DSN Research and Technology Support

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The activities of the Development Support Group in operating and maintaining the Venus Station (DSS 13) are discussed and progress noted. Activities included planetary radar experiments (Venus and Mercury), radio source sky survey using the 26-m antenna, Faraday rotation data collection, weak radio source flux density measurement, X-band 400-kW radar development and testing, Block IV receiver/exciter installation and testing/checkout, 26-m antenna receiving system temperature improvement, differential very long baseline interferometry (VLBI) experiments, clock synchronization transmissions, DSS 14 high-power transmitter maintenance support, and Pioneer 10 science support.

During the two month period ending December 15, 1973, the Development Support Group operated the Venus Station (DSS 13) and performed the following activities.

I. In Support of Section 331

A. Planetary Radar

For a total of five and one-half hours, DSS 13 supported the ranging of the planet Venus to gather data for use by the MVM'73 project. Pseudonoise (PN) code and code timing pulses were supplied, via microwave link, to DSS 14 for use as a modulating signal for the 400-kW R&D transmitter, and to synchronize the demodulating system. In addition to these ranging efforts, five and one-half hours of special Mercury ranging were supported in a similar fashion, with 10 data runs being completed. Additionally, preliminary testing, with DSS 14 transmitting and both DSS 14 and DSS 13 receiving, of a proposed "active VLBI" experiment was performed. This experiment, with Greenbank Radio Observatory as the cooperating station, is scheduled for early in 1974.

B. Station Monitor and Control (RTOP-68)

As part of the work being done under Research and Technology Operating Plan 68 (RTOP-68), the SDS-930 computer and DSS 13 26-m antenna were used for six hours to continue testing of a developmental conical scanning antenna drive program destined to be used at DSS 14.

II. In Support of Section 333

A. Sky Survey

Using the noise adding radiometer (NAR) and the 26-m antenna in a fixed position(usually 180° az and 80–87° el), data are collected on the total antenna system temperature as the Earth's rotation sweeps the antenna beam across the sky. This observing, conducted automatically during the hours when the station is closed (nights, holidays, and weekends) collected a total of 534 hours of data during this period.

B. Faraday Rotation

In anticipation of the launch of the MVM'73 spacecraft, it was decided to provide backup for the single receiver being used to collect Faraday rotation data. Purchase orders have been placed for two more receivers for evaluation but, pending their arrival, a receiver was obtained on loan from Teledyne Corporation. After extensive modification of the antenna previously used with the Smythe receiver, the Teledyne receiver was placed into service and is currently collecting data. Stanford Research Institute delivered and installed a second receiver but the antenna drive mechanism failed and this receiver is currently not functioning. At the end of the period, both the Teledyne and one Stanford receiver are collecting data from Applications Technology Satellite 1 (ATS-1), data that will be used by the MVM'73 project to provide ionospheric correction for the spacecraft ranging and doppler data.

C. Weak Source

With the reinstallation of the S-band radar operational (SRO) feedcone onto the DSS 13 26-m antenna and the relocation of the maser/refrigerator from the electronics room into this feedcone, the resulting low receiving system temperature has made it feasible to again measure the strength of weak radio sources. Late in November this project was resumed with 13 hours of data being collected on radio sources 3C123, 3C138, 3C147, 3C353, NGC7027, PO 237-23, and PO 2345-23.

In anticipation of full-scale resumption of the associated antenna gain measurement portion of this program, the standard gain feedhorn was removed from the 26-m antenna and returned to Section 333 for examination and calibration.

III. In Support of Section 335

A. X-Band Radar (400 kW)

The first klystron (VA-949J) was installed into the modified test bed and tested at a power output of just over 200 kW. During this testing, three directional couplers failed, two with overheated internal matching loads and one with water leaks in the cooling tubing. On December 6, 1973, this first klystron apparently failed and was removed from the test setup.

A replica of the inside framework of a 64-m-type feedcone has been constructed at DSS 13. A dual klystron power amplifier with combiner, water loads, and couplers, as required for complete testing, will be constructed in this replica. Available space is limited and integration of the two klystron power amplifiers into the cone will be difficult. Pending the availability of the actual feedcone, this replica will enable construction, fitting, and testing to take place.

