafting

Drafting continues working with ongoing projects such as updating site utility drawings, Raster to Vector conversions are 75 percent complete. Elevation Encoder Coupling, HVAC Antenna Walking Platform modification, and Antenna Grab Bar drawings were completed. Updating of the VLBA and VLA HVAC schematics currently are underway. The "manual drawing" file list is being placed on a computer database and this work continues when time permits. Drafting miscellaneous work included support for printing and design projects to VLA staff, PRA (Personnel Recreation Association) duties and employee good-bye photo posters. More current drawings were placed on a web page.

Engineering

Dichroic panel material for three spare VLBA Dichroic panels is being ordered. A summer student, Steve Ball, was recruited and assigned to work with Jim Ruff in building an optical telescope. The optical telescope was built in this quarter and will be used to measure antenna-pointing efficiency. It also will be used as an aid in pinpointing causes of pointing errors. The first on-antenna data collection with the telescope is expected by the end of the 4th quarter. Another summer student, Melanie Clarke, was recruited to work on an antenna ray-tracing program that may be used for VLBA holography and subreflector measurement. Melanie reduced existing photogrammetry data, which now is in a usable state.

In areas of safety, VLA/VLBA Antenna fall arrest development continues and is expected to be completed in the 4th quarter. The design and location of apex tie points for employees to tie off while working at the antenna apexes is underway.

Q-band and K-band receiver supports were redesigned for easier access to the receivers. Redesign of the L-Band polarizer window ring for Electronics Division was made for a proper fit. Engineering work on the ALMA Bins and Modules in preparation for fabrication is in progress. A prototype grab bar for accessing the VLA dishes was installed on Antennas 1 and 11, and underwent successful testing. The grab bar installation has been added to the overhaul schedule. ALMA site layout, design and the ordering of materials is complete and work on the site should begin next quarter.

Miscellaneous work accomplished in this quarter: AOC HVAC Damper installation by Trane was overseen and is complete. An AOC noise survey was made and improvements were made to the HVAC system that significantly improve the auditorium noise problems. VLBA SC painting for the year 2000 is completed. Material for the touch up and repair of the spare VLBA subreflector has been specified, ordered and received.

Administrative

Scheduling and Safety

The A array move schedule has been prepared and issued. Coincident to the preparation of the move to the A array, sections of track were repaired as needed; all designated station foundations were inspected and repaired as needed, both transporters were serviced and are ready for the moves. Coordination of antenna receiver installations and planning of VLBA maintenance visits have been done and will continue into the fourth quarter. The process of linking preventive maintenance and other work procedures with the MAINSAVER program were started and will continue into the fourth quarter. We completed 80% of the links for the Antenna Mechanics. However, they have no access to the VLA server where the procedure files are located. Currently, the VLA server is only accessible to employees at the VLA Control Building. All employees are expected to be linked to the server by the end of next quarter.

We performed the VLA semi-annual site safety inspection on August 7. The eighteen items uncovered have either been corrected or scheduled for correction. Housekeeping around all the shops had improved greatly since the last inspection. Safety awareness sessions were held on Decision Driving Practices, Work Hazard Identification and Reporting and Emergency Evacuation Planning. Six employees received certification on operation of aerial lift, forklift and rail vehicles. All hazardous waste solvents were gathered and carried off by an EPA authorized collector. Twenty-seven accidents/incidents are recorded to date. Seventeen are from within ES Division.

Administration

The 10-hour/day summer work schedule is finished for the year at the VLA. The ES Division "End of Summer" party was organized and held. Two employees completed training in Heavy Equipment Operation and two completed welding certifications. Monthly staff coordination and project meetings were conducted, with division heads, supervisors and engineers to plan, schedule and review ongoing work effort. Preparations were made for the visit and tour for the NSF Director, Rita Colwell. Prepared ES Division budgetary, attendance, monthly, and quarterly reports. Preventive Maintenance procedures continue to be entered into the Mainsaver maintenance database. Lew Serna and Jon Thunborg attended the Scientific Retreat held at the AOC in Socorro. A VLA Server "Dyonisos," has been installed in the Control Building. Employees are currently being linked to the new server.

One new Temporary Full Time ALMA Laborer (Carl Oler) was hired for ALMA work.

2000 Fourth Quarter Goals and Objectives

1. Repair of the Visitor Center roof will continue into the fourth quarter. Bids received by the State of New Mexico were too high: $10,000 being the limit and $13,000 the lowest bid received. A letter has been sent to the State to reaffirm our need, and we expect the State to complete repairs.
2. Continue installation of K and Q-band receivers on VLA antennas as they become available.
3. Fire alarm system repairs - an earlier study reveals several dysfunctional building panels needing repair or maintenance to return to proper operating conditions. This task coincides with the recent relocation of the main fire alarm control panel in Operations.
4. Design and install remote start/stop function onto VLA Operations touch screen console which will allow Operators to remotely start or stop VLA power generators during commercial outages.
5. Antenna drive motor tachometer generator replacement - a prototype design development to improve operation and reduce failure rate of motors due to brush wear.
6. Test transporter limp pump system - designed to recover from main hydraulic pump failure of transporter. Evaluation of improvements made on the system continues.
7. Begin work on VLA Vertex Room mock-up for EVLA.
8. Vehicle and equipment repairs as needed.
9. Redo exterior stucco on Guest House.
10. Install motor starter on Transporter 1.
11. Complete Waveguide LPS Repairs.
12. Provide Confined Space and High Angle Rescue training.
13. Complete two K-band feed towers.
14. Finish fabrication of all Apex Handrails.

15. Design and Fabricate VLA Elevation Motor hoist mount.
16. Begin Installation of VLA Fall Arrest.
17. Finish Fabrication of Hatch Ladder Grab Bars.
18. Prepare ALMA site for Underground work.
19. Lay ALMA underground conduits for power, fiber, telephone.
20. Place ALMA Transformer and Switch Pads.
21. Complete repairs on MC-9 Yellow Bus.
22. Complete repairs on Jackson Track Tamper.
23. Complete repairs on Transporter pumps.
24. Finish painting Antenna #6.
25. Finish Antenna Panel Adjustments.
26. Complete OSHA confined space and high angle rescue training.
27. Complete "Torch Cutting and Cylinder Handling" training.
28. Prepare preliminary budget for Year 2002.
29. Link all employees to server.
30. Complete modification to CB water pump.
31. Complete HVAC upgrade documentation (VLBA).

G. TUCSON

Closure of the 12 Meter Telescope

The 12 Meter Telescope began life as the 36 Foot Telescope, the telescope responsible for the birth of Millimeter-wavelength molecular astronomy. Its history is one of success, innovation, and an unparalleled desire by the staff operating this facility over its 32-year lifetime to provide a high level of service to the astronomical community.

The 36 Foot Telescope made its first millimeter-wavelength astronomical measurements in October 1968. This was the start of a period of explosive growth in this new area of astronomical research, during which most of the dozens of molecular species known to exist in the interstellar medium were first detected with the 36 Foot.

In the early 1980s the telescope's reflecting surface and surface support structure were replaced and in 1984 it was re-christened as the 12 Meter Telescope. Its scientific program subsequently evolved from one dominated by astrochemistry to a broader mix of studies of molecular clouds and Galactic star formation, evolved stars, astrochemistry, and external galaxies.

The 12 Meter Telescope was the only millimeter-wavelength telescope in the U.S. operated full-time as a national facility. More than 150 visitors used it each year. It offered users flexibility and the opportunity to respond quickly to new scientific developments. Its low-noise receiving systems covered a wide range of frequencies (all atmospheric windows from 68 GHz to 300 GHz) and much attention was given to making the instrument work reliably throughout this range. Flexible spectral line and continuum back-ends allowed the observer to match the instrument to the scientific goals. The development of multi-beam receivers and the on-the-fly observing technique inaugurated a new era of high-speed source mapping on angular scales complementary to those of the millimeter-wave interferometers. The telescope control system offered great flexibility and provided a proven remote observing capability.

On February 22, 2000, NRAO announced that it would close the 12 Meter Telescope at the end of the current observing season. On July 26, 2000, the 12 Meter Telescope made its final astronomical measurements as a U.S. national astronomical facility. The final data set was an on-the-fly image of the CO (1-0) emission from a star formation region in the Cygnus-X region (see figure). On August 1, 2000, NRAO loaned the 12 Meter Telescope and associated equipment to the University of Arizona for a period of six months. It is anticipated that a consortium led by the University of Arizona will submit a proposal to the National Science Foundation requesting funding to continue operating the 12 Meter Telescope. During the six-month period of the loan, ALMA prototyping tests which were scheduled before the closure announcement will be made.

All Tucson employees now work for the ALMA project on development tasks involving antenna design, electronics and receiver development, imaging and calibration studies, and site characterization.

