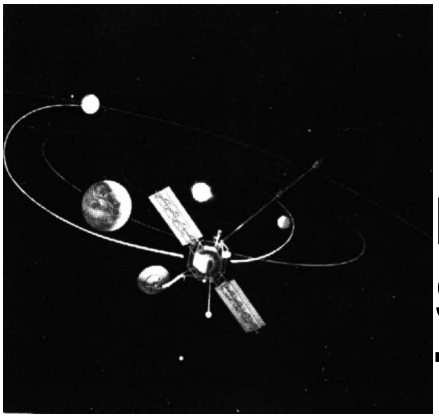

MARINER VENUS / MERCURY 1973

STATUS BULLETIN

MARINER 10 AT SOLAR SUPERIOR CONJUNCTION; THIRD ENCOUNTER PLANNED

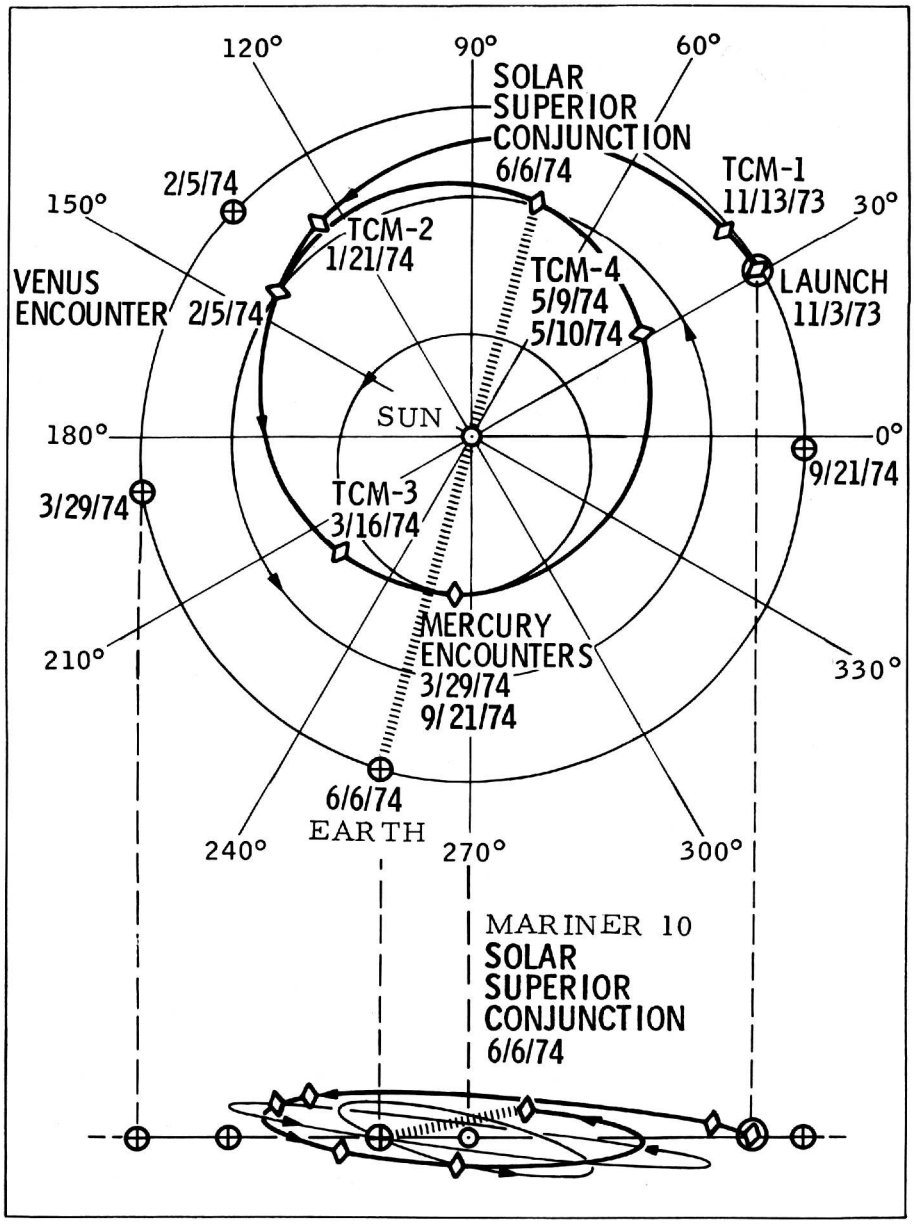

Fig. 1. Mariner 10 Orbit Position Relative to Earth and Sun at Time of Superior Solar Conjunction

MARINER VENUS/MERCURY 1973 PROJECT OFFICE
Jet Propulsion Labratory California Institute of Technology
National Areonautics and Space Administration
Pasadena, California

7 June 1974

BULLETIN NO. 32

THIRD MERCURY ENCOUNTER PLANNED

Mariner 10's fourth Trajectory Correction Maneuver on 9-10 May achieved eminently satisfactory flyby altitude and latitude coordinates at Mercury for television coverage of the sunlit surface on 21 September 1974. All spacecraft subsystems continue to perform normally, and attitude control gas usage remains well within predicted values. Therefore Mission Operations are proceeding on the assumption that there is to be a third encounter with Mercury, probably around 16 March 1975. To achieve a third flyby, however, a fifth trajectory correction maneuver will have to be performed around 2 July 1974 because of propulsion subsystem constraints.

Mariner 10 is now about 108 million kilometers (67 million miles) from the Sun (Fig. 1) and 260 million kilometers (160 million miles) from Earth. The spacecraft's speed in orbit relative to the Sun is 32 km/s (71,600 mph), and that of the Earth about 29.4 km/s (65,600 mph). But since the two bodies are moving on opposite sides of the Sun, the distance or range between them is changing relatively slowly.

