Mariner Mars 1971 Mission Support

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At the start of the Mariner 9 orbit operations, some confusion existed over the varying number of bit errors observed in the picture transmissions. This article presents a summary of observations made in an attempt to clarify the situation.

Bit errors in the *Mariner 9* telemetry stream seem to be a mystery to many operations and management personnel, both in the Project and the DSN. Part of the reason for this mystery is that no one ever drew a calibration curve between the Project observable (picture spikes) and the DSN observable (telemetry signal-to-noise ratio). The results of such a calibration are presented in this article.

For the playbacks of P5 (periapsis 5), P6, and P7, simultaneous readings of picture spikes [Mission and Test Computer (MTC) calculation], Block Decoder Assembly (BDA) signal-to-noise ratio (SNR) [BDA/Telemetry and Command Processor Assembly (TCP) calculation], and DSS elevation (from predicts) were taken. The results are plotted on Figs. 1 through 3. For P5, the A telemetry system at DSS 14 was used, and the diplexer was switched in near the end of the playback. For P6, the B telemetry string was used, the diplexer was stuck in the IN position, and ranging was turned on about halfway through the playback; Fig. 1 shows the spectacular results. For P7, the B string was used with the diplexer out, and ranging was turned OFF part way through the playback.

On Fig. 4 the following information is plotted:

(1) The SIRD requirements for playback and real-time spectral data.

(2) Figure 3, translated into bit error rate from pixel errors per picture. Note that the MTC counts a picture element (pixel) error whenever any 9-bit pixel value differs by more than 40 from both the preceding and following pixels, both plus or both minus. The test is not made on the first and last bits of each line. Therefore, single bit errors in the three most-significant bits are counted, and single bit errors in the six least-significant bits are not counted. This translation considers multiple bit errors per pixel relatively improbable.

(3) The BDA observed bit error rate, translated from a DSIF calibration curve. (The calibration curve is actually for the BDA word error rate, and the zone of uncertainty is caused by assuming a range of one to three possible bit errors per word in error.)

Lastly, on the P7 playback, the number of pseudonoise (PN) bits in error and the number of "full lines" per picture, as calculated by the MTC, were tabulated. For the 21,628 good lines in the P7 playback, there were 39 PN bit errors, yielding a 1 in 17,190 error rate. Prior to ranging being turned off, the rate was 1 in 6000 at an average SNR of 5.54; after ranging was turned off, the rate was 1 in 79,300 at an average SNR of 7.55.

From these graphs the following conclusions can be drawn:

(1) Threshold for playback is at a displayed BDA SNR of 2.85, or alternately at an MTC spike count of 8700.

(2) Until December 13, 1971, the real-time spectral science threshold is at a displayed BDA SNR of 6.90. Thereafter, none is defined.

(3) The displayed BDA SNR is in error (on the high side), especially at SNRs above 4.5, and possibly also at lower SNRs.

(4) As signal levels decrease, the Project personnel should be prepared to see much higher PN error and pixel spike counts than they have seen to date.

(5) The time that the ranging channel is left on during high-rate telemetry periods should be minimized.

(6) Ranging should be accomplished at higher elevations, if possible.

(7) If the sequence and available resources allow it, the preferable mode is "Listen Only" at DSS 14.

(8) The B string performs slightly better than the A string at DSS 14 from a bit error point of view. (A separate check over the same period of time also showed fewer dropped lines from the B string than the A string.)

(9) There appears to be a base range of 0–150 spikes on each picture which are not attributable to the telecommunications/ground system.