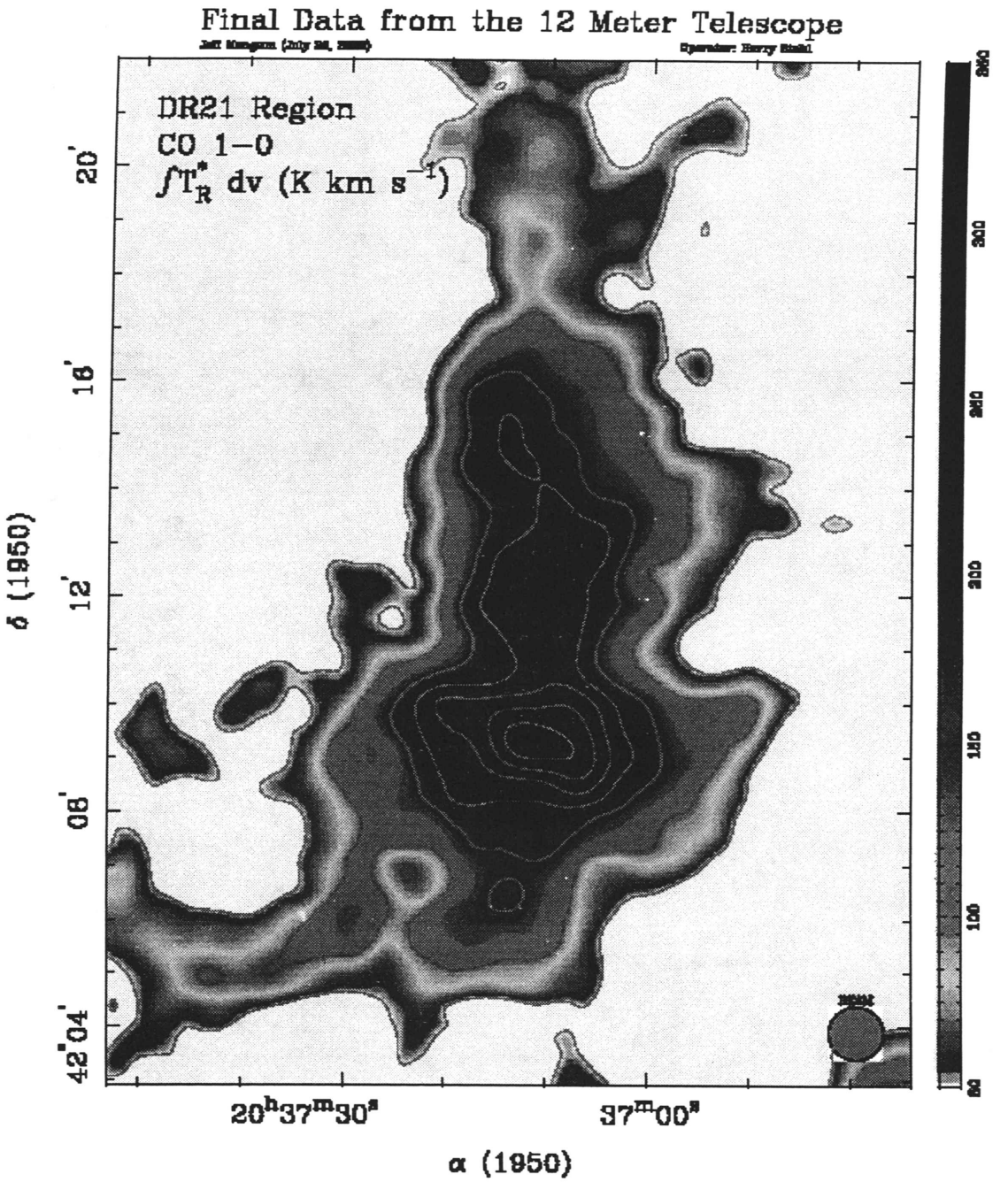

Figure 1: On-The-Fly image of the integrated CO 1-0 spectral line intensity from the DR21(OH) molecular cloud.

H. DATA MANAGEMENT

Data Management Initiative

The Data Management initiative has concentrated on planning activities and the preparation of proposals for the National Archive for Radio Astronomy, and the National Virtual Observatory. The progress towards goals for 2000 is as follows:

Essential:

- Establish core management team - The core team has been established and is in place. Cornwell is Associate Director for Data Management, Hunt is Deputy Assistant Director for DM/Telescope Management, and Kemball is Deputy Assistant Director for DM/Technology development. Hunt is responsible for overseeing systems support throughout the Observatory.
- Develop Data Management Plan for Observatory addressing data handling for all NRAO telescopes, including objectives for data handling, roadmap for reaching objectives, and management processes - Planning is in progress. A white paper describing overall activities is in place. Documents on management processes and initial developments are in progress. These documents are being constructed by the Data Management Executive Committee composed of all telescope computing managers and all computing project managers, as well as the core DM management team. This group is working very successfully on establishing consensus on the best practices to be used in managing DM activities.
- Pursue sources of funding for data management objectives - In progress via the Observatory budget for 2001, the NRAO participation in the proposal for a National Virtual Observatory, and in the proposal for a National Archive for Radio Astronomy.
- Participate in NSF proposal for a National Virtual Observatory - In progress. NRAO is a member of the ad hoc Interim Steering Committee that is preparing a proposal to the NSF ITR program and a concept paper for submission to NASA.
- Develop community-based proposal for a National Archive for Radio Astronomy - In progress. White papers on the structure, computing, and management of NARA have been developed in conjunction with NCSA and NAIC. These have been presented in a variety of forums, and have been distributed to key members of the radio astronomical community for comments. We expect to submit a preproposal to the NSF CISE/ITR program in late November 2000, followed by a full proposal in April 2001.
- Review EVLA and ALMA activities for compatibility with data management objectives - In progress. EVLA activities are aligned with overall DM goals. Discussions are in progress with the ALMA project to align the computing work required for ALMA with that expected for the DM initiative.
- Develop Observatory-wide budget for 2001 - Done as part of the Observatory-wide planning.

Important:

- Conduct audit of existing resources and assets, ongoing plans and commitments, and accomplishments over last three years - This has yet to start in earnest.
- Establish Data Management Executive Committee composed of relevant computing managers to aid in execution of data management goals - Done.
- Establish Data Management Scientific Working Group composed of scientists to advise on and help achieve data management goals - Done. The Project Scientist is Frazer Owen. The group meets monthly.

Computer Security

One of the provisions of the NRAO Computing Security Policy is to minimize potential intrusion paths by blocking services which are known not to be required outside of the NRAO. At both Green Bank and Charlottesville, the routers which connect us to the Internet are now compliant with this: unless access to a service has been identified as necessary

and is explicitly permitted, network traffic attempting to make use of it will not be allowed through. The Array Operations Center in Socorro, and Tucson, are very close to this point; careful analysis of network logs must be completed to ensure that all necessary access has been accounted for.

Goal: Bring AOC and Tucson routers into full compliance with the policy during the next quarter.

Networking

In June 2000, the NSF made an award to the New Mexico Institute of Mining and Technology (NMIMT) and the University of New Mexico for a connection to the high-speed Abilene network. As part of this work, the Internet link shared by NMIMT and the NRAO in Socorro will be upgraded. The work, which is being carried out by NMIMT, is progressing and it should be operational around the end of October. This connection will provide the AOC with a 45 Mbps link to Abilene and the vBNS+ network, about 15 times the speed of the current Internet connection.

Goal: By November 2000, upgrade the link between NRAO and NMIMT from 10 Mbps Ethernet to 100 Mbps, to allow us to take full advantage of the increased bandwidth.

Videoconferencing is now routine for regular internal meetings, and was recently used very successfully in Socorro to allow other NRAO sites to be involved in the VLA 20th Anniversary celebration. Of particular interest to the external NRAO community is the ISDN gateway in Charlottesville, which is now available; this allows non-NRAO sites with ISDN video capability to participate in videoconferences with any (or all) of the four major NRAO sites. To date, this feature has been used by collaborators in Japan and Germany with very good results at 128 Kbps. Some enhancements to the videoconferencing remain to be done, including electronic whiteboards and outfitting of auditoriums in Socorro and Green Bank to better accommodate remote presentations.

Goal: Order remaining equipment and complete videoconferencing setups at all four major sites by the end of the next quarter.

System Administration Workshop

From August 14 to17 in Socorro, the NRAO held a very successful workshop on system administration, similar to the one on real-time computing held last year. Nearly all NRAO staff members with some level of involvement in system and network administration attended the workshop—more than 20 people in all.

In addition to the fact that the work of almost every NRAO observer, visitor, and staff member relies in some way upon the services provided by this group, several major projects involving them are either underway or in the planning stages. These include Windows 2000 deployment; implementing the Computing Security Policy; improving web services by "mirroring" the NRAO web pages across multiple sites; and reducing differences in the configuration of UNIX environments across the NRAO from both user and system perspectives, which in turn will improve system dependability. All of these have broad impact on our user community, and require significant coordination and cooperation—and hence good communications—among the administrators at every site. The workshop provided a valuable forum for discussion and setting directions for these projects. We hope to hold another such meeting in 2002.

Goals:

- By October 2000, form working groups whose members will carry out the major projects described above (where one does not already exist).
- By November 2000, determine the tasks and the effort required to accomplish them; develop timelines and assign tasks to members of the working groups. Put procedures in place to monitor progress on a regular basis.

Green Bank Computing

In 1998, it was clear that the network infrastructure in Green Bank, and in the old Jansky Lab in particular, is insufficient to support the data rates expected with the GBT. Further, to avoid problems with radio frequency interference (RFI), we need to use fiber rather than the more common, and inexpensive, unshielded twisted pair (UTP) cable. We were able to acquire the fiber in 1998, but not the Ethernet switch to support this new medium. We were given funds this year to acquire the switch, so we have begun the process of installing the cable. At present, fiber cable has been installed on the second floor of the Jansky Lab. When manpower is available, we will install the cable on the first floor and in the Residence Hall. This will probably not now be until the first quarter of 2001, because the outfitting of

the GBT clearly has priority. The Ethernet switch, to be delivered in December 2000, will allow us to connect the two wings of the Jansky Lab at 1 Gigabit/sec.

We have made the decision to move all of the server class machines to space in the shielded area of the Jansky Addition. This will include the Unix computer and file servers, the Windows NT servers, the Windows Domain Controller, and the AS400, which is the main business computer. In this area alone, we are prepared to depart from our policy of using fiber cable. The new AS400 to be acquired later this year and its associated Windows NT server will have shielded twisted pair (STP) connections to a dedicated UTP unmanaged Ethernet switch. This will substantially reduce the cost of the acquisition.

We have completed the installation of a new Windows NT server to support the use of the personnel and payroll software package by the Fiscal and Personnel divisions at all NRAO sites. With direct connections to the server over the Intranet, users in Socorro found that the performance was unacceptable. We have therefore installed a dual-processor Citrix server to run the application and to serve the displays to the remote users.

In order to provide the GBT with a computer with multiple displays, we are investigating the possibility of dual- and quadruple-graphics cards attached to PCs running RedHat Linux.

