# Helios Mission Support

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TDA Mission Support

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*This article reports on activities of the Network Operations organization in support of the Helios Project from 1 February 1977 through 15 April 1977.*

## I. Introduction

This article is the fifteenth in a continuing series of reports that discuss Deep Space Network support of Helios Mission operations. Included in this article is information concerning the inferior solar conjunction periods, demonstration tracks following Mark III Data System implementation, the STDN-DSN telemetry and command cross-support operations, and other mission-oriented activities.

## II. Mission Operations and Status

Helios-1 entered a period of inferior solar conjunction from 30 March 1977 until 9 April 1977. The spacecraft entered a grayout period over DSS 42 (Canberra, Australia) on 2 April at a Sun-Earth-Probe (SEP) angle of 0.7734 degrees, and exited over DSS 63 (Madrid, Spain) on 3 April at a SEP angle of 0.4049 degrees. During the grayout the spacecraft was covered by a core memory read-in using format 3, data mode 4, and a bit rate of 8 bits per second (b/s) coded. Following the grayout a spacecraft emergency was declared on 3 April over DSS 14 (Goldstone, California). Apparently a regulator switch onboard put the spacecraft into an undefined (silent) configuration. As a result DSS 14 lost the downlink. The spacecraft was then commanded to reconfigure to the noncoherent mode, Driver 1, and TWT2 to medium power. DSS 14 then reacquired the downlink carrier and subcarrier, but no telemetry data was present. The spacecraft was then commanded to generate 1024 b/s coded and soon the station's telemetry string acquired lock. All experiments were checked and all were functioning properly. From the data received no anomaly was found and it was assumed that a signal spike caused the regulator switch to react as it did. No similar problem has occurred since.

The last major event for Helios-1 during this period occurred on 13 April 1977. On that day the Helios-1 spacecraft passed through its fifth perihelion. At that time the spacecraft was traveling at a velocity of 66.0456 kilometers per second, at a distance of 128 million kilometers from Earth and 46 million kilometers from the Sun. The round-trip light time at that time was 14 minutes and 2.7 seconds. The coverage for this event was provided by DSS 44 (Australia) with a downlink bit rate of 256 b/s. The spacecraft was configured in Format 2 with shock data read in data mode 3, which was triggered by experiment 5. All subsystems and experiments functioned normally.

Helios-2 continues to perform normally minus the use of its receiver 1 (Ref. 1), which is inoperative. Helios-2 entered its period of inferior solar conjunction on 29 March 1977 and ran until 11 April 1977. The spacecraft entered its grayout period over DSS 12 (Goldstone, California) on 3 April at a Sun-Earth-probe angle of 0.7148 degrees, and exited over DSS 63 on 4 April at a Sun-Earth-probe angle of 0.3534 degrees. As with Helios-1, Helios-2's grayout was covered by a core memory read in, Format 3, data mode 4, and a bit rate of 8 b/s coded.

The next significant event for Helios-2 will be its third perihelion, scheduled to occur on 23 April 1977. The results of this event will be incorporated in the next article of this series.

Total DSN coverage for this period for both Helios-1 and -2 is recorded in Table 1. The coverage is shown for both 26-meter and 64-meter networks.

## III. Special Activities

### A. Mark III Data System (MDS) Support of Helios

Demonstration tracks were conducted during this period with DSS 63 (Spain) and DSS 44 (Australia). The MDS performance has been greatly improved over what was reported in the previous article (Ref. 1). Personnel at both stations displayed a good understanding of MDS operations, and operator errors were at a minimum. The system problems reported earlier have since been corrected with only a few exceptions. Of these, the most bothersome to operations was the continuing unreliability of the Communications and Monitor Formatter (CMF). To find solutions to CMF problems, a special procedure has been initiated within the DSN to analyze and hopefully find permanent solutions to improve the reliability of the CMF. The progress of this procedure will be documented in future articles.

Following a successful series of demonstration tracks at DSS 62 and DSS 44, both stations were placed under configuration control for support of Helios flight operations.

