DSN Research and Technology Support

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The activities of the Venus Station (DSS 13) and the Microwave Test Facility (MTF) during the period June 14 through October 10, 1976, are discussed and progress noted.

Continuing remote controlled pulsar observations are noted, along with routine observations of 22 pulsars. Preliminary installation of equipment for planned unattended operation of the Venus Station is reported, along with extensive measurements and performance evaluation of the 26-m antenna. Support of the X-band radar at the Mars Station (DSS 14), and stability and reliability testing of the DSS 13 receiving system is reported. Klystron testing and other DSN support activities of the DSN High-Power Transmitter Maintenance Facility are noted, along with energy conservation modifications to two buildings at DSS 13. Radio Science experiment support included Planetary Radio Astronomy, Pulsar Rotation Constancy, Interstellar Microwave Spectroscopy and Very Long Baseline Interferometry observations. An increased schedule of clock synchronization transmissions, planned on five-day centers, is noted, as 39 transmissions were made to Australia, DSS 43, and Spain, DSS 63.

I. Development Support Group

The activities of the Development Support Group, in operating the Venus Station (DSS 13) and the Microwave Test Facility (MTF) during the period June 14 through October 10, 1976, are discussed.

II. Station Automation

In support of RTOP 68 (Station and Network Monitor and Control Technology Development) and RTOP 69 (Tracking Station Systems Technology), DSS 13 will be the demonstration station with which remotely operated, unattended tracking operation is demonstrated.

The first phase, remote controlled observation of pulsars has been demonstrated on several occasions. During this period, 35 station support hours, of which 6 hours were remote controlled tracking, were utilized in support of this project. During the remote controlled pulsar observations, pulsars 0031–07, 0329+54, 0355+54, 0628–28, 0736–40, and 0833–45 were successfully observed without intervention by on-station personnel. The rest of the support time was devoted to troubleshooting and performance measurement.

III. Pulsar Observations

In support of the Radio Science Experiment "Pulsar Rotation Constancy" (OSS 188-41-51-09), DSS 13 provided 130-3/4 hours of observations, during which the emissions from the pulsars tabulated in Table 1 were recorded. These data, recorded at 2388 MHz, left circular polarization (LCP), are used to determine precise pulse-to-pulse spacing, changes in this spacing, pulse shape, and pulse power content of the signals received from these pulsars.

IV. Maser-Receiver-NAR Reliability-Stability Testing

Reliability and stability testing of the DSS 13 total receiving system is conducted during nonmanned station periods. The 26-m antenna is prepositioned to a fixed azimuth and elevation and the Noise Adding Radiometer (NAR) data collection system automatically records total receiving system temperature as the 26-m antenna beam is swept across the sky by the rotation of Earth. During this period, the antenna was fixed in azimuth at 360 degrees and progressively positioned from 49.9 to 49.1 degrees elevation, and 496-/2 hours of testing were automatically performed. This testing is performed at 2295 MHz, using right circular polarization (RCP) on the 26-m antenna.

V. Unattended Operation, DSS 13

In preparation for the planned unattended operation of DSS 13, the Polarization Diversity S-Band (PDS) feedcone removed from DSS 14 has been modified into a feedcone having all the capabilities of an S-Band Polarization Diversity (SPD) feedcone, except simultaneous reception of two polarizations, but using only two waveguide switches instead of three. Two Block III Receiver-Exciters, obtained surplus from the Spaceflight Tracking and Data Network (STDN), have been installed in the Operations and Data Processing building at DSS 13 and completely checked out with the STDN and DSN frequency converters. The first "milestone" demonstration is planned to be an automated telemetry reception track from a spacecraft in March, 1977.

VI. 26-m Antenna Measurements and Evaluation

In order to evaluate the effects of several years of experimental operation on the stability of the surface panel adjustments, careful measurements of the surface deviation from the desired parabola were made on the 26-m antenna. Measurements were made at three different elevation angles: near zenith, near horizon, and at 33 degrees. The subreflector was removed and returned to JPL for precision measurements, and installation of a removable vertex plate. While the feedcone was off the antenna, antenna waveguide run measurements were made in preparation for installation of the modified feedcone described above, designated SVU (*S*-band, *V*enus, *U*nattended).

Replacement of the oil seal on one elevation ball screw was performed, and an examination of the gearbox was made to ensure that no hidden damage existed. The oil seal replacement solved the oil leakage problem, and, although brass shavings and a piece of broken gear were found in the gearcase, no immediate problem is foreseen.

After reinstallation of the subreflector, new vertex plate, and feedcone, pointing evaluation tracks were performed, using an automated program called SCOUR (*SC*an and *CO*rrect *U*sing *R*eceiver), which utilizes the SDS-930 to provide antenna control. Using Virgo A, 3C144, and 3C273 as sources, 21-1/2 hours of pointing error evaluation were performed.

Several problems were experienced with the S-band maser refrigerator with which the 26-m antenna is equipped. During this period, the displacer crosshead drive has been overhauled and replaced twice. The system is working correctly at this time, although some audible roughness exists in the drive mechanism.

