STEREO MOC Status Report
Time Period: 2016:179 - 2016:185

STEREO Ahead (STA) Status:

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

   - On day 179, during the DSS-26 support, turbo decoder lock was lost briefly at 1827z. This anomaly resulted in the loss of 102 frames of SSR data.

   - On day 181, during the DSS-54 support, turbo decoder lock was lost briefly at 0946z. This anomaly resulted in the loss of 1 frame of SSR data.

   - On day 181, during the DSS-14 support, turbo decoder lock was lost briefly at 1712z. This anomaly resulted in the loss of 15 frames of SSR data.

   - On day 183, during the DSS-24 support, turbo decoder lock was lost intermittently between 1607z and 2239z. This anomaly resulted in the loss of 10 frames of SSR data.

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 85 degrees C and decreasing with the HGA angle at 12.7 degrees and increasing, with respect to the spacecraft-Sun line.

   - On day 179, the 5th battery conditioning event was successfully conducted at 1724z on the Ahead spacecraft to redistribute the electrolytes within the nickel hydrogen battery cells. The test results were very consistent with the previous test in 2014.

   - On day 180, at 0100z, ESA successfully conducted an uplink frequency ramping test with the Ahead observatory in preparations for assisting the Cassini Project with an uplink transfer between the DSN and the ESA stations. The space weather broadcast may have dropped out for several 2.3 minute periods.

- The average daily science data return for Ahead was 6.0 Gbits during this week.

STEREO Behind (STB) Status:

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

   - None as recovery tracks are every other week.

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.