This was accomplished for DSS 62 on 1 March 1977 and for DSS 44 on 22 March 1977. Both stations have provided excellent support since those dates.

The next station to be reconfigured to the MDS will be DSS 14 at Goldstone, California. DSS 14 will be the first 64-meter antenna station to undergo modification. The station will cease operations on 16 April 1977 and is scheduled to return on 15 June 1977 fully implemented in the MDS configuration for the test and training phase. The status of DSS 14's progress will be reported in future articles.

### B. STDN-DSN Cross-Support

On 1 March 1977 the STDN-DSN cross-support was activated to support Helios operations. On that date a demonstration track was conducted using the STDN station at Goldstone, California, and DSS 12 at Goldstone. In this particular pass Helios-2 (spacecraft 91) was tracked by STDN's antenna. The resultant downlink was microwaved to DSS 14, which in turn microwaved the signal to DSS 12. At DSS 12 the signal was processed through the station's back-up telemetry string and the data were transmitted to JPL and Germany via high-speed data line. Commanding was accomplished in the reversed order. During the cross-support period the DSS 12 was tracking another spacecraft with its own antenna and processing this data on its prime telemetry and command system. This overall configuration is shown in Fig. 1. During this first track the main problem encountered was the initial poor signal quality being received at DSS 12 from STDN. After a period of system troubleshooting it was found that the receiver STDN was using was not functioning properly. Having four multifunction receivers available, each one was brought into operation until the most efficient was found. After that was accomplished DSS 12 established a solid lock on the STDN data and the track proceeded without incident. This first track was used primarily for feeling the system out and matching equipment to optimize the data quality and system performance. On 4 March 1977 the same activity was performed using DSS 11 and, except for a few minor operator errors, the system functioned well. Both demonstration tracks were considered successful and the system functional.

Since these initial tracks, the STDN-DSN cross-support has been utilized on a regular basis over Goldstone for Helios support. The configurations used at DSS 11, DSS 12, and STDN are depicted in Fig. 2, 3, and 4, respectively.

Thus far the performance has been the same as was experienced during the first cross-support period which ended on 15 November 1976. As reported in a previous article (Ref. 2) the signal-to-noise ratio from STDN was approximately 4 db below that of a 26-meter DSN station, the reason being a higher system temperature and a lower receiver sensitivity at the STDN site. Table 2 shows a summary comparison between STDN and the DSN, of downlink AGC and SNR residuals for this period of STDN/DSN cross-support.

## References


1. Goodwin, P. S., Burke, E. S., and Rockwell, G. M., "Helios Mission Support," in *The Deep Space Network Progress Report 42-38*, pp. 50–54, Jet Propulsion Laboratory, Pasadena, California, April 15, 1977.
2. Goodwin, P. S., Burke, E. S., and Rockwell, G. M., "Helios Mission Support," in *The Deep Space Network Progress Report 42-37,* pp. 39–42, Jet Propulsion Laboratory, Pasadena, California, February 15, 1977.

**Table 1. Helios tracking coverage**

| Month | Spacecraft | Station type | Number of tracks | Tracking time, h, min |
|---|---|---|---|---|
| February | Helios-1 | 26 meter | 30 | 211:49 |
| | | 64 meter | 0 | 0 |
| | Helios-2 | 26 meter | 52 | 291:04 |
| | | 64 meter | 1 | 5:00 |
| March | Helios-1 | 26 meter | 51 | 376:23 |
| | | 64 meter | 6 | 37:04 |
| | Helios-2 | 26 meter | 90 | 502:04 |
| | | 64 meter | 1 | 14:47 |

**Table 2. Comparison of STDN and DSN downlink performance (1 March through 21 April 1977)**

| Spacecraft | STDN | Standard deviation | Sample size | DSSs 11, 12, 14 | Standard deviation | Sample size |
|---|---|---|---|---|---|---|
| Helios-1 | | | | | | |
| AGC Residual | −1.9 | NA | 1 | +0.4 | 1.0 | 60 |
| SNR Residual | NA due to maser problem | NA | NA | +0.4 | 0.9 | 48 |
| Helios-2 | | | | | | |
| AGC Residual | −3.2 | 3.0 | 20 | −0.9 | 0.7 | 38 |
| SNR Residual | −0.2 | 2.4 | 21 | −1.1 | 0.8 | 37 |

