STEREO MOC Status Report
Time Period: 2016:130 – 2016:136

STEREO Ahead (STA) Status:

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

   - On day 130, during the DSS-45 support, telemetry lock was lost intermittently between 0339z and 05585z due to heavy rain at the Canberra complex. This anomaly resulted in the loss of 11,041 frames of real-time and SSR data. See DR# C112055 for more information.

   - On day 130, during the DSS-24 support, turbo decoder lock was lost intermittently beginning at 1814z through 2039z. This anomaly resulted in the loss of 19 frames of SSR data.

   - On day 132, during the DSS-65 support, turbo decoder lock was lost intermittently between 0934z and 0942z due to heavy rain at the Madrid complex. This anomaly resulted in the total loss of 11,573 frames of real-time and SSR data. As there was sufficient track time, SSR pointers were repositioned on the next support and all SSR data was recovered. See DR# M109356 for more information.

   - On day 133, during the DSS-26 support, turbo decoder lock was lost intermittently between 2022z and 2024z. This anomaly resulted in the loss of 8 frames of SSR data.

   - On day 134, during the DSS-55 support, turbo decoder lock was lost intermittently between 0916z and 1058z. This anomaly resulted in the loss of 9 frames of real-time telemetry and 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 98 degrees C and decreasing with the HGA angle at 10.8 degrees and increasing, with respect to the spacecraft-Sun line.

   - On day 130, the 34th SECCHI stepped calibration was executed at 1200z to recalibrate the COR1 imager. This was the 3rd SECCHI stepped calibration roll to be conducted without

gyro use. Note that the G&C control bandwidths that were loaded on day 055 for improving roll error were in effect for each data collection step.

- On day 133, at 1710z, Fault Protection release 2.3.19 and MOps macro release 1.1.29 were loaded to C&DH RAM and verified. These releases contain a new autonomy rule for detecting a loss of battery state of charge quicker and commands for correcting a wheel over speed reset condition.

- On day 134, the Ahead observatory was used to phase calibrate the 4th uplink array, using DSS-24, 25, and 26 for 1.9 hours, to support the array use for STEREO Behind battery recovery. At 1559z, the transmitter at DSS-26 tripped off-line for 11 minutes due to a coolant temperature issue. See DR# G117166 for more information. An 11.5 dB gain in uplink AGC was observed in the spacecraft transponder data. No SSR playback was conducted as the phasing of transmitters would have caused periodic dropped frames.

- On day 135, the Ahead observatory was used again to phase calibrate the 5th uplink array, using DSS-24, 25, and 26 for 1.9 hours, to support the array use for STEREO Behind battery recovery. A 12 dB gain in uplink AGC was observed in the spacecraft transponder data. No SSR playback was conducted as the phasing of transmitters would have caused periodic dropped frames.

- On day 136, the PLASTIC instrument increased their record rate to 3.3 kbps at 0000z.

- The average daily science data return for Ahead was 5.4 Gbits during this week.

STEREO Behind (STB) Status:

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

   - On day 134, the 4th uplink array for STEREO Behind recovery was conducted using DSS-24, 25, and 26. The uplink array was phase calibrated using the Ahead observatory first for 1.9 hours then the arrayed stations were switched to point to the Behind observatory. The configuration consisted of

with the three 34m stations at the Goldstone complex using the 80 kW and two 20 kW transmitters incorporating the frequency segmented acquisition sequence with the MOC sending commands for battery recovery. Initial commanding was delayed by two minutes due to software issue with the command bind at the station. This anomaly resulted in four commands being aborted. 283 commands covering 36 frequency segments were sent for battery state of charge recovery.

- On day 135, the 5th uplink array for STEREO Behind recovery was conducted using DSS-24, 25, and 26. The uplink array was phase calibrated using the Ahead observatory first for 1.9 hours then the arrayed stations were switched to point to the Behind observatory. The configuration consisted of with the three 34m stations at the Goldstone complex using the 80 kW and two 20 kW transmitters incorporating the frequency segmented acquisition sequence with the MOC sending commands for transmitter carrier recovery. At 2342z, the DSN command state did not transition operational for the last segment due to a known software issue. See DR# G117169 for more information. 680 commands covering 34 frequency segments were sent. The DSN 70m station, DSS-14, and the Allen Telescope Array observed concurrently. Intermittent carrier locks were reported by both DSS-26 and DSS-14, but at different times. No downlink signal was detected by the Allen Telescope Array. Use of the DSN radio science receiver recording during the monthly carrier recovery uplink array recovery supports for definitive signal verification has been requested.

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. Recovery operations were reduced to every other week beginning on March 21st to minimize the impact on DSN resources.

- 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, 2015. 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 monthly within a three day period, once for battery recovery and again for carrier recovery. The next use of the uplink array is scheduled for June 11th and 12th.

- 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.