Utilization of the Venus Station (DSS 13) 26-Meter Antenna During CY 1979

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The various activities for which the Venus Station's 26-m antenna was used are described and the number of manned tracking hours devoted to each activity are given. A brief description of the goal of each activity supported is provided, and, where appropriate, the observing technique is summarized.

I. Introduction

This article describes the activities, both tracking and significant non-tracking, to which the Venus Station (DSS 13) 26-m AZ-EL antenna provided support during January-December 1979. The Venus Station, a non-mission support committed station, is normally staffed for 40 hours each week. Its activities can broadly be classified into:

A. Operations

Activities which either directly supported the spacecraft tracking mission of the DSN or were closely associated with those activities.

B. Advanced Systems Development

Activities, usually funded from the NASA 310 program, which are aimed at development of techniques and equipment with which future DSN needs can be met.

C. Non-Flight Project

Activities, primarily radio astronomy, which are not directly related to DSN spacecraft tracking nor associated with specific development of equipment or techniques.

In the following discussion of activities, grouped as above, the numbers in parentheses immediately following the activity title are the number of hours of antenna support provided, unless otherwise described in the text.

II. Operations

A. Pioneer Venus Radio Scintillation (29-½ h)

This activity, which used the Pioneer spacecraft as a signal source, measured the amplitude and frequency fluctuations in the spacecraft downlink. Later correlation with other data allowed these fluctuations to be related to turbulence characteristics of the solar wind near the Sun.

B. Voyager Telemetry Support (137-¼ h)

During the temporary non-availability of normally scheduled DSN stations, primarily DSS 12, the Voyager Project was provided with downlink telemetry to minimize the data gaps which would otherwise have resulted. These data were primarily provided when DSS 12 was taken out of service for a few days to perform major maintenance and main reflector adjustment.

III. Advanced Systems Development

A. Mark IV Radiometric Tracking Systems Development (238 h)

This activity, which utilized the Voyager spacecraft as signal sources, demonstrated the feasibility of using narrowband (less than 1 MHz) signals in a delta VLBI technique for spacecraft navigation, particularly during the Jupiter encounter period.

B. Mark IV Differential One-Way Range (DOR) Systems Development (6-¼ h)

This activity is to demonstrate the feasibility of using wideband (greater than 1 MHz) signals in differential VLBI measurements to perform spacecraft navigation. This activity also uses the Voyager spacecraft in cruise mode and at the forthcoming Saturn encounter. The bandwidth employed is approximately 3.6 MHz.

C. Viking Delta VLBI (22 h)

In this activity, VLBI observations are made of the Viking spacecraft and also quasars which are near the spacecraft pointing angles. Using these data from the spacecraft, which is in orbit around Mars, the orbit of Mars can be tied into the nearly inertial reference frame formed by the quasars.

D. Radio Source Catalog Development (42-½ h)

The goal of this activity is to identify, precisely determine locations, and measure the flux densities of a large number of compact radio sources which are usable as part of an intercontinental baseline S- and X-band VLBI network. This is an on-going activity and more than 600 sources with flux densities greater than 0.1 Janskys have been so identified and located.

E. VLBI System Design Analysis (28-¼ h)

This experiment is used to demonstrate the feasibility of using VLBI techniques to measure relative tracking station locations and to effect inter-station clock synchronization to the nano-second level. The pre-implementation work required to prepare the DSN for the Block I VLBI subsystem is also performed under the aegis of this activity.

F. ARIES-VLBI Laser Intercomparison (265-½ h)

In this activity, a comparison is made between the accuracy of Earth vector measurements made using VLBI observations and those made using laser ranging of Earth orbiting satellites.

G. DSS-13 S-X Feed Concepts (41-¼ h)

This activity had as its goal the development of a high illumination efficiency, common aperture, S-X Cassegrain Feed system. The Phase 1 design has been field tested on the DSS 13 26-m antenna to provide design verification of aperture efficiency, bandwidth, impedance match and noise temperature when mounted onto a large Cassegrain parabolic antenna. This feed system has been in routine use on the DSS 13 26-m antenna throughout 1979, being utilized primarily to support simultaneous S-X reception for various VLBI projects which utilize dual band spacecraft as signal sources.

H. DSS 13 S-X Unattended Systems Development (34 h)

This activity is to develop the operations methodology and systems engineering required for an unattended tracking station for the DSN. Specifically, DSS 13 is being developed as a remote-controlled unattended station and the data base thus developed will be used to predict life cycle costs and the feasibility of implementing an automated station.

This is one of the major activities which have been on-going at DSS 13 during 1979, and the 34 h represents only *manned* hours specifically devoted to computer program development and testing, and does not include the large number of hours used in the unmanned mode during nights and weekends.

I. Microwave Phase Center Calibration

The purpose of this activity is to develop techniques to determine time and phase delays in the ground tracking receiving system and relate RF Phase Centers for these measurements to the physical structure and configuration.