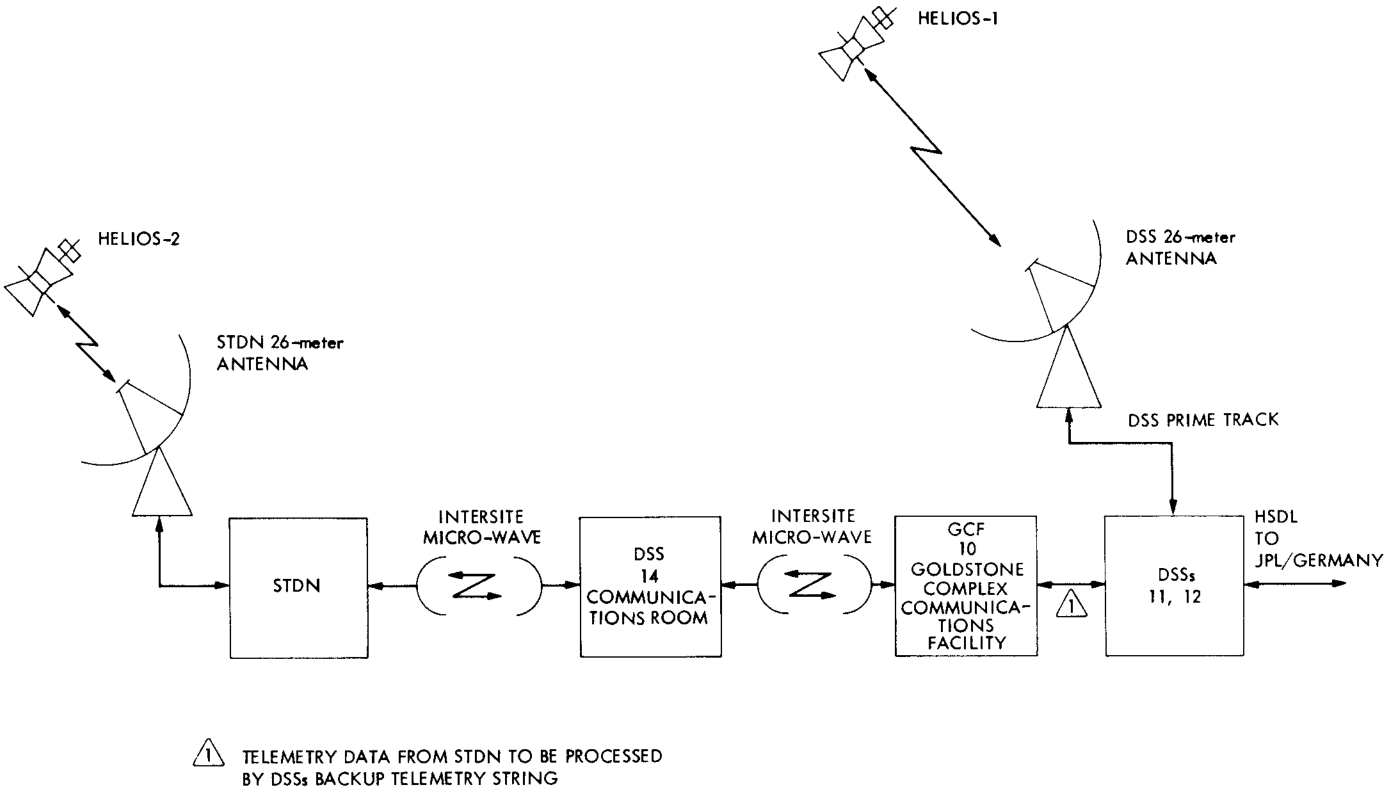


Fig. 1. Goldstone STDN-DSN cross-support configuration

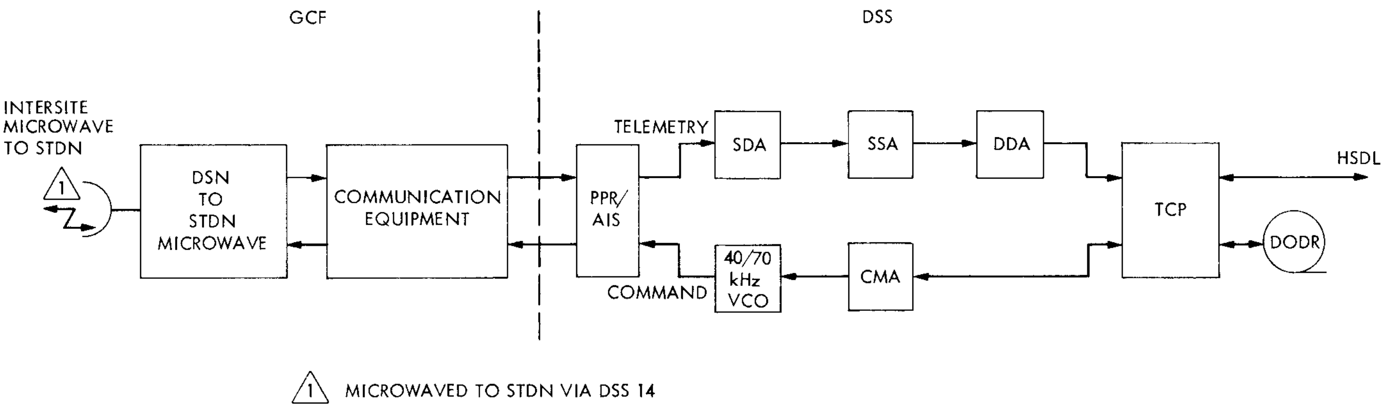