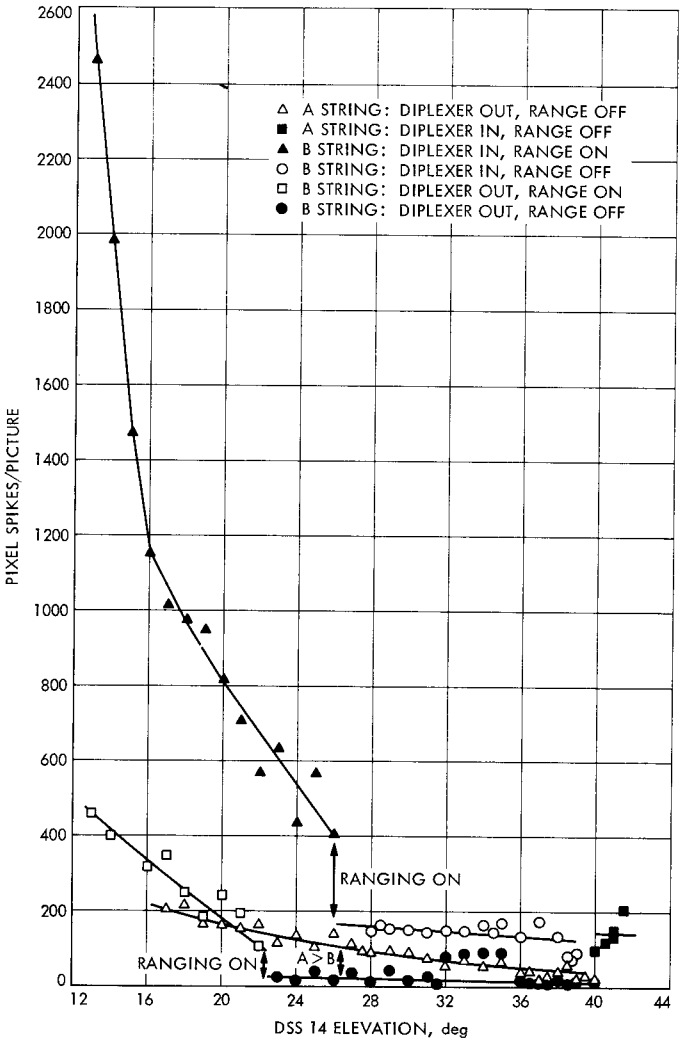

Fig. 1. Effect of DSS 14 elevation on pixel spike count

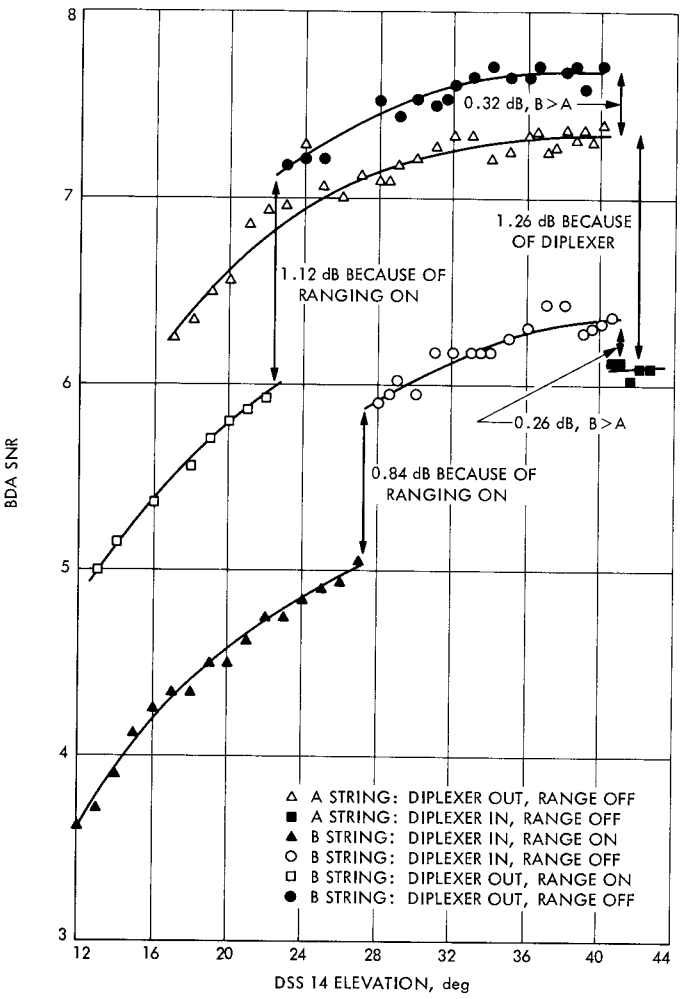

Fig. 2. Effect of DSS 14 elevation on BDA SNR