We have installed a new server which will run the maintenance database (MainSaver) applications to track GBT repairs. The software is also installed and will be fully deployed next quarter.

We have installed two new color printers. One of our old greyscale PostScript printers failed, and was replaced with a color model for use by the GBT operators. The second was provided by the ALMA project, so that the engineers in Tucson could print directly, via the Intranet, to a printer in the machine shop.

Socorro Computing

New Hardware

The AOC has replaced the Ultra-1s Acoma and Laguna, our slowest public workstations, with two new dual processor 800MHz Pentium-III systems, named Alcor and Mizar. The new machines also have 500 MB of memory and 29 GB of available disk. The Ultra-1s will replace slower desktop machines.

A number of old and unreliable tape drives on public systems were replaced; in all we purchased and installed five new Exabyte drives and three new DAT DDS-3 drives.

Networking and Communications

The PC network upgrade is approximately 95 percent complete. All Windows PCs except for a few in the Electronics division open areas have been converted to switched Ethernet. The remaining systems will either be left as is because of wiring restrictions or converted by early October.

The AOC-VLA communications upgrade is also 95 percent complete. The obsolete DDS and Codex hardware at each end has been replaced by one (AOC) or two (VLA) access servers, greatly increasing the reliability of the connection. A small but positive side effect of the removal of the old hardware is an increase in the available T1 bandwidth by about 10 percent. Dial-in modems on the VLA side allow an alternative connection in case of T1 link failure between the VLA and the AOC. Instructions for use of the servers will be made available on the Web by the middle of October.

Systems Support

The AOC plans to upgrade most Unix systems to use SSH version 2 in the near future. SSH is a replacement for RSH which provides an encrypted connection. After the conversion remote access via unencrypted shell connections will be restricted. We are developing documentation to ease the transition from RSH-style commands to SSH. There will be more detailed information available as we get closer to the changeover.

Testing at the AOC of the new Unix printing system CUPS has begun. CUPS is already in use in Charlottesville. The new system will be more stable than the current one, and will also allow a wider variety of document formats such as PDF, TEX, DVI, JPEG, etc. to be sent directly to the printer without prior conversion to Postscript. CUPS will be available in October for those who wish to assist in testing; final conversion will take place later in the year.

VLBA Support

In the Operations Management System (OMS) project, the correlator management tools intended to replace the functionality of the existing tools (cjobs, et al.) have been turned over to the correlator operations group for testing. This includes tools for correlator queue management, queue resolution, report generation and on-site tape determination. Parallel testing of OMS and cjobs will begin the final week of this quarter and is expected to last several weeks into the fourth quarter.

VLA Support

In July, we released the first version of JOBSERVE allowing preparation of observe files for VLA observations involving the Pie Town antenna. This version also included a number of bug fixes. Further testing by NRAO staff is in progress, and we expect to release another, improved, version of JOBSERVE in October.

EVLA

Timelines and possible scenarios for development of the EVLA were discussed, with emphasis on the special factors introduced by the hybrid array. Formulation and analysis of possible architectures for the EVLA software were begun. A reasonable beginning has been made on the development of an antenna class, and work has started on the positioning of that antenna class within a larger system context. Some modeling of the LO chain was done, and time was spent on an analysis of the proposed WIDAR correlator. Evaluation of enabling technologies for the EVLA Archive (XML, FITS, ORDBMS) has begun.

In the correlator controller project, tests of the system controller were concluded successfully, shifting the focus of our attention to its second component, the array processor. First test results of the array processor are encouraging. Good progress was made on the Serial Line Controller, which will enable communication between the new system and the old (not yet upgraded) antennas. Most tests were performed on a SLC simulator test bench at the AOC.

In September 2000, Steve Blachman, the leader of the Array Support Group and designer of the EVLA online system, left NRAO. Plans to refill this position are ongoing.

User Support, Miscellaneous

The AOC hosted the first NRAO Systems Administrators workshop in early August. The workshop marked the first time virtually all System Administrators from the major NRAO sites were able to meet and discuss future plans. The primary focus of the workshop was to initiate work on standardizing NRAO-wide computing practices. Plans are to make significant progress in this area during this winter when our major operating systems (Sun Solaris, Linux/Redhat and Microsoft Windows) are scheduled to be upgraded.

Goals for Fourth Quarter, 2000

Items to be completed:

* complete new VLA-AOC communications documentation
* Install CUPS printing system
* Remove old server Arana from service
* Order and install additional Videoconferencing equipment
* Upgrade remaining Linux systems to RedHat 6.2
* Gain expertise with Solaris 2.8 and make installation plan
* Make router filter lists for security purposes
* Parallel testing of OMS and cjobs; evaluate test results
* Complete serial line controller interface
* Develop software layer between synchronous VLA antennas and the EVLA asynchronous antenna class software

Items to receive serious attention:

* Install dedicated Web/ftp server
* Exhaustive cleanup of system files
* Continue tests with CORBA
* Correlator controller: testing of array processor code
* Construct a prototype C++ antenna object.

I. AIPS++

In the last quarter our major achievements were to support the first and second public releases of AIPS++ (versions 1.2 and 1.3), and to prepare the third release (version 1.4).

As described in the last quarterly report, the AIPS++ Goals for 2000 are as follows:

E 1. Support the existing releases (1.2 and 1.3) of AIPS++ by NRAO, consortium, and astronomical users.
This continues and has taken about 25 percent of our time. We expect to increase this to about 30 percent in order to keep up with the slowly increasing flux of defect reports and requests for help.

E 2. Support GBT commissioning and first scientific observations.
This continues. We believe that we are well situated for the expected commencement of GBT commissioning in November 2000.

E 3. Issue two main releases (1.3 and 1.4) of AIPS++, improving the completeness of scientific capabilities and thus broadening the user community.
Version 1.3 is released and being shipped. Version 1.4 is due to be shipped in late October, and is on schedule for this date. Version 1.4 will have as the major deliverable the possibility of end-to-end processing for VLA data. Our target is to release 1.4 at the ADASS meeting in Boston on November 13.

E 4. Provide simulation capabilities for ALMA within AIPS++, including construction of data sets with simulated errors, calibration and imaging, and evaluation of imaging performance.
Work on adding pointing errors has be delayed and will be done during the last quarter, concluding our work in this area for this year.

E 5. Coordinate development of calibration and imaging pipelines within AIPS++.
A coordination meeting was held in Socorro in late January. This served to align the work going on at different AIPS++ sites. Further coordination has continued this quarter.

E 6. Develop a plan for constructing an NRAO-wide Data Management System based on AIPS++, designed to deliver complete data products that make NRAO telescopes more accessible to astronomers, and incorporating the university community into the production, analysis, and archiving of these data.
Complete. A plan was presented to the Director, and after some modification, was accepted. An Associate Director for Data Management was appointed May 1, with responsibility for drawing up a Data Management plan. Further goals and progress in Data Management are given elsewhere.

I 7. Complete AIPS++ such that processing of mainstream VLA and VLBA observations can be accomplished entirely within AIPS++.
This is ongoing. For the VLA, end-to-end processing of data is now possible. Data editing has been substantially improved as a result of a close collaboration with a group of testers at the AOC. Work on the VLBA is currently deferred.

I 8. Coordinate with the VLA Upgrade Project, the use of AIPS++ facilities with the upgraded VLA.
We contributed a section on computing for the VLA Expansion proposal to address these issues.

I 9. Develop a prototype calibration and imaging pipeline for the VLBA with the goal of simplifying use of the VLBA by non-experts.
This activity is continuing via the development of AIPS++ scripts for the reduction of known data sets.

I 10. Develop visualization capabilities inside AIPS++ using already secured NSF grant, with the goal of aiding processing of radio-astronomical observations into scientific results.
A mini-workshop of all AIPS++ visualization developers was held in Socorro in September. This was very useful in transferring knowledge and in determining plans.

D 11. Issue developer's prerelease of AIPS++ for development of new AIPS++ on limited and controlled platform, thereby expanding the pool of available developers outside the existing consortium.
This has been deferred until after the release of 1.4. Hence we now expect this pre-release to occur in late 2000.

D 12. Conduct outreach initiative to publicize AIPS++ and to educate new users.
We gave a number of presentations at the NRAO synthesis imaging workshop: a talk on AIPS++, and a series of tutorials on the use of the package. We plan a series of demonstrations at the ADASS meeting in Boston during November.

E = Essential, I = Important, D = Desirable

J. TELESCOPE USAGE

The following telescopes have been scheduled for research and maintenance in the following manner during the third quarter of 2000.

	12 METER	VLA	VLBA
Scheduled Observing (hrs)	292.00	1712.40	1062.00
Scheduled Maintenance and Equipment Changes	0.00	243.90	264.00
Scheduled Tests and Calibration	0.00	257.80	328.00
Time Lost	46.00	81.00	46.10
Actual Observing	246.00	1631.40	1015.90

K. VERY LARGE ARRAY OBSERVING PROGRAMS

Third Quarter, 2000 was spent in the following configurations: DnC configuration from: July 1 to July 17; D configuration from July 17 to September 30.