Fig. 2. DSN DSS 11 cross-support configuration

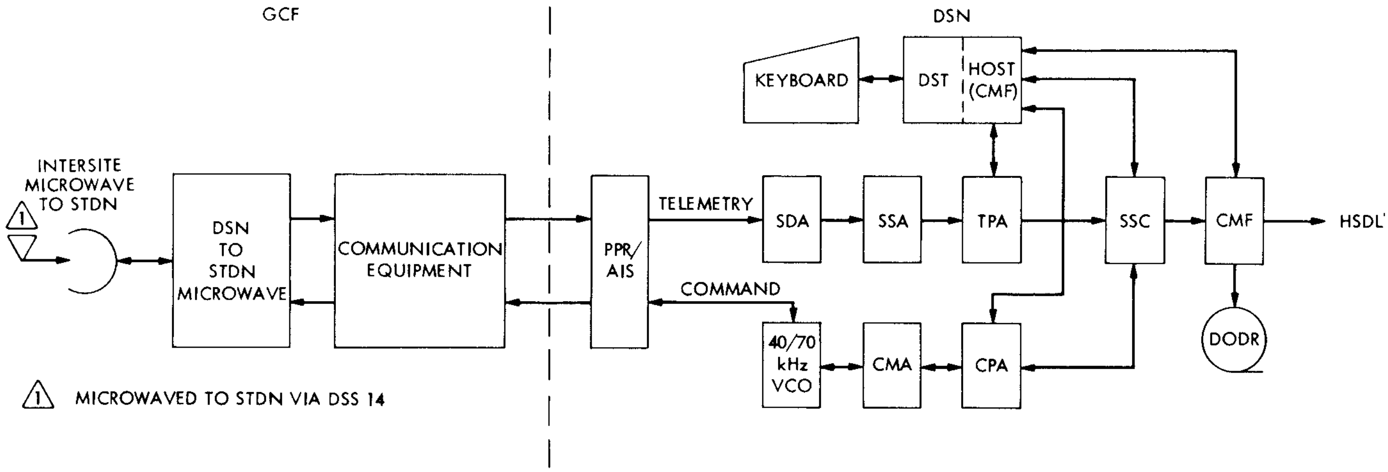


**Fig. 3. DSN DSS 12 