B. Block IV Receiver/Exciter

We continued to provide support to the installation and checkout of the Block IV receiver/exciter at DSS 14. Installation is now complete and, working until the configuration at DSS 14 was frozen for MVM'73 launch, testing and checkout were supported with a total of 273 manhours. The Block IV receiver/exciter is now partially operational and is being used to support MVM'73.

C. Antenna Pointing (26-m)

Inasmuch as we were resuming normal receive capability operation, and reinstallation of the SRO feedcone may have resulted in a change in the agreement of the radio frequency axis of the antenna with the mechanical axis, some test tracking was done with the scan and correct using receiver (SCOUR) computer program. In three hours of tracking using Cassiopeia A and Cygnus A as sources, a new set of preliminary azimuth and elevation offsets was obtained for use during other tracking activities.

D. Receiving System Temperature Improvement (26-m)

With the completion of the first phase of the dual uplink carrier testing, it was felt that the maser/refrigerator could be relocated from the electronics room into the feedcone and thus improve the receiving system temperature from 29 K to approximately 17 K at zenith. This relocation was effected and the maser compressor was also reinstalled into the closed cycle refrigerator

(CCR) room on the antenna (vice the outboard elevation bearing platform). Unfortunately this compressor soon failed and was replaced by the spare. The failed unit has been repaired and is ready for reinstallation if necessary.

IV. In Support of Section 391

In an investigation of its application to spacecraft positioning, a differential very long baseline interferometry (VLBI) experiment was carried out with Pioneer 10 and a radio source as signal sources; the cooperating stations were DSS 13 and DSS 42. A total of 18½ hours on four separate passes were spent observing, in the VLBI mode, the spacecraft Pioneer 10 and radio source OW-174.

V. In Support of Section 422

A. Clock Synchronization Transmissions

Regular clock synchronization transmissions have not yet been scheduled by DSN scheduling but special transmissions were made to DSSs 42 and 43. These transmissions, along with the regularly scheduled maintenance, disclosed some system problems. Marginal radio frequency (RF) drive to the 100-kW klystron was corrected by replacement of the $\times 14$ multiplier in the exciter chain. A synthesizer failed and was replaced in the programmed oscillator used for frequency control. A total of nine transmissions have been made during the last two months.

B. DSS 14 High-Power Transmitter Maintenance

In preparation for the launch of the MVM'73 spacecraft, the complex spare 20-kW klystron was installed at the Microwave Test Facility and correct operation assured. Some minor tuning was accomplished, then the klystron, with a complete set of operational data, was shipped to DSS 14 in case of need.

During a routine checkout, the 100-kW DSN transmitter was discovered to be inoperational. With the assistance of the DSS 14 staff, DSS 13 personnel replaced the klystron, socket tank and magnet, and restored the system to operational condition. Due to schedule requirements at DSS 14, this work was accomplished during four consecutive night operations.

The previously reported (Ref. 1) difficulty with reflected power on the R&D 400-kW transmitter was found to be spurious signals caused by a defective radio frequency connector in the input line to the frequency multiplier. Replacement of this connector cleared up the poorly transmitted spectrum and full 400-kW operation is now possible without reflected power "kickoffs."

C. Pioneer 10 Tracking

If the tracking load at DSS 14 can be relieved, a planetary radar experiment is planned with the comet Kohoutek as a target. It is proposed that DSS 13 take over tracking Pioneer 10 for several days during early January, 1974. In validation of DSS 13's capability to receive good data, and with the cooperation of DSS 12 for telemetry reduction, a test track was made of Pioneer 10 with the telemetry subcarrier being transmitted to DSS 12 via the intersite microwave link. Good data were obtained with the telemetry S/N ratio being 2.5 from DSS 13 vs 2.8 with DSS 12 receiving.

VI. In Support of Section 825

With the closer approach of Pioneer 10 to Jupiter, a stepped-up level of radiation monitoring was provided from DSS 13. The radiation at 2295 MHz from Jupiter was monitored for a total of 87.5 hours. Radio star calibrators, as tabulated in Table 1, were also observed for 122 hours.

Reference

1. Jackson, E. B., "DSN Research and Technology Support," in *The Deep Space Network Progress Report,* Technical Report 32-1526, Vol. XVII, pp. 100–102. Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1973.

Table 1. Radio star calibrators used in Pioneer 10 science support

3C48	3C147	3C309.1	Virgo A
3C123	3C218	3C348	NGC7027
3C138	3C286	3C353	PO237-23