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

No.	Observer(s)	Programs
AA243	Allen, M. (Toronto) Kronberg, P. (Toronto) Clarke, T.	Distribution and structure of H II regions in M82. 0.7 cm
AA246	Adornes, A. (UFSM, Brazil) Ludke, E. (UFSM, Brazil) Bergmann, T. (UFRGS) Norris, R. (CSIRO)	An HI imaging survey of southern Seyfert galaxies. 20 cm
AA247	Anglada, G. (IAA, Andalucia) Rodriguez, L. (Mexico/UNAM)	Exciting sources of new CO bipolar outflows. 3.6 cm

No.	Observer(s)	Programs
AA248	Aalto, S. (Chalmers, Onsala) Huttemeister, S. (Bonn U.) Horellou, C. (Chalmers, Onsala)	HI in the "Medusa" merger, NGC 4194. 20 cm
AA249	Anglada, G. (IAA, Andalucia) Rodriguez, L. (Mexico/UNAM) Estalella, R. (Barcelona) Beltran, M. (CfA)	IRAS 2A, MMS 2, and SVS 13 sources in HH7-11. 0.7 cm
AB937	Bohringer, H. (MPIfEP, Garching) Schuecker, P. (MPIfEP, Garching) Feretti, L. (Bologna) Giovannini, G. (Bologna) Govoni, F. (Bologna)	Search for radio halos in REFLEX clusters. 20 cm
AB952	Brosius, J. (NASA/GSFC) Thompson, B. (NASA/GSFC) White, S. (Maryland)	Coronal magnetography: coordinated observations with SOHO/CDS. 2, 3.6, 6, 20 cm
AB954	Barton, E. (DAO) van Zee, L. (DAO)	Compact narrow emission line galaxies. 20 cm
AB958	Beltran, M. (CfA) Estalella, R. (Barcelona) Ho, P. (CfA) Anglada, G. (IAA, Andalucia)	Young thermal radio jets. 0.7 cm
AB961	Bosma, A. (Marseille Obs) Freeman, K. (Mt. Stromlo) Bureau, M. (Leiden) Athanssoula, E. (Marseille Obs) O'Brien, J. (Mt. Stromlo)	Edge-on barred spirals. 20 cm
AB963	Bower, G.	Polarimetry of Cygnus X-1. 2, 3.6, 6 cm
AB964	Brunner, R. (Caltech) Fassnacht, C. Djorgovski, G. (Caltech) Stern, D. (JPL) Perley, R. Ulvestad, J.	Optically selected z>4 quasars. 6 cm
AB965	Bosma, A. (Marseille Obs) O'Brien, J. (Mt. Stromlo) Freeman, K. (Mt. Stromlo) Athanassoula, E. (Marseille Obs) Bureau, M. (Leiden)	Thin edge-on galaxies. 20 cm
AB968	Butler, B. Palmer, P. (Chicago)	Observing OH occultation events involving Comet S2 linear. 20 cm

No.	Observer(s)	Programs
AB985	Berger, E. (Caltech) Becker, K. (Oberlin College) Clarke, M. (Carleton Collge) Mellon, R. (Pennsylvania State) Teng, S. (Maryland) Woodruff, T. (Southwestern)	X-ray brown dwarf LP944-20. 3.6 cm
AC524	Cartwright, J. (Caltech) Taylor, G. Readhead, A. (Caltech) Pearson, T. (Caltech)	Polarization monitoring observations of 3C273. 0.7, 1.3 cm
AC544	Castelletti, G. (IAFE) Golap, K. Dubner, G. (IAFE) Goss, W. M.	CTB80. 90 cm
AC548	Clarke, T.	Rotation measure of distant radio sources behind nearby galaxy clusters. 6 cm
AC555	Cappa, C. (IAR) Goss, W. M.	Wolf-Rayet ring nebulae. 6 cm
AC556	Chen, Y. (Shanghai Obs) Zheng, X. (Nanjing) Zhang, Q. (CfA) Ho, P. (CfA)	Ammonia mosaic of OMC-2 and OMC-3. 1.3 cm
AC557	Clarke, T.	Search for polarized sources behind galaxy clusters. 6 cm
AD436	Djorgovski, S. (Caltech) Brunner, R. (Caltech) Harrison, F. (Caltech) Ulvestad, J. Perley, R. Mahabal, A. (Caltech)	A possible population of type 2 quasars. 3.6 cm
AD437	Dunn, D. (UC, Berkeley) de Pater, I. (UC, Berkeley) Engel, C. (CSIRO) Sault, R. (CSIRO)	Jupiter's atmosphere. 1.3, 2 cm
AF370	Falcke, H. (MPIR, Bonn) Brunthaler, A. (MPIR, Bonn) Bower, G. Aller, M. (Michigan) Aller, H. (Michigan) Terasranta, H. (Helsinki)	III Zw 2, a superluminal jet in a spiral galaxy. 0.7, 1.3, 2, 3.6, 20, 90 cm

No.	Observer(s)	Programs
AF372	Feretti, L. (Bologna) Govoni, F. (Bologna) Giovannini, G. (Bologna)	New radio halos and relics from the NVSS. 20 cm
AF373	Fabian, D. (Wisconsin) Pisano, D. (Wisconsin) Wakker, B. (Wisconsin) Wilcots, E. (Wisconsin)	HI in galaxy groups. 20 cm
AG575	Greenhill, L. (CfA) Chandler, C. Herrnstein, J. (Renaissance Tech) Reid, M. (CfA)	Orion BN/KL: the maser shell around source I. 0.7 cm
AG586	Gaensler, B. (MIT) Gotthelf, E. (Columbia) Vasisht, G. (JPL) Slane, P. (CfA)	Anomalous X-ray pulsars. 6 cm
AG587	Gaensler, B. (MIT) Crawford, F. (MIT) Kaspi, V. (MIT) Manchester, D. (CSIRO) Camilo, F. (Columbia)	Parkes multi-beam pulsars. 6, 20 cm
AG593	Green, D. (Cambridge)	Newly identified Galactic SNR G353.9-2.0. 3.6, 20, 90 cm
AG594	Gary, D. (New Jersey Tech) Lee, J. (New Jersey Tech) Gallagher, P. (New Jersey Tech) Bastian, T.	Solar active regions with VLA and OVSA. 2, 3.6, 6, 20 cm
AG596	Gibb, A. (Leeds) Hoare, M. (Leeds)	SiO and methanol imaging of the HH25 MMS outflow. 0.7, 1.3 cm
AG598	Guerra, E. (Rowan) Haarsma, D. (Calvin College) Patridge, R. B. (Haverford College)	Inverted spectrum radio sources. 0.7, 1.3, 6, 20 cm
AH669	Mioduszewski, A. (Sydney) Rupen, M.	Galactic black hole X-ray transients. 1.3, 2, 3.6, 6, 20 cm
AH706	Hofner, P. (NAIC) Kurtz, S. (Mexico/UNAM) Vargas, C. (Puerto Rico)	Catalog of methanol masers in massive star forming regions. 0.7 cm
AH707	Helfand, D. (Columbia) Becker, R. (UC, Davis) White, R. (STScI) Warwick, R. (Leicester)	A new X-ray/radio image of the Milky Way. 20 cm

No.	Observer(s)	Programs
AH709	Rupen, M. Narayan, R. (CfA) Williams, R. (Florida)	Radio variability in V404 Cyg. 3.6 cm
AH710	Hatchell, J. (Manchester) Millar, T. (Manchester) Fuller, G. (Manchester)	Shock associated SiO in high mass star forming regions. 0.7 cm
AH711	Hunter, D. (Lowell Obs) Wilcots, E. (Wisconsin)	Extended gas around irregular galaxies. 20 cm
AH713	Hameed, S. (New Mexico State) Young, L. (NMIMT)	HI imaging of early type spirals. 20 cm
AH724	Holzapfel, W. (Chicago) Carlstrom, J. (Chicago) Dawson, K. (AAO)	Point source contamination of BIMA anisotropy fields. 3.6, 6 cm
AH725	Hyman, S. (Sweet Briar College) Lazio, T. J. W. (NRL) Kassim, N. (NRL)	A new Galactic Center transient? 6, 20 cm
AI079	Ivison, R. (U. College London) Barvainis, R. (REB Research) Lewis, G. (Washington) Padadopoulos, P. (Leiden)	Molecular gas in z=4 superluminous galaxy APM 0827+5255. 0.7, 1.3, 6, 20 cm
AI082	Irwin, J. (Queens) Saikia, D. (TIFR) English, J. (STScI)	HI observations of 11 edge-on spiral galaxies. 20 cm
AI083	Isaak, K. (Cambridge) Chandler, C. Carilli, C. Withington, S. (Cambridge)	Search for HCN emission from BR 1202-0725 at z = 4.7. 2 cm
AJ271	Jamrozy, M. (Jagellonian) Machalski, J. (Jagellonian)	Detection of radio cores in candidate "giant" radio galaxies. 3.6 cm
AK485	Kulkarni, S. (Caltech) Bloom, J. (Caltech) Djorgovski, S. (Caltech) Frail, D. Harrison, F. (Caltech)	Radio afterglows of gamma-ray bursts. 2, 3.6, 6 cm

No.	Observer(s)	Programs
AK509	Kulkarni, S. (Caltech) Frail, D. Galama, T. (Caltech) Bloom, J. (Caltech) Berger, E. (Caltech) Harrison, F. (Caltech)	Radio afterglows from gamma-ray bursts.
AL500	Laing, R. (Oxford) Parma, P. (Bologna) de Ruiter, H. (Bologna) Bridle, A. Fanti, R. (Bologna)	Decelerating relativistic jets in FRI radio galaxies. 3.6 cm
AL511	Lang, C. Goss, W. M.	The Snake galactic center filament. 3.6, 6 cm
AL513	Lim, J. (SA/IAA, Taiwan) Carilli, C.	Polarized dust emission in NGC 1333/IRAS 4A. 0.7 cm
AL515	Ledlow, M. (New Mexico) Owen, F.	Search for giant, low-power FRI radio galaxies. 20 cm
AL516	Lim, J. (SA/IAA, Taiwan) Wen-Shuo, L. ((Taiwan) Ho, P. (CfA)	HI imaging of Seyfert galaxies. 20 cm
AL517	La Rosa, T. (Kenesaw State) Lang, C. Lazio, T. J. W. (NRL) Kassim, N. (NRL) Anantharamaiah, K. (Raman Institute) Gross, C. (NRL)	Polarimetric study of the galactic center source G359.85+0.39. 6 cm
AL518	Lebron, M. (Mexico/UNAM) Osorio, M. (Mexico/UNAM)	Possible hot core in G111.6+0.3. 1.3 cm
AM643	Muhle, S. (Bonn U.) Klein, U. (Bonn U.) Wilcots, E. (Wisconsin) Duric, N. (New Mexico) Huttemeister, S. (Bonn U.)	Magnetic fields in starburst galaxies. 3.6, 6 cm
AM651	Mohan, R. N. (IIA, Bangalore) Dwarakanath, K. (Raman Institute) Goss, W. M. Srinivasan, G. (Raman Institute)	HI emission from optically selected interstellar clouds. 20 cm