Helios cross-support configuration**

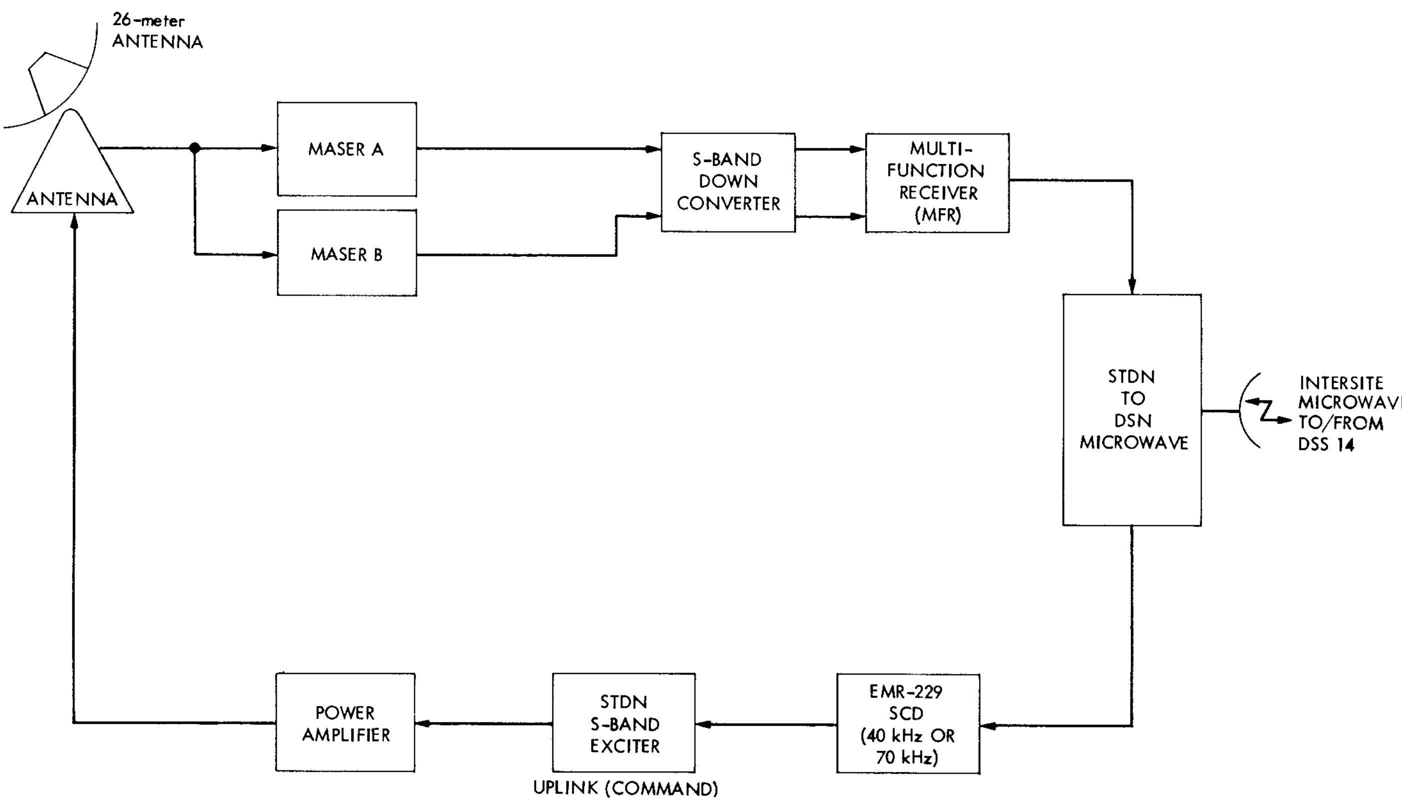


**Fig. 4. STDN Helios cross-support configuration**