The DSS 13 26-m antenna has been fitted with two "outrigger" antennas, six feet in diameter, which transmit and receive with two identical antennas mounted at the near-field collimation tower, 1.6 km distant. By proper choice of antenna polarization, signals can be transmitted "round robin" through this system of four antennas, and measurements made. Signals can also be received on the 26-m antenna after having passed through a portion of this array, and comparison measurements made.

J. Radiometer Performance Monitoring

This activity makes serendipitous use of the times when the 26-m antenna is not being used for tracking, e.g., nights and weekends. During these periods, the antenna is used to demonstrate the utility of a Noise Adding Radiometer (NAR) in making precision total power measurements of the noise output from a low-noise receiver mounted on a large parabolic antenna. The antenna is placed into various fixed azimuth and elevations and left stationary for periods of time ranging from 8 to 72 hours. During these periods, the Earth's rotation sweeps the antenna beam across the sky and review of the NAR output enables determination of overall gain stability at various antenna attitudes. If the incremental positions are properly chosen, and the number of observations is large enough, a radio map of the sky is also obtained from these data. During 1979 a total of 689-3/4 h were devoted to this activity.

IV. Non-Flight Project

A. VLBI Investigation of Twin Quasi-Stellar Objects 0957 + 561A, B (RAES 176) (8-¼ h)

This activity performs VLBI observations of this unusual pair of objects which are apparently separated by only 6 arc-seconds. Such observations, assuming sufficient source flux density, can determine the nature of the source's compact radio emission and variability in time.

B. Pulsar Rotation Constancy (176-¼ h)

These observations are used to monitor the short term variations in the period of the Vela Pulsar (0833-45). Also, twenty-three additional well behaved pulsars are studied to discover (a) the nature of the events causing the observed pulsar timing noise, (b) the proper motion of the pulsar, and (c) how a young, erratic pulsar evolves into an older, more stable pulsar. The observing program's goal is to measure the phase of the pulse train from each pulsar at intervals of one week to one month.

C. Planetary Radio Astronomy (137-¼ h)

This program studies the properties of the planet Jupiter's radio emission and uses the results of these observations to construct improved models of Jupiter's radiation belt environment. This program also measures and studies the thermal emission from the atmospheres of the outer planets and uses these data to construct atmospheric models.

D. ALSEP-QUASAR VLBI (3-½ h)

This experiment uses VLBI techniques to tie the lunar ephemeris to the nearly inertial extragalactic reference frame formed by the quasars observed. By combination with the lunar laser ranging, the Earth's orbit also may be tied into the quasar reference frame. Such high accuracy observations are also of value to test gravitational theories and to measure the Earth-Moon tidal friction interaction.

V. Conclusion

Since the Venus Station is not committed to provide mission support, long term testing and other developmental and radio astronomy activities can be carried out without significantly impacting the utilization of the DSN to fulfill its primary flight project support requirements. During CY 1979, a total of 1169.75 manned tracking hours were provided by DSS 13 in support of operations, advanced systems development, and non-flight project activities. This utilization is graphically depicted in Fig. 1. In addition to the manned tracking support, a substantial amount of support was provided in the unmanned mode to S-X Unattended Systems Development and Radiometer Performance Monitoring activities.

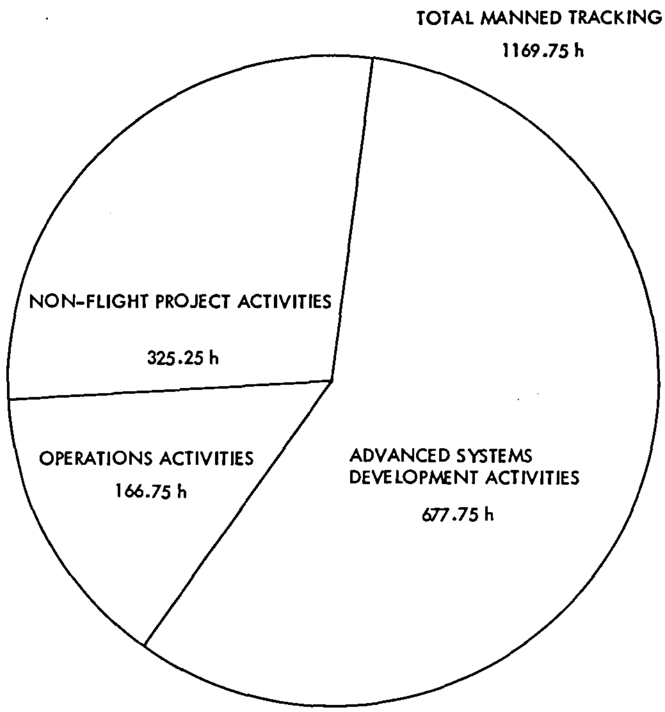

Fig. 1. Tracking utilization of 26-m antenna, Venus Station (DSS 13) during 1979