No.	Observer(s)	Programs
AM652	Minier, V. (Chalmers, Onsala) Booth, R. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala) Polatidis, A. (NFRA) Pestalozzi, M. (Chalmers, Onsala)	Ammonia emission from methanol maser regions. 1.3 cm
AM653	Mohan, R. N. (Raman Institute) Anantharamaiah, K. (Raman Institute) Goss, W. M.	Radio recombination lines from dwarf starburst galaxies. 2 cm
AM654	Molinari, S. (IPAC) Testi, L. (Arcetri) Cesaroni, R. (Arcetri) Shepherd, D.	Ammonia observations of candidate massive protostars. 1.3 cm
AM655	Murgia, M. (Bologna) Parma, P. (Bologna) Fanti, R. (Bologna) de Ruiter, H. (Bologna) Bondi, M. (Bologna) Ekers, R. (CSIRO) Fomalont, E.	Synchrotron age of low luminosity radio galaxies. 2, 3.6, 6 cm
AM659	Massi, M. (MPIR, Bonn) Menten, K. (MPIR, Bonn)	Day-to-day variation of T Tauri stars. 1.3 cm
AM661	Monnier, J. (CfA) Greenhill, L. (CfA) Tuthill, P. (Sydney) Danchi, W. (NASA/GSFC)	Spectral variability of the WR 112 binary system. 0.7, 1.3, 2, 3.6, 6, 20 cm
AM663	Motte, F. (MPIR, Bonn) Schilke, P. (MPIR, Bonn) Menten, K. (MPIR, Bonn) Lis, D. (Caltech)	Mosaicing of active high mass star forming region W43. 2, 3.6, 6 cm
AM664	Mason, B. (Caltech) Myers, S. Udomprasert, P. (Caltech) Cartwright, J. (Caltech) Pearson, T. (Caltech) Readhead, A. (Caltech)	Observations of radio sources in CBI intrinsic anisotropy field. 0.7, 1.3 cm
AM665	McHardy, I. (Southampton) Uttley, P. (Southampton)	Radio variability of the Seyfert galaxy NGC 4051. 3.6, 6 cm
AM666	Moran, E. (UC, Berkeley) Laurent-Muehleisen, S. (UC, Davis) van Breugel, W. (LLNL) Becker, R. (UC, Davis)	Origin of narrow line Seyfert 1 radio variability. 1.3, 2, 3.6, 6, 20, 90 cm

No.	Observer(s)	Programs
AN093	Natta, A. (Arcetri) Testi, L. (Arcetri) Wilner, D. (CfA) Shepherd, D.	Protoplanetary disks around intermediate mass PMS stars. 0.7, 3.6 cm
AO147	Ogley, R. (CNRS, France) Mirabel, I. F., I. (CNRS, France) Chaty, S. (Open U.) Marti, J. (U. Jaen) Rodriguez, L. (Mexico/UNAM) Stirling, A. (Lancashire)	Super-soft X-ray white dwarf binaries. 3.6, 6 cm
AO152	Owen, F. Ledlow, M. (New Mexico) Dwarakanath, K. (Raman Institute) Keel, W. (Alabama)	Radio continuum spectrum for 154109+661544. 0.7, 1.3, 2, 3.6, 6 cm
AP380	Pooley, G. (Cambridge) Hardcastle, M. (Bristol, UK) Riley, J. (Cambridge) Alexander, P. (Cambridge) Gilbert, G. (Cambridge)	Radio jets of FRII radio sources. 3.6, 6 cm
AP400	Palmer, P. (Chicago) de Pater, I. (UC, Berkeley) Snyder, L. (Illinois)	OH imaging of comet LINEAR (C/1999 S4). 20 cm
AP401	Pisano, D. (Wisconsin) Wilcots, E. (Wisconsin)	Possible gas rich companions to isolated galaxies. 20 cm
AP402	Pisano, D. (Wisconsin) Wilcots, E. (Wisconsin)	Fraction of isolated galaxies with companions. 20 cm
AP404	Petric, A. (NMIMT) Rupen, M.	Continuum imaging of face on spirals. 6, 20 cm
AR428	Reynaud, D. (CNRS, France) Downes, D. (IRAM) Roussel, H. (CNRS, France) Vigroux, L. (CNRS, France) Beck, R. (MPIR, Bonn)	Magnetic fields in the barred spiral NGC 1530. 3.6, 6 cm
AR431	Rand, R. (New Mexico) Higdon, J. (Groningen/Kapteyn) Duric, N. (New Mexico) Lacey, C. (NRL)	Thermal and non-thermal emission in the barred spiral galaxy M83. 3.6, 6, 20 cm
AR432	Rosenberg, J. (Massachusetts) Schneider, S. (Massachusetts)	HI imaging of low surface brightness galaxies. 20 cm

No.	Observer(s)	Programs
AR435	Rudnick, L. (Minnesota) Koralsky, B. (Minnesota) Petre, R. (NASA/GSFC) Gotthelf, E. (Columbia) Holt, S. (NASA/GSFC)	Cas A: probing the X-ray/radio connections. 6 cm
AR436	Roberts, M. (Stanford) Romani, R. (Stanford) Gaensler, B. (MIT)	Unidentified GeV sources in the Galactic plane. 6, 20 cm
AR439	Reipurth, B. (Colorado/JILA) Rodriguez, L. (Mexico/UNAM)	Binary sources that excite Herbig-Haro systems. 3.6 cm
AR440	Rudnick, L. (Minnesota) Young, A. (Minnesota) Makishima, K. (Tokyo U.) Tshiro, M. (Tokyo U.) Iyomoto, N. (Tokyo U.) Kassim, N. (NRL) Worrall, D. (Bristol, UK)	Radio lobe physics—radio spectra and inverse Compton X-rays. 20, 90 cm
AR441	Rudnick, L. (Minnesota) Young, A. (Minnesota) Kassim, N. (NRL) Slee, O. (CSIRO) Sarazin, C. (Virginia) Andernach, H. (Guanajuato U.) Roy, A. (MPIR, Bonn)	Cluster "relic" physics—spectral and X-ray studies. 6, 20, 90 cm
AS568	Sramek, R. Weiler, K. (NRL) Van Dyk, S. (UCLA) Panagia, N. (STScI)	Properties of radio supernovae. 1.3, 2, 3.6, 6, 20 cm
AS686	Saikia, D. (NCRA, India) Ishwara-Chandra, C. (NCRA, India)	Giant radio sources. 6, 20 cm
AS688	Sjouwerman, L. (NFRA) Lindqvist, M. (Chalmers, Onsala) van Langevelde, H. (NFRA) Diamond, P. (Manchester) Winnberg, A. (Chalmers, Onsala)	SiO masers in Galactic Center OH/IR stars. 0.7 cm
AS689	Su, Y. (NCU, Taiwan) Lim, J. (SA/IAA, Taiwan) Ho, P. (CfA)	Search for hot molecular gas around candidate massive protostars. 1.3 cm

No.	Observer(s)	Programs
AS691	Schmitt, H. (STScI) Wiklind, T. (Chalmers, Onsala) Antonucci, R. (UC, Santa Barbara) Kinney, A. (NASA)	CS mapping of the nuclear region of Seyfert Galaxies. 0.7 cm
AS692	Statler, T. (Ohio U.) van Gorkom, J. (Columbia) Krejny, M. (Ohio U.) Terndrup, D. (Ohio State)	HI imaging of the shell elliptical NGC 2634. 20 cm
AS693	Stocke, J. (Colorado/JILA) McLin, K. (Colorado/JILA) Gibson, B. (Colorado/JILA) Carilli, C. Hibbard, J. van Gorkom, J. (Columbia)	HI in galaxies in the vicinity of local Ly A clouds. 20 cm
AS694	Stelzer, B. (MPIfEP, Garching) Newhauser, R. (MPIfEP, Garching) Fernandez, M. (MPIfEP, Garching) Guenter, E. (TLS, Germany) Menten, K. (MPIR, Bonn) Schmitt, J. (Hamburg U.) Hambaryan, V. (Byurakan Obs)	Coordinated multi-wavelength observations of YY Gem. 6, 20 cm
AS695	Shah, R. (Virginia) Carilli, C. Menten, K. Wootten, H. A. Menten, K. (MPIR, Bonn)	DCN in the absorbing system of PKS1830-211. 0.7 cm
AT245	Taylor, A. R. (Calgary) Dickey, J. (Minnesota) McClure-Griffiths, N. (Minnesota) Gaensler, B. (MIT) Green, A. (Sydney) Heyer, M. (Massachusetts) Irwin, J. (Queens) Jackson, J. (Boston) Landecker, T. (DRAO) Brunt, C. (DRAO) Kerton, C. (DRAO) Lockman, F. Martin, P. (Toronto)	Galactic plane HI survey. 20 cm
AT246	Thompson, B. (NASA/GSFC) White, S. (Maryland) Thomas, R. (NASA/GSFC) Davila, J. (NASA/GSFC)	Electron emission measure calibration for solar EUV spectrometers. 3.6, 6, 20 cm

