DSN Research and Technology Support

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The activities of the Development Support Group at Goldstone are discussed and progress noted on continuing efforts. Activities reported include planetary radar support for the MVM'73 missions, sky survey radio source activity, dual uplink carrier testing, testing 100-kW klystrons for use at DSSs 43 and 63, 400-kW transmitter testing of ignitrons and power supplies, support of DSS 14 400-kW transmitter, and very long baseline interferometry (VLBI) activity with National Radio Astronomy Observatory (NRAO), Effelsburg, Germany, and DSS 43.

I. Introduction

During the two months ending August 6, 1973, the Development Support Group utilized almost its entire resources in operation of the Venus Station (DSS 13) both as a supporting research and technology (SRT) test bed station and in its new role as the DSN High Power Transmitter Maintenance Facility. Only machine shop support for these operations and occasional special testing were conducted at the Microwave Test Facility.

II. Section 331 Support

Continuing support of the Mariner Venus/Mercury 1973 spacecraft mission, two Venus and eight Mercury ranging missions were supplied with pseudonoise (PN) code and code timing signals transmitted to DSS 14 via the intersite microwave link. A total of 73 hours of data gathering was thus supported.

The development receiver which had been removed from DSS 14 for maintenance (Ref. 1) was reinstalled. The $\times 32$ multiplier in the receiver's local oscillator chain, whose output power had decreased by 6 dB, was replaced. A filter was designed, fabricated, and installed to reduce spurious signals being generated in the $\times 2$ multiplier which precedes the $\times 32$, and interstage attenuators were added to optimize overall performance. The receiver was reinstalled during the week ending July 15, 1973, and performance has been good since that time.

III. Section 333 Support

The station receiver (tuned to 2295 MHz), the 26-m antenna, a computing counter (HP-5360A) with a systems programmer (HP-5376A), an SDS-910 computer (for antenna pointing), a punched paper tape reader for timing and programming, a chart recorder, and a digital printer were interconnected to form an automated total power radiometer called a noise adding radiometer (NAR). Operating theory and a description of an earlier version of this radiometer are given in Ref. 2.

This automated system is used on weekends or on midnight shifts when the station is normally closed .The 26-m antenna is placed into a fixed position (usually 180 deg Az and 80-87 deg El), and the NAR is started when the on-duty crew leaves the station. When the station is reopened the outputs of the chart recorder and digital printer are collected and forwarded to Section 333 for analysis. During this reporting period, a total of 434 hours of data was thus collected on radio sources passing through the fixed 26-m antenna beam.

IV. Section 335 Support

A. Dual Uplink Carrier Testing

With baseline performance established at an intermodulation product (IMP) level weaker than −180 dBm, long-term testing for stability evaluation continued. A total of 181 hours of testing was conducted during this period.

The diplexer which was removed in May 1973 because of increased noise and IMP was carefully examined under magnification. Hairline cracks were discovered on the interior broad wall surfaces of both hybrid sections. This particular diplexer was the prototype for all subsequent diplexers of this type, and the manufacturer tells us that it had fabrication seams where we observed the hairline cracks. Subsequent production models do not have these particular fabrication seams.

B. 100-kW Klystron Testing

It is planned to equip the two overseas 64-m antennas (DSSs 43 and 63) with 100-kW DSN transmitters. The klystrons to be used are Varian Associates Model X3060, originally manufactured in 1965 and 1966. They have been kept in controlled environment storage with periodic activation of the built-in vacuum pump and filament to ensure maintenance of internal vacuum.

During this last two-month period these tubes have undergone acceptance class testing in a special test fixture designed and constructed for versatile testing of components of the 100/400-kW transmitters. Additionally, these klystrons were retuned to 2115 MHz (previously tuned to 2388 MHz) with an approximate instantaneous bandwidth of 10 MHz. Six klystrons were in storage and five of them have proved to be serviceable.

C. 400-kW Transmitter Testing

Whenever certain protective circuits on the 100/400-kW transmitters are actuated, the high-voltage dc (60–66 kV) is rapidly (less than 100 μs) removed by short-circuiting the high-voltage dc power supply through a load resistor to prevent excessive current being drawn. The switch which effects this short circuit is an ignitron whose igniter is pulsed from the protective circuit.