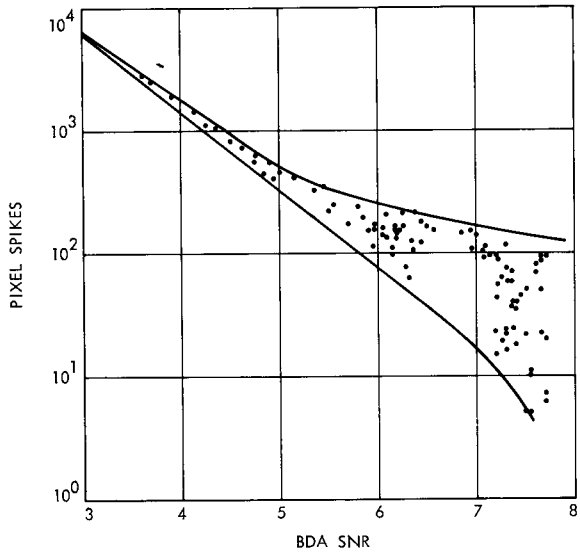

Fig. 3. Pixel spike/BDA SNR calibration

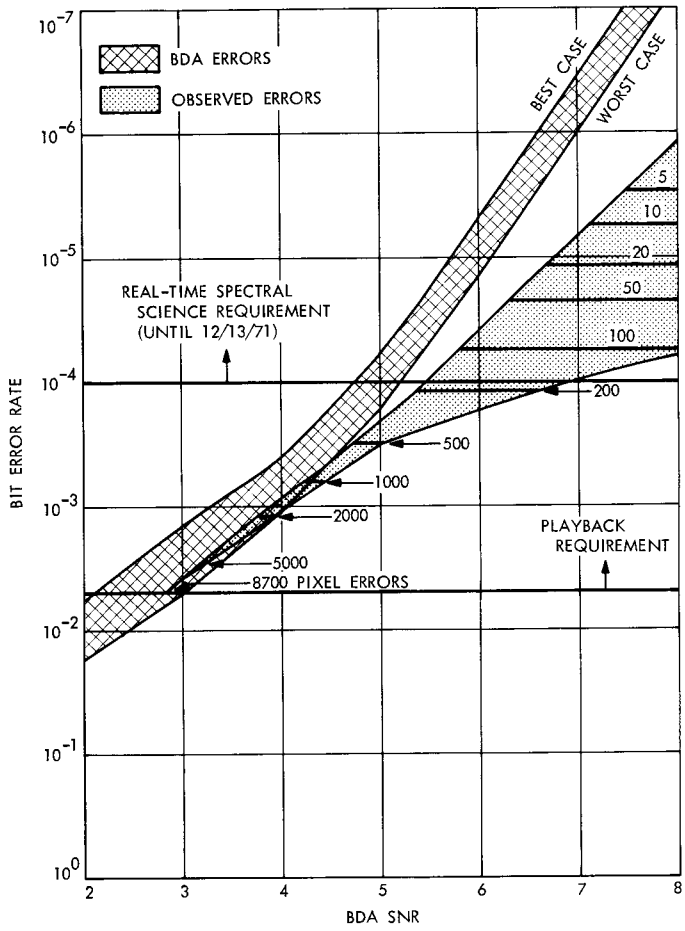

Fig. 4. Bit error rate/BDA SNR calibration