No.	Observer(s)	Programs
AT247	Thompson, M. (Kent) Gibb, A. (Leeds)	Temperature structure of hot cores. 1.3 cm
AU083	Udomprasert, P. (Caltech) Mason, B. (Caltech) Myers, S. Pearson, T. (Caltech) Readhead, A. (Caltech)	Point sources towards Abell 478 and Abell 754. 0.7, 1.3 cm
AV242	Venturi, T. (Bologna) Bardelli, S. (Bologna) Dallacasa, D. (Bologna) Tzioumis, T. (CSIRO) Morganti, R. (NFRA) Hunstead, R. (Sydney)	Radio halos in merging cluster A3562. 20 cm
AV244	Vourlidas, A. (George Mason) Cook, J. (NRL) Bastian, T. Gary, D. (New Jersey Tech)	Coronal active regions. 3.6, 6, 20 cm
AW536	Wong, T. (UC, Berkeley) Thornley, M. Blitz, L. (UC, Berkeley) Bock, d. (UC, Berkeley) Helfer, T. (Arizona) Regan, M. (DTM/Carnegie) Sheth, K. (Maryland) Vogel, S. (Maryland)	HI in nearby spirals with CO observations. 20 cm
AW539	Wilcots, E. (Wisconsin) Hunter, D. (Lowell Obs) Kearns, K. (Wisconsin)	Mapping the extended HI around irregular galaxies. 20 cm
AW541	Wardle, M. (Sydney) Yusef-Zadeh, F. (Northwestern) Roberts, D. (Illinois) Green, A. (Sydney) Lazendic, J. (Sydney)	OH absorption towards the W28 SNR. 20 cm
AW543	Wiseman, J. (Johns Hopkins) Fuller, G. (Manchester) Wootten, H. A.	Gas kinematics around the youngest protostars and jets. 1.3 cm
AY086	Yun, M. (U. Massachusetts) del Olmo, A. (IAA) Huchtmeier, W. (MPIR, Bonn) Perea, J. (IAA) Verdes-Montenegro, L. (IAA)	HI clouds in densest compact groups. 21 cm

No.	Observer(s)	Programs
AY111	Yin, Q. Huang, J. (Nanking) Zheng, W. (Johns Hopkins)	Two newly discovered Wolf-Rayet galaxies. 2, 6, 20 cm
AY115	Yusef-Zadeh, F. (Northwestern) Roberts, D. (Illinois) Wardle, M. (Sydney)	Extended nature of OH emission from G357.7+0.03. 20 cm
AZ120	Zhang, Q. (CfA) Hunter, T. (CfA) Sridharan, T. (CfA) Ho, P. (CfA)	Disk/Jet system around the high-mass young star in AFGL 5142. 1.3 cm
AZ126	Zijlstra, A. (Manchester) Walsh, J. (ESO) Pequignot, D. (Meudon)	A planetary nebula in the Fornax dwarf spherical galaxy. 1.3, 2, 3.6 cm
AZ128	Zhao, J-H. (CfA) Bower, G. Goss, W. M.	Monitoring Sgr A*. 0.7, 1.3, 2 cm
BB124	Beasley, A. Herrnstein, J. (Renaissance Tech)	Monitoring of WR140. 3.6, 6, 20 cm
BB125	Beasley, A. Claussen, M. Herrnstein, J. (Renaissance Tech)	Monitoring of WR 140. 3.6, 6, 20 cm
BC105	Cotton, W. D. Saslaw, W. (Virginia)	Search for lensing by the star in front of 3C435B. 3.6 cm
BD069	Diamond, P. (Manchester) Kemball, A. J.	TX Cam: the final curtain. 0.7 cm
BG098	Greenhill, L.G. (CfA) Diamond, P. Moran, J. (CfA)	Maser motions in Orion BN/KL. 0.7 cm
BG099	Gomez, J-L. (IAA, Andalucia) Agudo, I. (IAA, Andalucia) Marscher, A. (Boston) Marchenko, (Boston) Alberdi, A. (IAA, Andalucia) Garcia-Miro, C. (IAA, Andalucia) Cawthorne, T. (Lancashire)	Polarization of sources with compact stationary components. 0.7, 1.3, 2 cm

No.	Observer(s)	Programs
BG105	Giovannini, G. (Bologna) Feretti, L. (Bologna) Venturi, T. (Bologna) Taylor, G. Lara, L. (IAA, Andalucia) Cotton, W. D.	VLBA observations of two compact symmetric objects. 3.6, 6 cm
BG106	Giovannini, G. (Bologna) Feretti, L. (Bologna) Venturi, T. (Bologna) Taylor, G. Lara, L. (IAA, Andalucia) Cotton, W. D.	Second epoch of three symmetric radio galaxies. 3.6, 6, 20 cm
BG107	Greenhill, L.G. (CfA) Moran, J. (CfA) Diamond, P. (Manchester) Henkel, C. (MPIR, Bonn)	Wrap up to monthly monitoring of the NGC 4258 maser. 1.3 cm
BM125	Murgia, M. (IRA, Bologna) Dallacasa, D. (Bologna) Stanghellini, C. (Noto) Fanti, R. (Bologna)	Spectral analysis of CSOs. 3.6, 6, 20 cm
BM127	Marscher, A. (Boston) Cawthorne, T. (Lancashire) Stirling, A. (Lancashire) Gear, W. (Cardiff) Stevens, J. (MRAO) Marchenko, S. (Boston) Lister, M. (JPL) Gabuzda, D. (JIVE) Yurchenko, A. (St. Petersburg) Smith, P. (KPNO) Foster, J. (HCRO)	Evolution of polarized intensity of AGN at millimeter-optical wavelengths. 0.7 cm
BP068	Palmer, P. (Chicago) Goss, W. M.	H_2CO masers with the VLBA. 6 cm
BR069	Rusin, D. (Pennsylvania) Norbury, M. (Manchester) Koopmans, L. (Manchester) Wilkinson, P.N. (Manchester) Browne, I. (Manchester) Jackson, N. (Manchester) Myers, S.T. Fassnacht, C. Marlow, D. (Pennsylvania) Tegmark, M. (Pennsylvania)	New CLASS gravitational lens systems B2319+051 and B0852+052. 6 cm

No.	Observer(s)	Programs
BT050	Taylor, G. Hough, D. (Trinity) Venturi, T. (Bologna)	Faraday rotation measure in FRII radio galaxies. 6 cm
BY012	Yi, J. (Onsala) Booth, R.S. (Onsala) Winnberg, A. (Onsala) Humphreys, E. (Onsala) Conway, J. (Onsala) Diamond, P. (Manchester)	V=1 and v=2 SiO masers in Mira variables R Cas and TX Cam. 0.7 cm
V053	Witzel, A. (MPIR, Bonn)	Polarization variability of intraday variable sources.

L. VERY LONG BASELINE ARRAY OBSERVING PROGRAMS

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

No.	Observer(s)	Programs
BA041	Aller, H. (Michigan) Aller, M. (Michigan) Hughes, P. (Michigan) Wardle, J. (Brandeis) Homan, D. (Brandeis) Roberts, D. (Brandeis)	Sources with rapidly variable polarization. 0.7, 1.3, 2 cm
BA042	Attridge, J. (Haystack) Homan, D. (Brandeis) Wardle, J. (Brandeis)	Observations of jet proper motions and circular polarization in a large sample of blazars. 6 cm
BB108	Bower, G. Moscadelli, L. (Cagliari, Italy)	Testing the Galactic Center scatterline law with interstellar hydroxyl and methanol masers. 2 cm
BB124	Beasley, A. J. Herrnstein, J. (Renaissance Tech)	Monitoring of WR140. 3.6, 6, 18 cm
BB125	Beasley, A. J. Claussen, M. Herrnstein, J. (Renaissance Tech)	Monitoring of WR140. 3.6, 6, 18 cm
BB126	Brisken, W. (Princeton) Benson, J. Fomalont, E. Goss, W. M. Thorsett, S. (UC, Santa Cruz)	Parallaxes of ten nearby radio pulsars. 18 cm
BB129	Brogan, C. Claussen, M. Goss, W. M.	Zeeman observations of OH masers associated with SNRs. 20 cm

No.	Observer(s)	Programs
BC081	Cotton, W. D. Fanti, C. (Bologna) Fanti, R. (Bologna) Dallacasa, D. (Bologna) Foley, A. (NFRA) Schilizzi, R. (NFRA) Spencer, R. (Manchester)	Faraday rotation in the core of 3C138. 6 cm
BC103	Chatterjee, S. (Cornell) Cordes, J. (Cornell) Goss, W. M. Fomalont, E. Beasley, A. Benson, J. Lazio, T. J. W. (NRL) Arzoumanian, Z. (NASA/GSFC)	Gated VLBA pulsar astrometry. 18 cm
BC104	Chatterjee, S. (Cornell) Cordes, J. (Cornell) Goss, W.M. Fomalont, E. Beasley, A.J. Benson, J. Lazio, T. J. W. (NRL) Arzoumanian, Z. (NASA/GSFC)	High frequency VLBA pulsar astrometry. 6 cm
BC105	Cotton, W. D. Saslaw, W. (Virginia)	Search for lensing by the star in front of 3C 435B. 3.6 cm
BC106	Coles, W. (UC, San Diego)	Measurements of the solar wind speed near the sun using IPS. 1.3, 2, 3.6, 6 cm
BD056	Di Matteo, T. (Cambridge) Carilli, C. Fabian, A. (Cambridge)	Multi-frequency observations: a crucial test for the ADAF paradigm in nearby dead quasars. 4,2 cm
BD067	Desai, K. (Renaissance Tech) Benson, J. Kern, J. (NMIMT)	Search for anisotropic interstellar scattering of pulsars. 90 cm
BD069	Diamond, P. (Manchester) Kemball, A.	TX Cam: the final curtain. 0.7 cm
BE020	Edwards, P. (ISAS) Murphy, D. (JPL) Tingay, S. (ATNF)	Optical jet sources. 4 cm