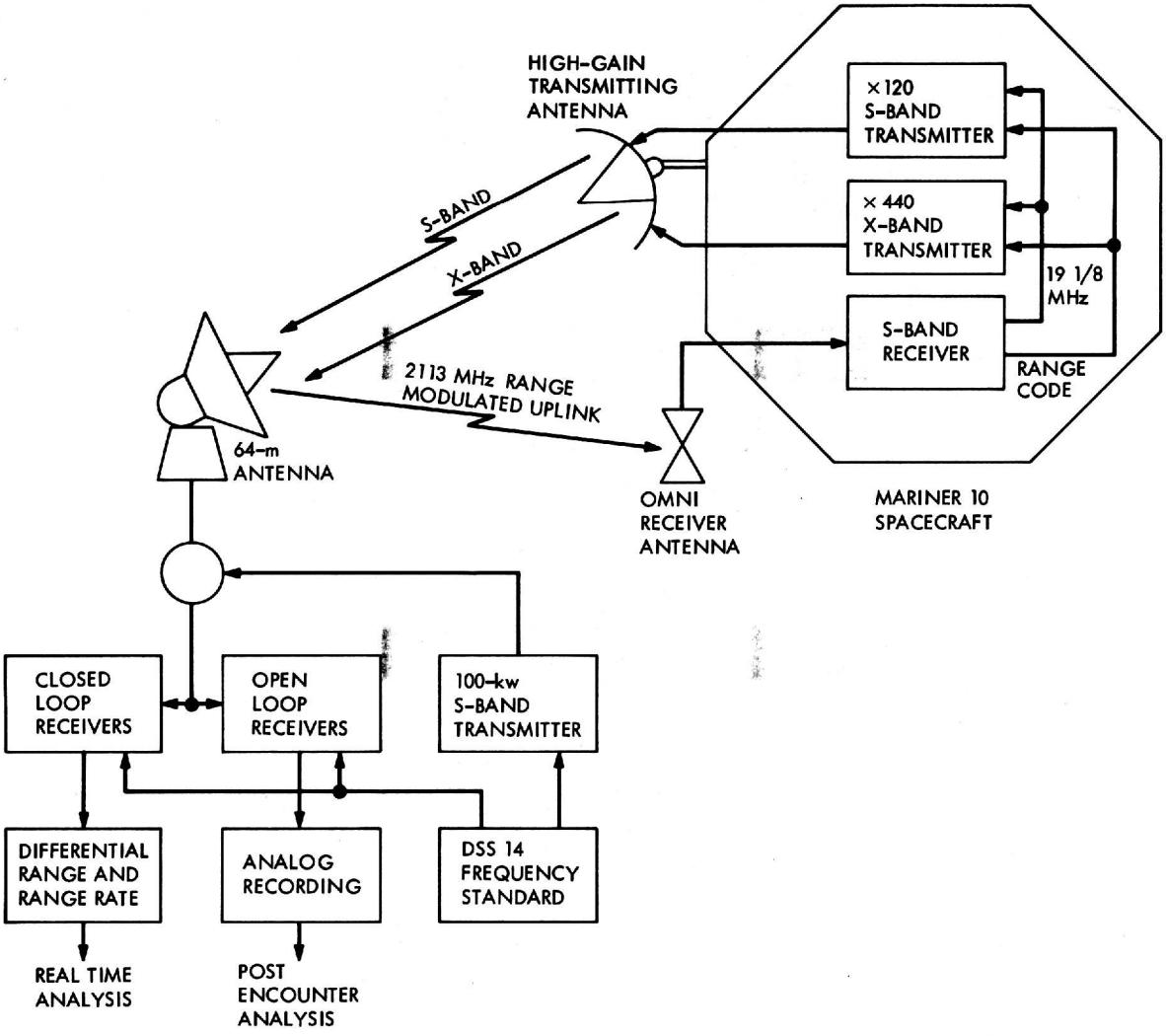

Fig. 2. Dual S- and X-Band Radio System at DSS 14 Goldstone for Mariner 10 Radio Communications

MARINER 10 AT SOLAR SUPERIOR CONJUNCTION

At the time of solar superior conjunction on 6 June 1974, the dual-channel S-Band and X-Band radio signals emanating from Mariner 10's high-gain antenna passed within 1.67 degrees of the Sun's surface as viewed from Earth. (See Fig. 1.) Effects of the solar corona's electron cloud on these signals are being recorded at Goldstone's DSS 14, using the R & D open-loop receivers and Block IV closed-loop receivers as shown in Figs. 2 and 3. The open-loop receiver data is being processed at the Stanford

University Center for Radio Astronomy while the closed-loop data is being processed at JPL. Using a real-time spectrum analyzer located at DSS 14, the same data is also being recorded by Dr. R. M. Goldstein of JPL.

Primary effects of the solar corona on the radio signals are scintillation and differential S/X-Band phase delay. Mariner 10 is the first space mission in which an X-Band signal has been used to probe the Sun's environment. In addition, dual-channel S/X-Band ranging data is being gathered. Data quality remains good despite low signal strength and high noise conditions. The influence of the Sun's coronasphere upon the range values became increasingly significant as the date of superior conjunction approached. Differences between S- and X-Band range as large as 3.6 microseconds have already been noted due to coronal effects. The maximum time delay expected when the S-Band frequency is used in both the uplink and downlink signals is about 11 microseconds, whereas with S-Band used in the uplink only and X-Band in the downlink the maximum delay should be about 6 microseconds. The reason for the difference in the delays is because the coronal effect has an inverse square dependence on the radio frequency, and the X-Band frequency is 11/3 the S-Band frequency.

Relativistic effects due to the Sun's enormous gravitational field acting on Mariner's radio signals are expected to cause a maximum delay of about 160 microseconds. No differences in relativistic delay will be seen between the S- and X-Band signals. (See Fig. 4.)

