NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

Quarterly Report
October 1 - December 31, 1966

RESEARCH PROGRAMS

Interferometer (Three 85-foot telescopes)

Completion of the construction of the central control building necessary for the three element operation is now scheduled for January 1967. Modifications to the two 85-foot telescopes are near completion. The third 85-foot telescope is about 90 percent complete, with gear setting and final check-out by NRAO personnel remaining to be done.

300-foot Telescope

	Hours
Scheduled observing	97.0
Scheduled maintenance	630.5
Time lost due to equipment failure, interference, power and weather	0.0

G. Westerhout (University of Maryland) continued his galactic survey of neutral hydrogen distribution. P. Henderson (University of Maryland) completed a short study of HI distribution near the galactic plane in order to study the "hat brim" effect of the spiral arm location near the edge of the Milky Way. R. Davies (University of Wisconsin) made some preliminary HI scans in the regions of Cassiopeia and near selected galactic clusters. J. Miller (University of Wisconsin) observed HI in absorption near selected HII regions on September 20-22 in order to correlate radio radial velocities with optical velocities determined by Miller at the Kitt Peak National Observatory. C. Varsavsky (Argentine National Radio Astronomy Institute) observed HI in the Taurus region from September 29 to October 3.

The remainder of this period was spent on surface adjustment (see page 3, this report).

140-foot Telescope

		Hours
Scheduled		1729.0
Equipment changes and scheduled maintenance		253.5
Time lost due to:	equipment failure	117.25
	interference	3.75
	power	0.25
	weather	157.50

Receiver problems accounted for almost all the equipment time lost. Adverse weather resulted in poor observing conditions at the shorter wavelengths and also forced postponement of a scheduled installation.

J. Schraml performed telescope tests at 2695 MHz and 1410 MHz. M. Cohen (University of California, San Diego) made scintillation measurements, and measurements undertaken by P. Mezger, W. Altenhoff, I. Pauliny-Toth, and K. Kellermann, as reported in the previous quarter, were continued at these frequencies. Z. Turlo (Torun, Poland) observed effects of atmospheric phase fluctuations at 11 and 20 cm wavelengths.

K. Kellermann and I. Pauliny-Toth measured flux densities of variable sources at 15.375 GHz and 4995 MHz. P. Mezger mapped one galactic source at 15.375 GHz.

Lunar occultations of three sources were observed by S. von Hoerner and J. Taylor (Harvard) at 234, 256, and 405 MHz.

Polarization measurements were conducted by C. Mayer (Naval Research Laboratory) and J. Hollinger (N.R.L.) at 19.354 GHz and 10.456 GHz using Naval Research Laboratory equipment.

The 100 channel autocorrelation receiver was used by S. Goldstein (University of Virginia) to observe neutral hydrogen in directions of stars having optical interstellar lines. W. Dent (University of Michigan) used the autocorrelation receiver at 1220 MHz and 1420 MHz to investigate extragalactic neutral hydrogen absorption.

At the end of the quarter, the telescope was shut down to install a cooling system to operate a 6 cm parametric amplifier at near the temperature of liquid helium.

ELECTRONICS DIVISION -- EQUIPMENT DEVELOPMENT

During the past quarter the manpower assignments within the Electronics Division have been divided among the following programs:

3-Element Interferometer Construction	50%
New Autocorrelation Receiver	10%
Interference Protection	4%
6 cm Cooled Paramp Integration	6%
New Standard Receivers	5%
Millimeter Receiver Development	6%
Visitor Support and Routine Maintenance	10%
Planning of New Programs	3%
Very Long Baseline Interferometer	6%

The interferometer is in an intensive assembly and construction phase. At the present time the IF, delay, and correlator portions of the systems are complete, the on-line computer has been received and accepted, and the

front-ends, local oscillator, and computer interface subsystems are under construction, with almost all materials on hand.

The design and prototyping of the 416-channel autocorrelation receiver is complete, and materials for construction are on order or have been received.

The very-long baseline interferometer has been completed, and one-half of the system has been shipped to Arecibo. First observations are expected in January 1967.

A tabulation of all radio transmitters within the Quiet Zone has been made, and a computer program to evaluate interference levels from these sources at Green Bank has been completed.

A 6 cm cooled parametric amplifier has been received from Airborne Instruments Laboratory, and evaluation and integration of the amplifier for use on the 140-foot telescope is nearly complete. The amplifier uses a closed-cycle cryogenic refrigerator and achieves a system noise temperature of 120°K and a bandwidth of 250 MHz.

Two Honeywell DDP-116 computers have been received and accepted. These computers will be used for data recording, pointing correction, data analysis, and autocorrelation receiver output display at the 140-foot and 300-foot telescopes. The interface equipment for the computers has been designed, but not yet constructed.