No.	Observer(s)	Programs
BF043	Fey, A. (USNO) Gaume, R. (USNO) Eubanks, T. M., (USNO) Johnston, K. (USNO) Ma, C. (NASA/GSFC)	Southern hemisphere astrometry for the celestial reference frame. 3.6 cm
BF057	Falcke, H. (MPIR, Bonn) Aller, H. (Michigan) Aller, M. (Michigan) Bower, G. Brunthaler, A. (MPIR, Bonn) Terasranta, H. (Metsahovi)	III Zw 2, the first superluminal jet in a spiral galaxy: an update. 2, 0.7 cm
BF058	Falcke, H. (MPIR, Bonn) Reid, M. (CfA) Henkel, C. (MPIR, Bonn) Brunthaler, A. (MPIR, Bonn)	Toward measuring proper motions of local group galaxies. 1.3 cm
BG097	Gudel, M. (Paul Scherrer) Beasley, A. J. Benz, A. (IoA) Brinkman, A. (Utrecht) Mewe, R. (Utrecht) Savin, D. (Columbia)	Energy release in stellar coronae. 4 cm
BG098	Greenhill, L. (CfA) Diamond, P. (Manchester) Moran, J. (CfA)	Maser motions in Orion BN/KL. 0.7 cm
BG103	Gabuzda, D. (JIVE) Pushkarev, A. (ASC)	Unique parsec-scale properties of the BL Lac object 0820+225. 2, 4, 6 cm
BG105	Giovannini, G. (Bologna) Feretti, L. (Bologna) Venturi, T. (Bologna) Cotton, W. D. Lara, L. (IAA, Andalucia) Taylor, G.	Observations of two compact symmetric objects. 3.6, 6 cm
BG106	Giovannini, G. (Bologna) Feretti, L. (Bologna) Venturi, T. (Bologna) Taylor, G. Lara, L. (IAA, Andalucia) Cotton, W. D.	Second epoch of three symmetric radio galaxies. 3.6, 6, 18 cm
BG107	Greenhill, L. (CfA) Moran, J. (CfA) Diamond, P. (Manchester) Henkel, C. (MPIR, Bonn)	Wrap up to monthly monitoring of the NGC 4258 maser. 1.3 cm

No.	Observer(s)	Programs
BH064	Hachisuka, K. (NAO) Fujisawa, K. (NAO) Honma, M. (NAO) Imai, H. (NAO) Kameno, S. (NAO) Kameya, O. (NAO) Kawaguchi, N. (NAO) Manabe, S. (NAO) Miyoshi, M. (NAO) Sasao, T. (NAO) Sawada-Satoh, S (NAO).	Accurate positions of masers associated with Mira type stars. 1, 0.7 cm
BH068	Homan, D. (Brandeis) Wardle, J. (Brandeis)	Direct distance measurements to compact radio sources at high redshift. 1, 2, 4, 6 cm
BH069	Hachisuka, K. (NAO) Fujisawa, K. (NAO) Honma, M. (NAO) Imai, H. (NAO) Kameya, O. (NAO) Kawaguchi, N. (NAO) Manabe, S. (NAO) Nishio, M. (NAO) Omodaka, T. (NAO) Sasao, T. (NAO) Sawada-Satoh, S. (NAO)	Determination of the velocity of Galactic rotation at IRAS 21008+4700. 1 cm
BJ032	Johnston, K. (USNO) Fey, A. (USNO) Gaume, R. (USNO) Clark, T. (NASA/GSFC) Ma, C. (NASA/GSFC) Eubanks, T. M. (USNO) Kingham, K. (USNO) Boboltz, D. (USNO) Vandenberg, N. (Interferometrics) Himwich, E. (Interferometrics) Shaffer, D. (Radiometrics) Gordon, D. (NASA/GSFC) Fomalont, E. Walker, R. C.	Geodesy/astrometry observations for 2000. 3.6 cm
BL082	Lazio, T. J. W. (NRL) Desai, K. (Renaissance Tech) Fey, A. (USNO)	Search for refractive angular wander of B2 2050+36. 4, 13, 20, 50, 90 cm
BL086	Lobanov, A. (MPIR, Bonn Ros, E. (MPIR, Bonn) Zensus, J. A. (MPIR, Bonn)	Monitoring of the ongoing flare in the VLBI core of 3C345. 0.7, 1, 2 cm

No.	Observer(s)	Programs
BL089	Lazio, T. J. W. (NRL) Chatterjee, S. (Cornell) Cordes, J. (Cornell) Bhat, R. (Manchester)	Galactic electron density and the angular broadening of pulsars. 18 cm
BL092	Lister, M. (JPL) Piner, B. (JPL) Preston, R. (JPL) Tingay, S. (ATNF)	Pearson-Readhead survey at 43 GHz. 7 cm
BM125	Murgia, M. (Bologna) Dallacasa, D. (Bologna) Stanghellini, C. (Bologna) Fanti, R. (Bologna)	Spectral analysis of CSOs. 3.6, 6, 18 cm
BM127	Marscher, A. (Boston) Cawthorne, T. (Lancashire) Stirling, A. (Lancashire) Gear, W. (Wales) Stevens, J. (Cambridge) Marchenko, S. (Boston) Lister, M. (JPL) Gabuzda, D. (NFRA) Yurchenko, A. (St. Petersburg) Smith, P. (KPNO-NOAO) Foster, J. (UC, Berkeley)	Evolution of polarized intensity of AGN at millimeter-optical wavelengths. 0.7 cm
BM133	Moran, E. (UC, Davis) Becker, R. (UC, Davis) Laurent-Muehleisen, S. (UC,Davis) van Breugel, W. (LLNL)	Parsec-scale radio morphology of narrow-line Seyfert 1 galaxies. 6 cm
BM135	Monnier, J. (CfA) Danchi, W. (NASA) Greenhill, L. (CfA) Tuthill, P. (Sydney)	When winds collide: imaging the shock interface in the WR+OB binary WR112. 6 cm
BM138	Mutel, R. (Iowa) Ignace, R. (Iowa) Gayley, K. (Iowa)	Wolf-Rayet binaries WR 146 and WR 147. 3.6, 18 cm

No.	Observer(s)	Programs
BN009	Norbury, M. (Manchester) Blandford, R. (Caltech) Browne, I. (Manchester) Jackson, N. (Manchester) Koopmans, L. (Manchester) Marlow, D. (Groningen) Myers, S. Pearson, T. (Caltech) Readhead, T. (Caltech) Rusin, D. (Pennsylvania) Wilkinson, P. (Manchester)	Long track observations of top CLASS lens candidates. 20 cm
BN014	Nagar, N. (Maryland) Falcke, H. (MPIR, Bonn) Wilson, A. (Maryland)	Accretion and obscuration in LINERs: What can we learn from the AGN core and twin pc-scale jets in M89? 2, 4, 6, 20 cm
BO008	Ogley, R. (Saclay) Chaty, S. (Open University) Dhawan, V. Marti, J. (Jaen) Mirabel, F. (Saclay) Pooley, G. (MRAO) Rodriguez, L. (UNAM/Mexico)	Search for new microquasars. 2, 4 cm
BP056	Piner, B. (JPL) Jones, D. (JPL)	15 GHz observations of the compact radio intermediate quasar PG 2209+184. 2 cm
BP062	Piner, B. (JPL) Edwards, P. (ISAS)	Multi-epoch observations of the TeV sources 2155-304 and 1 ES. 2 cm
BP068	Palmer, P. (Chicago) Goss, W. M.	H_2CO masers with the VLBA. 6 cm
BP070	Patnaik, A. (MPIR, Bonn) Kemball, A.	Propagation effects in the gravitational lens B1600+434. 0.7, 2 cm
BR067	Ratner, M. (CfA) Bartel, N. (York U.) Bietenholz, M. (York U.) Lebach, D. (CfA) Lestrade, J-F. (Paris Obs) Ransom, R. (York U.) Shapiro, I. (CfA)	Astrometry of IM Peg in 2000 for the Gravity Probe-B mission. 2, 3.6, 6 cm

No.	Observer(s)	Programs
BR069	Rusin, D. (Pennsylvania) Norbury, M. (Manchester) Koopmans, L. (Manchester) Wilkinson, P. (Manchester) Browne, I. (Manchester) Jackson, N. (Manchester) Myers, S. Fassnacht, C. Marlow, D. (Pennsylvania) Tegmark, M. (Pennsylvania)	New CLASS gravitational lens systems B2319+051 and B0852+052. 6 cm
BS070	Shen, Z. (NAO) Inoue, M. (NAO) Kellermann, K. Moran, J. (CfA)	Superluminal bent jet in PKS 1921-293. 6, 0.7 cm
BS080	Sawada-Satoh, S. (NAO) Inoue, M. (NAO) Kameno, S. (NAO) Shibata, K. (NAO)	Relative position between maser spots and nucleus in NGC 1052. 0.7, 1, 2 cm
BS081	Strelnitski, V. (Maria Mitchell) Benson, P. (Wellesley) Kogan, L. Salter, D. (Wellesley)	Multi-epoch imaging of VS UMa in the 1.35cm H_20 maser line. 1 cm
BT048	Taylor, G.	Imaging extreme Faraday rotation measures in quasar cores. 0.7, 1.3, 2 cm
BT050	Taylor, G. Hough, D. (Trinity U.) Venturi, T. (Bologna)	Faraday rotation measure in FR II radio galaxies. 6 cm
BT053	Tingay, S. (ATNF)	Continued observations of the nearby FR II radio galaxy, Pictor A. 4 cm
BV040	Vlemmings, W. (Leiden) Baudry, A. (Bordeaux) Diamond, P. (Manchester) Habing, H. (Leiden) Schilizzi, R. (JIVE) van Langevelde, H. (JIVE)	Monitoring the amplified stellar image in four AGB stars. 20 cm
BW044	Wilson, A. (Maryland) Mundell, C. (Maryland) Nagar, N. (Maryland) Ulvestad, J.	Testing the AGN megamaser paradigms with all VLBA observable H_20 megamasers. 4, 6, 13, 20 cm