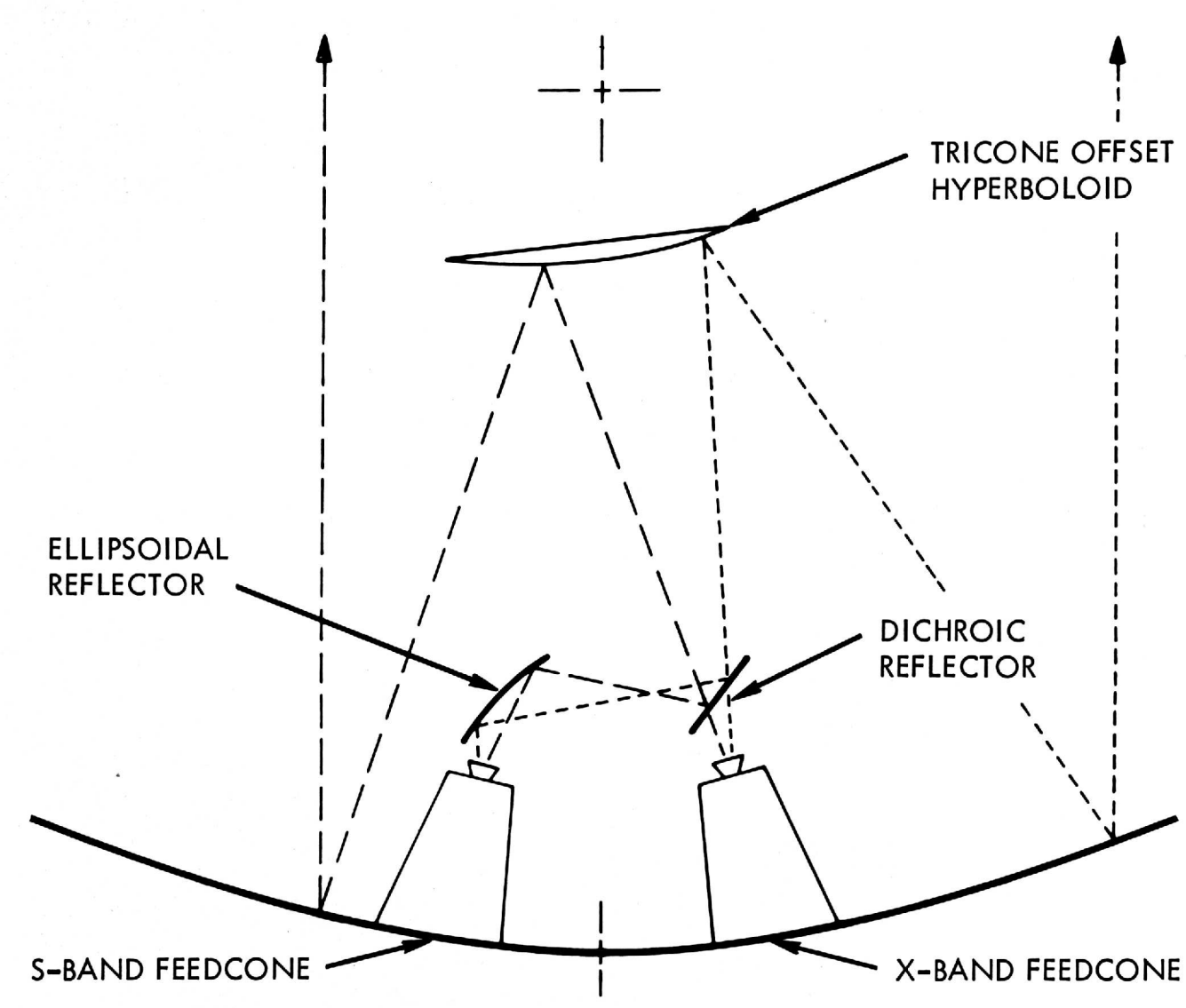

Fig. 3. Microwave Optics System of DSS 14 Goldstone 64-meter Antenna for Dual S- and X-Band Communications