The single ignitron used in this circuit at DSS 14 has proved to be marginal with regard to its ability to "hold off" normal operating high voltage without premature breakdown. To correct this difficulty, a new system employing two smaller ignitrons in series has been designed, fabricated, tested, and installed at DSS 13 for long-term operational evaluation prior to installation at DSS 14. This test installation was made during the week ending June 24, 1973.

The klystron focusing magnet, motor field and generator field excitation in the 100/400-kW transmitter system have been furnished by specially designed and built SCR power supplies. Recently, Hewlett Packard has introduced a line of similar power supplies which may prove suitable for this application (10 kW dc at voltages from 110 to 400 V). During the past two months several of these Hewlett Packard supplies have been undergoing evaluation at DSS 13 along with measurements of the transfer function of the entire high-voltage dc control system.

V. Section 422 Support

In support of the DSN High Power Transmitter Maintenance Facility, DSS 13 personnel removed the outer shell from an X-3075 klystron and repaired the input coaxial connector, which had become waterlogged. The klystron was then installed into the test fixture for acceptance testing. However, the tuning of the klystron cavities had shifted to the extent that neither DSS 13 personnel nor a representative from the manufacturer were able to retune the klystron, and it was returned to Varian Associates for repair.

To compensate, insofar as possible, for the loss of the 400-kW transmitter left inoperative by the loss of this

klystron, DSS 13 personnel modified a DSN 400-kW transmitter cabinet and installed a 100-kW klystron and associated magnet therein. This provides a 100-kW capability for spacecraft support, pending repair and return from Varian Associates of one of the 400-kW klystrons.

The 10-W transistorized S-band driver amplifier was removed from the DSS 13 400-kW 2388-MHz transmitter and used to replace a defective unit at DSS 14. This exchange, which was effected by DSS 13 personnel, enabled the planetary ranging in support of MVM'73 to continue at DSS 14.

VI. Section 825 Support

A. Very Long Baseline Interferometry (VLBI)

By special arrangement we provided 58 hours of cooperative VLBI observations of the radio sources in Table 1. The first series of observations was cooperative with the 100-m antenna at Effelsburg, Germany, and the 43-m antenna at NRAO in Greenbank, West Virginia. The second series of observations, reduced to only six hours by failure of both maser/refrigerators at DSS 43, was cooperative with DSS 43 only. Preliminary analysis of the data from the first series verifies the presence of fringes between DSS 13 and NRAO and between DSS 13 and Effelsburg. The data from the second series have not yet undergone examination.

B. Pioneer 10 and 11 Spacecraft Support

The NAR described earlier is also used to obtain measurements of the radiation from the planet Jupiter and certain radio source calibrators to provide a comparison set of radiation measurements against which the measurements telemetered back by Pioneer 10 and 11 can be compared. During this two-month period, 152 hours were expended observing the targets tabulated in Table 2, measurements being made at 2295 MHz.

References

1. Jackson, E. B., "DSN Research and Technology Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. XVI, pp. 102–104, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1973.
2. Batelaan, P. D., Goldstein, R. M., and Stelzried, C .T., "A Noise-Adding Radiometer for Use in the DSN," in *The Deep Space Network, Space Programs Summary 37-65, Vol. II*, pp. 66–69, Jet Propulsion Laboratory, Pasadena, Calif., Sept. 30, 1970.

Table 1. VLBI observations

Radio source	Cooperating stations (in addition to DSS 13)
3C84	Effelsburg, NRAO
3C274	↓
3C279	↓
3C345	↓
3C373	↓
CTA-21	↓
DW-0742+10	↓
P1347-03	Effelsburg, NRAO
3C345	DSS 43
3C454	↓
CTA102	↓
NAR 0512	↓
BL LAC	↓
2145+06	↓
0048−09	↓
0332−403	↓
0202−17	↓
0122−00	↓
0438−43	↓
1633+38	↓
0022−42	DSS 43

Table 2. Sources observed with NAR at 2295 MHz

3C48	3C286
3C123	3C309.1
3C138	3C318
3C147	3C348
3C218	3C353
3C274 (Virgo A)	Jupiter
3C283	NGC 7027