No.	Observer(s)	Programs
BW050	Wrobel, J. Fassnacht, C. Myers, S. Taylor, G.	FIRST sources in the NOAO deep wide field J1432+3416. 4 cm
BW051	Walker, R. C. Benson, J.	Constraining a possible helical flow in 3C120. 20 cm
BY012	Yi, J. (Chalmers, Onsala) Booth, R. (Chalmers, Onsala) Winnberg, A. (Chalmers, Onsala) Humphreys, E. (Chalmers, Onsala) Conway, J. (Chalmers, Onsala) Diamond, P. (Manchester)	v=1 and v=2 SiO masers in Mira variables R Cas and TX Cam. 0.7 cm
BZ023	Zhang, H. (Beijing Normal University) Gabuzda, D. (JIVE) Jin, C. (Beijing) Nan, R. (Beijing)	Mapping the parsec-scale rotation-measure distribution of 3C147. 3.6, 4 cm
TF015	Foley, L.	Fringe Finders. 0.7, 1, 2, 4, 6, 13, 20 cm
V047	Gurvits, L. (NFRA)	Structure of extremely high redshift quasars at 1.6 and 5 GHz. 6, 18 cm
V053	Witzel, A. (MPIR, Bonn)	Polarization variability of intraday variable sources. 6 cm
W009	Linfield, R. (JPL) Ulvestad, J.	The most compact TDRSS Sources: J1924-2914 and J2218-0335.
W018	Snellen, I. (Cambridge) Tschager, W. (Leiden) Schilizzi, R. (NFRA) de Bruyn, A. G. (NFRA) Miley, G. (Leiden) Rottgering, H. (Leiden) vanLangevelde, H. Fanti, C. (Bologna) Fanti, R. (Bologna)	GPS galaxies and quasars. 18 cm
W035	Gurvits, L. (NFRA) Frey, S. (FOMISGO) Schilizzi, R. (NFRA) Kellermann, K. Lobanov, A. (MPIR, Bonn) Moran, E. (UC, Berkeley) Laurent-Muehleisen, S. (UC, Davis) Pauliny-Toth, I. (MPIR, Bonn)	Structure of extremely high redshifted quasars. 6, 18 cm

No.	Observer(s)	Programs
W075	Edwards, P. (ISAS, Japan) Lovell, J. (CSIRO) Hirabayashi, H. (ISAS, Japan) Moellenbrock, G. Fujisawa, K. (NAO, Japan) Jauncey, D. (CSIRO) Reynolds, J. (CSIRO) Tzioumis, A. (CSIRO) Tornikoski, M. (Helsinki)	High brightness temperature source PKS 1921-293. 6 cm
W079	Meier, D. (JPL) Tingay, S. (CSIRO) Preston, R. (JPL) Murphy, D. (JPL) Jones, D. (JPL) Fujisawa, K. (NAO, Japan) Hirabayashi, H. (ISAS, Japan) Kobayashi, H. (NAO, Japan) Edwards, P. (ISAS, Japan)	Centaurus A. 6 cm
W314	Murphy, D. (JPL) Conway, J. (Chalmers, Onsala) Polatidis, A. (NFRA) Preston, R. (JPL) Hirabayashi, H. (ISAS, Japan) Murata, Y. (ISAS, Japan) Kobayashi, H. (NAO, Japan)	Regular monitoring of 1928+738. 6 cm
W327	Horiuchi, S. (NAO, Japan) Migenes, V. (Guanajuato U.) Murata, Y. (ISAS, Japan) Shen, Z. (NAO, Japan)	OH and formaldehyde absorption. 6, 18 cm
W330	Kameno, S. (NAO, Japan) Wajima, K. (ISAS, Japan) Zhi-Qiang, S. (NAO, Japan) Inoue, M. (NAO, Japan) Sawada-Satoh, S. (NAO, Japan)	Complementary multi-frequency GPS survey. 6 cm

M. 12 METER OBSERVING PROGRAMS

No.	Observer(s)	Programs
C326	Clancy, R. T. (SSI, Boulder) Sandor, B. (High Altitude Obs)	Thermal and compositional studies of the Mars and Venus atmospheres.

No.	Observer(s)	Programs
E69	Ehrenfreund, P. (Leiden) Charnley, (NASA/Ames) Butner, H. (Arizona) Ruiterkamp, R. (Leiden)	Study of the organic composition of star-forming cores seen by ISO and their relation to cometary ices.
E70	Engargiola, G. (UC, Berkeley) Plambeck, R. (UC, Berkeley) Mangum, J.	Hunting for YSOs in a smooth black blob: combined interferometric and single-dish survey of B133.
H347	Horn, J. (UCLA) Morris, M. (UCLA) Uchida, K. (Ohio State)	Study of molecular gas in the giant HI cloud surrounding the blue compact galaxy II Zw 44.
K368	Kalenskii, S. (Lebedev)	Study of methanol masers.
L350	Larinov, G. (Lebedev) Promislov, V. (Lebedev)	Study of methanol masers.
M438	Magnani, L. (Georgia) LaRosa, T. (Kennesaw State) Shore, S. (Indiana)	^{13}CO observations of MBM 40.
M439	Mochizuki, K. (ISAS, Japan)	CO search in IC 1613, among the most metal-poor galaxies detected in the [CII] 158 micron lines.
P184	Pagani, L. (Paris Obs) Pardo, J. (Caltech)	Study of the physical structure of L134N.
T386	Turner, B.	A search for ethyl formate to test current models of complex molecule formation on dust grains.
T389	Snyder, L. (Illinois) Friedel, D. (Illinois) Turner, B.	A proposal to scan SGR B2N to compare with BIMA data.
W425	Womack, M. (St. Cloud State U.)	The search for chemical diversity in comets.
W427	Woodney, L. (Maryland) A'Hearn, M. (Maryland) McMullin, J.	Study of parent molecules in Comet Linear (1999 S4).

N. PERSONNEL

New Hires

Highberger, J.	Junior Research Associate	7/10/00
Stairs, I.	Research Associate	9/13/00

Terminations

Bower, G.	Research Associate	8/31/00
Flatters, C.	Assoc. Sci-SO Ops	8/31/00
Gallimore, J.	Research Associate	7/28/00
Hall, R.	Asst Dir/GBT Proj Mgr	9/29/00*
Lang, C.	Jr Research Associate	9/29/00
Petty, M.	Personnel Mgr	9/15/00*
Sumner, M.	Jr. Eng Associate	8/11/00
Schmidt, R.	Jr. Eng Associtate	9/26/00
Shah, R.	Junior Research Associate	8/10/00
Thornley, M.	Research Associate	7/28/00
Yun, M.	Asst. Sci/ALMA	8/31/00

Promotions

Balser, D.	to Assoc Scientist-GB Ops	7/01/00
Butler, B.	to Assoc Scientist-Res Support	7/01/00
Carilli, C.	to Scientist-SO Ops	7/01/00
Glendenning, B.	to Scientist/Head Computing-ALMA	7/01/00
Hunt, G.	to Dep Asst. Director	7/01/00
Kembal, J. A.	to Sci-Asst. Dir/AIPS++ Proj	7/01/00
McKinnon, M.	to Sci-Dep Asst Dir GB Ops	7/01/00
McMullin, J.	to Assoc Sci-Res Support	7/01/00
Napier, P.	to Sci(T) Hd/ALMA Ant	8/01/00
Radford, S.	to Scientist-Res Support	7/01/00

Other

Cotton, W.	Return from LOA	7/10/00
Bastian, T.	Transfer from Socorro to Charlottesville	8/01/00
Prestage, R.	Transfer from Socorro to Green Bank	7/01/00
Uson, J.	Return from LOA	7/28/00

O. PUBLICATIONS

Attached as Appendix A is a listing of all preprints received in the NRAO Charlottesville library during the reporting period authored by NRAO staff or based on observations on NRAO telescopes.

PREPRINTS RECEIVED, JULY - SEPTEMBER 2000

BALSER, D.S.; GOSS, W.M.; DE PREE, C.G. VLA High Sensitivity 4He Imaging of Galactic H II Regions.

BASTIAN, T.S. Propagation of Radio Waves in the Corona and Solar Wind.

BASTIAN, T.S.; DULK, G.A.; LEBLANC, Y. A Search for Radio Emission from Extrasolar Planets.

BERGER, E.; SARI, R.; FRAIL, D.A.; KULKARNI, S.R.; BERTOLDI, F.; PECK. A.; MENTEN, K.; SHEPHERD, D.S.; MORIARTY-SCHIEVEN, G.H.; POOLEY, G.; BLOOM, J.S.; DIERCKS, A.; GALAMA, T.J.; HURLEY, K. A Jet Model for the Afterglow Emission from GRB 000301C.

BRISKEN, W.F.; BENSON, J.M.; BEASLEY, A.J.; FOMALONT, E.B.; GOSS, W.M.; THORSETT, S.E. Measurement of the Parallax of PSR B0950+08 Using the VLBA.

BUTLER, B.J.; STEFFES, P.G.; SULEIMAN, S.H.; KOLODNER, M.A.; JENKINS, J.M. Accurate and Consistent Microwave Observations of Venus and Their Implications.

CHIUDERI DRAGO, F.; ALISSANDRAKIS, C.E.; BASTIAN, T.; BOCCHIALINI, K.; HARRISON, R.A. Joint EUV/Radio Observations of a Solar Filament.

DHAWAN, V.; MIRABEL, I.F.; RODRIGUEZ, L.F. AU-Scale Synchrotron Jets and Superluminal Ejecta in GRS 1915+105.

DICKELL, H.R.; GOSS, W.M.; DE PREE, C.G. WSRT and VLA Observations of the 6 cm and 2 cm Lines of H2CO in the Direction of W 58 C1(ON 3) and W 58 C2.

DUBNER, G.; VELAZQUEZ, P.F.; GOSS, W.M.; HOLDAWAY, M.A. High Resolution VLA Imaging of the Supernova Remnant W28 at 328 and 1415 MHz.

DUC, P.-A.; BRINKS, E.; SPRINGEL, V.; PICHARDO, B.; WEILBACHER, P.; MIRABEL, I.F. Formation of a Tidal Dwarf Galaxy in the Interacting System Arp 245 (NGC 2992/93)

DULK, G.A.; LEBLANC, Y.; BASTIAN, T.S.; BOUGERET, J.L. Acceleration of Electrons at Type II Shock Fronts and Production of Shock-Accelerated Type III Bursts.

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