

STEREO MOC Status Report
Time Period: 2016:172 - 2016:178

STEREO Ahead (STA) Status:

1. The following Ground System anomalies/events occurred during this reporting period:

- On day 172, during the DSS-63 support, turbo decoder lock was lost briefly at 0846z. This anomaly resulted in the loss of 19 frames of SSR data. See DR #M109430 for more information.
- On day 173, during the DSS-55 support, initial telemetry acquisition occurred 35 minutes late at 0845z as the antenna was red. SSR pointers were repositioned to minimize data loss. Later in the support, turbo decoder lock was lost briefly at 1212z. These anomalies resulted in the loss of 8 frames of SSR data. See DR #M109435 for more information.
- On day 176, during the DSS-25 support, turbo decoder lock was lost briefly at 1654z and again at 1818z. This anomaly resulted in the loss of 2 frames of SSR data.
- On day 176, a Subsystem Assessment Review for the spacecraft bus was held at APL to review performance post solar conjunction for AHEAD. All subsystems reported continuing nominal performance post conjunction on the Ahead observatory, with the exception of the known increase in fine pointing loss for G&C. While the impact to imaging science has been reduced by tuning G&C parameters, the G&C team is continuing to analyze performance and determine the cause of the changed behavior.

2. The following spacecraft/instrument events occurred during this week. The Ahead observatory operated nominally during this week on the center of the HGA main lobe. The HGA feed assembly was at 86 degrees C and decreasing with the HGA angle at 12.5 degrees and increasing, with respect to the spacecraft-Sun line.

- The average daily science data return for Ahead was 5.6 Gbits during this week.

STEREO Behind (STB) Status:

1. The following Ground System anomalies/events occurred during this reporting period:

- On day 172, during the DSS-26 34m support, using the 80 kW transmitter to minimize 70m contentions, the transmitter tripped off-line at 1714z due to a coolant flow anomaly. The transmitter was re-calibrated and placed back on line at 1810z. This anomaly resulted in the failure to radiate approximately 72 battery recovery commands covering 8 frequency segments. 279 commands were sent for battery state of charge recovery. See DR# G117268 for more information.
- On day 173, during the DSS-26 34m support, using the 80 kW transmitter to minimize 70m contentions, 351 commands were sent for battery state of charge recovery.
- On day 174, during the DSS-14 70m support, 560 commands were sent for transmitter carrier recovery. The Arecibo Observatory and the Allen Telescope Array observed concurrently, however, no downlink signal was detected by them or the DSN. Due to the duration of the support and the increased commands for each step, only 28 of the 36 frequency segments were commanded. Three commands must be received sequentially to power on the transmitter.

2. Detailed status of the recovery activities to restore operations from the Behind loss of communication anomaly, which occurred on October 1, 2014, are listed below.

- The Behind observatory entered superior solar conjunction at the 2.0 degree SPE angle on January 22, 2015. Recovery efforts resumed post solar conjunction on May 4th through June 27, 2015, as the spacecraft had cleared solar interference for LGA communications. The Failure Review Board recommendations were implemented consisting of battery state of charge recovery and powering on the downlink carrier. The Green Bank Radio Telescope and the Arecibo Observatory also observed the carrier recovery tracks. No downlink signal has been detected. Due to Behind's retrograde motion causing it to re-enter the region of solar interference, recovery operations were suspended from June 28th through November 29, 2015. Weekly recovery operations resumed on November 30, 2015. The

Green Bank Radio Telescope and the Allen Telescope Array will also observe the carrier recovery tracks depending on availability. While the Arecibo Observatory is willing also assist, the Behind observatory is only in view mid-April through mid-September. To minimize the impact on DSN resources, recovery operations were reduced to every other week beginning on March 21, 2016. Beginning in July, GSFC has directed to reduce Behind recovery operations to monthly, alternating the nominal single station recovery configuration with the uplink array use. Recovery operations will be suspended in July 2017 and resume in January 2020 when the LGA uplink returns to 125 bps.

- The Failure Review Board's recommended faster frequency segmented acquisition sequence was tested with the Ahead observatory on September 29, 2015. All 18 one kHz frequency steps were tested twice. While stepping down through the 1 kHz segments, on segment #9 going down in frequency, the transponder locked to the BLF and accepted 9 no-op commands as expected. An interesting finding, but not unexpected, was that the transponder continued to follow the moving carrier and accept all commands sent for the remaining 27 segments.
- As commands must be received to recover the Behind observatory, the first use of the newly developed DSN uplink arraying capability for Behind recovery operations occurred on March 17, 2016. The uplink array capability provides four times the uplink received power as a 70m station. The uplink array consists of using an 80 kW and two 20 kW transmitters from three 34m Goldstone stations, DSS-24, 25, and 26, with each uplink being precisely phase shifted to create a constructive interference. From testing with STEREO Ahead, an approximate 12 dBm increase in received uplink power, as compared to a single 34m, has been successfully demonstrated each time. As the Behind observatory may be rotating, a frequency segmented acquisition sequence will be used with the uplink array. For each use of the uplink array, as transponder feedback is required, the Ahead observatory is first used to calibrate the phased uplink array then the three stations are switched to point to the Behind observatory sending commands for recovery. The uplink array will be used twice every other month within a three day period, once for battery recovery and again for carrier recovery. The next use of the uplink array is scheduled for July 16th and 17th.

- As time goes by, the ephemeris error increases degrading DSN antenna pointing. However, with time the spacecraft range also decreases improving RF communications and the ability for other assets to acquire data on Behind. Analysis indicates that the total RF gain change is significant and the probability of command success increases with time.

Significant findings to date:

1. Analysis of the three DSN extracted telemetry frames from the carrier signal just before the planned observatory reset/anomaly occurred on October 1, 2014 showed nominal performance of the spacecraft, i.e., no anomalies, IMU off, and the star tracker providing an attitude solution.
2. Post reset, from the very limited telemetry, three packets, extracted from the carrier signal by the DSN, the X-axis gyro on IMU-A had failed. Unfortunately, this telemetry contained only G&C anomaly data and no spacecraft summary data, i.e., the state of the RF, G&C, fault protection and other subsystems is not known at the time of the anomaly. With a failed IMU and the star tracker being off-line for an undetermined duration, the sun sensors will keep the observatory pointed at the Sun, though the G&C will not have any roll knowledge, and cannot roll the observatory as part of the safing configuration to re-establish communications on the LGAs. From analysis of this telemetry and initial G&C simulations, it is highly suspected that the observatory is rotating about the principal axis of inertia due to an autonomous momentum dump initiated by highly biased gyro data flagged good by the IMU, but this has not yet been confirmed.
3. At least two anomalies occurred post reset, the star tracker not promoting to AAD mode and the X-axis gyro failure. Unfortunately, due to the number of possible combinations, the STEREO fault protection system is not designed for simultaneous failures.

Once communications are restored and the anomaly resolved, the Behind observatory will be returned to nominal science data collection as soon as it is safely possible.