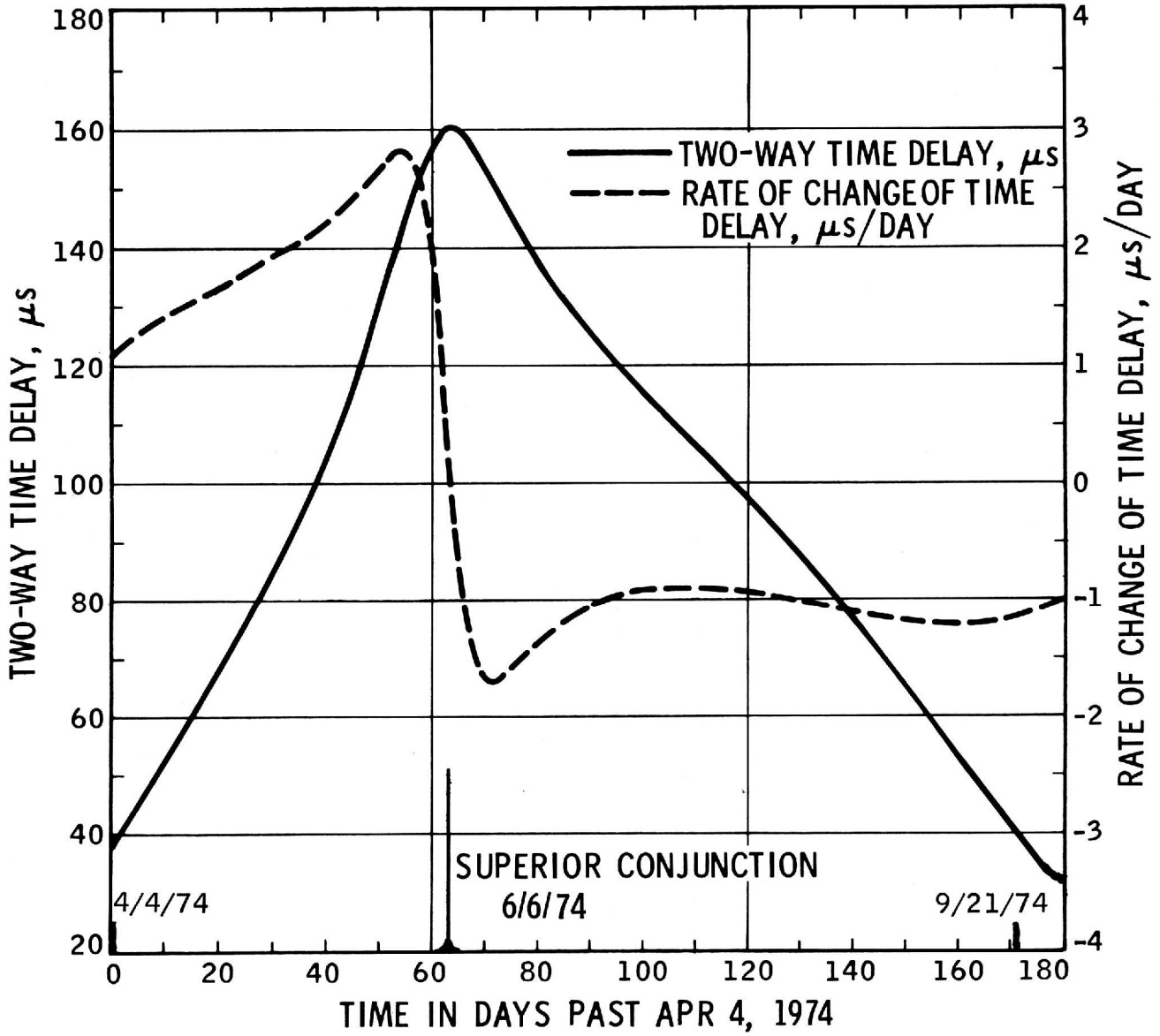

Fig. 4. Simulated Mariner 10 Relativistic Signal Delay Due To Sun's Gravity During the Period Between Mercury Encounters