THE NRAO 36-FOOT MILLIMETER WAVE ANTENNA, KITT PEAK, ARIZONA

Most of the work on the Kitt Peak site has been completed. Problems with the servo system are delaying the completion of the telescope. The manufacturer (Teledyne) tried to adjust the system to meet specifications, but without success, and it was concluded that a redesign of parts of the servo loop was needed. This redesign has been completed and is scheduled for testing in January.

300-FOOT TELESCOPE

Readjustment of the reflecting surface has been 85 percent completed during the quarter. All screen panels were removed and rolled in order to remove large dents in the surface. A portion of the studs, which support the surface panels, were severely corroded and have been replaced. All 15,000 studs have been readjusted to a best fit paraboloid, and 70 percent of the panels have been reinstalled. The work has been delayed somewhat by bad weather in November and December.

ANTENNA DESIGN STUDIES

The Largest Feasible Steerable Telescope (LFST)

During the last three months the review and comparison of the various designs already made has been started. The papers published by A. C. Schell

and others of the Air Force Cambridge Research Laboratories, which describe the multi-plate antenna, have been studied (IEEE Transactions on Antennas and Propagation, AP-14, 543 and 550, 1966). A test section of this type of antenna, with a reflecting area of 479 square meters, has been built and tested by AFCRL. A design for a very much larger antenna has been made, and the reports on this design work are now being studied by the NRAO group.

The progress of the CAMROC studies are also being followed with interest, and two members of the LFST group attended the most recent CAMROC meeting.

A start has been made on a concept by which many of the desirable properties of the LFST could be met by a synthetic antenna. The preliminary results of this work will shortly be circulated to all those on the LFST mailing list for their comments.

The Very Large Antenna Array Project (VLA)

The principal effort during the quarter has been to complete the system design to the degree needed for the VLA proposal and for the cost estimates which are part of this proposal.

Final reports on the site development study and the antenna study have been received from RCA, Moorestown, and from Limbaugh Engineers, Inc., respectively. A number of smaller reports covering various aspects of the electronic system has been received from IT&T Federal Laboratories.

D. Hogg has compiled an extensive and detailed study of the performance of various array configurations, and on this basis has recommended an array of 36 antennas on a Y-shaped track with arms 13.1 miles long, to produce angular resolution of one second of arc. B. Clark has outlined the computer system requirements, and W. Tyler and S. Weinreb have produced a general design for the electronics system.

The entire VLA Design Group has collaborated to write the VLA proposal, which will be issued in January 1967. The total cost of the minimum system is approximately $42 million (1966 prices). Expansion to include the highly important features of rapid polarization measurement, a second operating wavelength, and capability of spectral-line measurements will increase the cost by $6 million (1966 prices).

COMPUTER DIVISION

On October 17, 1966, an IBM 360 Model 50 was installed in the Charlottesville laboratory. It consists of a central processor, three disk drives, four tape drives, a printer, and a reader-punch. The new computer will replace the IBM 7040 system, now scheduled for removal in mid-February. Depending on the specific jobs to be processed, the increased speed and sophistication of the IBM 360/50 will result in an improvement of a factor of two to five in through-put time. The computer is open for 24 hours each

weekday, and for eight hours on weekends. Approximately 1100 jobs are being processed each month, half of which are directly connected with telescope data processing and half with theoretical work. The division now consists of four programmers, four computer operators, and a secretary-clerk-tape librarian.

MISCELLANEOUS

NRAO Airstrip

The airstrip paving was completed and the airstrip put back into service on November 2, 1966. Weather conditions have prevented completion of the grading and sowing of the shoulders, which have now been postponed until spring.

Interferometer Control Building

Progress has been made toward the completion of this facility. Beneficial use of the building is expected by about January 15, with completion of the air conditioning equipment about February 1.

Karl G. Jansky Lecture

The first annual Karl G. Jansky Lecture was delivered on October 28, 1966 by John G. Bolton, Director of the Australian National Radio Astronomy Observatory. Dr. Bolton traced the development of radio astronomy from its beginning in 1931 to the present day in a well-attended popular lecture. During his week's visit at the NRAO, he also delivered a technical colloquium on the C.S.I.R.O. radio astronomy program.

PERSONNEL

M. Davis joined the scientific staff as Assistant Scientist. He came from the Leiden Observatory, and he is completing his doctoral thesis from that institution.

A. Rahim was appointed to the Engineering Division on a one-year appointment as Assistant Engineer.

M. Hagstrom became a member of the Electronics Division, arriving from the Chalmers radio astronomy group, Sweden, during the quarter.

B. Chen joined the programming staff of the Computer Division.