VII. X-Band Radar, 8495 MHz, 400 W

During a series of radar observations of the comet D'Arrest, the VA949J klystrons used as final amplifiers failed and were removed. In preparation for restoring the system to service, the traveling-wave tube amplifiers (TWTA) used as klystron drivers were tested, and the TWT power supplies (Logimetrics Corp. Model A300) were modified with a new HV cable connector for improved reliability. This modification required fabrication of a complete new back panel assembly and rearrangement of connectors. After modification, one of the three power supplies developed an intermittent fault and was repaired. At this time, the TWTAs are operational.

VIII. Energy Conservation

The Operations and Data Processing (G-51) and Laboratory and Office (G-60) buildings at the Venus

Station have each been equipped with a time clock with which the lighting (interior and exterior) and air conditioning are operated. The air conditioning is on a multiday time clock, while the office and laboratory lighting is controlled by personnel-set timers, with a total time of 10 hours available. Excluding the transmitting systems, the air conditioning systems at Venus are the largest users of electricity, and automatic turnoff of this usage when the station is not manned will reduce consumption.

IX. Deep Space Network High-Power Transmitter Maintenance Facility (DSN HPTMF)

The X-3070 klystron loaned to Arecibo Radio Observatory has been returned in apparent good condition as evidenced by a vacuum check. Arecibo did not find it necessary to use this klystron.

At the request of the Transmitter Cognizant Operating Engineer (COE), a klystron socket tank, klystron focusing magnet, magnet adapter and 500-kW RF water load were loaned to Varian Corporation to be used in testing a repaired DSN 100-kW klystron. These items were returned after testing was completed.

In continuing support of the DSN mission, four each, 20-kW klystrons, Varian Model 5K70SG, were tested to assure usability in case of need. (These klystrons had been obtained from the STDN.) Two of the four klystrons meet all applicable specifications. Three arc detectors, fabricated by a vendor, were checked, wiring errors corrected, repairs made where necessary, and operation and response time verified. Additionally, a light source and power supply for the crowbar on the HV power supply at DSS 14 were repaired.

Routine scheduled maintenance was performed on the 20-kW test transmitters, and the DSS 13 transmitter control system was converted to the same solid state configuration used in the DSN. During this maintenance period, a documentation update program was started to ease the planned configuration of the system for unattended operation for uplink transmissions to spacecraft. During this maintenance period, the X-3070 magnet used in the Advanced Systems Demonstration transmitter failed due to inadequate coolant flow, and the system is currently inoperative.

As part of a program to improve the spectral purity of the uplink transmissions, a high-resolution spectrum analysis was made of the carrier emitted by the 20-kW test transmitters and also of the HV power supply used with these transmitters. The same spectral components, at similar relative amplitudes, were found in both the RF and HV dc spectra. Detailed analysis is being performed.

X. Planetary Radio Astronomy

In support of the Radio Science experiment "Planetary Radio Astronomy" (OSS 196-41-73-01), DSS 13 measures and records the radiation received at 2295 MHz from the planet Jupiter and various radio calibration sources. These measurements use the 26-m antenna, the S-band station receiving system, and the NAR. During this period, 109-3/4 hours of observations were made, during which the radiation received from Jupiter and the calibration sources tabulated in Table 2 were measured and recorded.

XI. Interstellar Microwave Spectroscopy

In support of the Radio Science Experiment "Interstellar Microwave Spectroscopy" (OSS 188-41-52-12) DSS 13 provided 23 hours of station support, including 17-3/4 hours of tracking reception at 2273.5 and 2321.729 MHz. Sources used for this experiment included 3C58, NGC 7822, and 118 + 48.

XII. VLBI Support

In support of the several programs that utilize Very Long Baseline Interferometry (VLBI) techniques, DSS 13 devoted 6-3/4 hours of tracking to check out new equipment utilized for this purpose. Sources observed were 3C84 and 3C273.

XIII. Clock Synchronization System

The interval between transmission of clock synchronization signals was shortened at the request of the Viking Project. This increased transmission schedule, programmed on five-day centers, was instituted in support of the encounter, orbit, and landing phases of Vikings I and II spacecraft with Mars.

Although Spain, DSS 63, had some difficulty with their receiving system, 18 transmissions were made to them as scheduled by DSN Scheduling. Another 21 transmissions were made to Australia DSS 43, for a total transmission time of 40-3/4 hours. Both stations are now reporting good reception and correlation with their local station clocks.

Table 1. Pulsars observed at DSS 13, June 14 through October 10, 1976

0031−07	0833−45	1818−04
0329+54	1133+16	1911−04
0355+54	1237+25	1929+10
0525+21	1604−00	1933+16
0628−28	1642−03	2021+51
0736−40	1706−16	2045−16
0823+26	1749−28	2111+46
		2218+47

Table 2. Radio calibration sources observed at DSS 13, June 14 through October 10, 1976

3C17	3C273	3C418
3C48	3C274	NRAO530
3C84	3C279	OJ287
3C123	3C286	PKS0237-23
3C138	3C309.1	PKS2134-00
3C145	3C345	Virgo A
3C147	3C348	
3C218	3C353	

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