STEREO MOC Status Report
Time Period: 2018:134 – 2018:140

STEREO Ahead (STA) Status:

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

   - On day 138, during the DSS-55 support, turbo decoder lock was lost intermittently at 1017z through 1054z and again at 1524z through 1534z due to rain at the Madrid complex. This anomaly resulted in the loss of 8181 frames of real-time telemetry and SSR data. See DR# M110598 for more information.

   - On day 139, during the DSS-55 support, turbo decoder lock was lost intermittently at 1126z through 1220z. This anomaly resulted in the loss of 1132 frames of real-time telemetry and SSR data. See DR# M110599 for more information.

   - On day 140, during the DSS-43 support, turbo decoder lock was lost intermittently at 0450z through 0456z and again at 0603z and 0638z. This anomaly resulted in the loss of 14 frames of SSR data. See DR# M110583 for more information.

   - On day 140, during the DSS-55 support, turbo decoder lock was lost briefly at 0855z. This anomaly resulted in the loss of one frame of SSR data.

2. The following spacecraft/instrument events occurred during this week. The Ahead observatory operated nominally during this week.

   - On day 135, the 109th momentum dump was executed successfully at 2000z, which imparted an estimated delta V of 0.089 m/sec. This was the 28th momentum dump that did not use the IMU. After thruster operations completed, there was a 0.1 degree of roll angle error which was dampened out over the next 8.5 minutes. Fine pointing stabilized 2.5 minutes after completion of the momentum dump.

   - The average daily science data return for Ahead was 6.5 Gbits during this week.

STEREO Behind (STB) Status:

1. Detailed status of the recovery activities this week to restore operations is listed below.

   - On day 138, during a 3.5 hour 1 kHz battery recovery support with DSS-14, 270 commands were transmitted for battery state of charge recovery. Due to the duration of the support, only 30 of the 36 frequency segments were commanded.

   - On day 139, during a 4 hour 1 kHz carrier recovery support with DSS-14, 440 commands were sent for transmitter carrier recovery. No carrier was detected by the DSN station. Due to the duration of the support and the increased commands for each step, only 22 of the 36 frequency segments were commanded. Three commands must be received sequentially to power on the transmitter.

   - On day 140, during a 4 hour 1 kHz carrier recovery support with DSS-14, 440 commands were sent for transmitter carrier recovery. No carrier was detected by the DSN station. Due to the duration of the support and the increased commands for each step, only 22 of the 36 frequency segments were commanded. Three commands must be received sequentially to power on the transmitter.

2. The Behind loss of communication anomaly occurred on October 1, 2014 from simultaneous failures of the star tracker and the IMU. Post superior solar conjunction, recovery operations resumed on November 30, 2015. By implementing the NASA Failure Review Board recommendations, the first recovery attempt began with carrier detection by the DSN on August 21st, through September 23, 2016. At a spacecraft range of ~2 AU, the observatory was found to be rotating slowly about its principal axis of inertia for which the uncontrolled attitude allowed some solar array input and continuous uplink and downlink communications on the LGA at emergency data rates. Over the next 22 continuous days, significant obstacles to recovery were overcome with a collaborative effort of the JHU/APL engineering team, NASA GSFC, DSN, FDF, SSMO scheduling, and Mission Operations teams. This consisted of:

   - Reliably commanding a rotating spacecraft with uncontrolled attitude at a distance of 2 AU

- How to power on the spacecraft that was never designed to be off without collapsing the battery voltage
- Acquiring telemetry at 35 bps from a spacecraft that is rotating with an uncontrolled attitude
- Warming a frozen propulsion subsystem with a degraded battery and limited solar array input with an uncontrolled attitude
- Configuring, loading, and verifying EA, C&DH, and G&C parameters and macros with very limited telemetry
- Conducting an autonomous momentum dump in the blind and transitioning to C&DH standby mode and successfully receiving telemetry on the HGA indicating star tracker lock and decreasing system momentum.

However, system momentum level remained above the threshold for re-establishing attitude control with the reaction wheels. Due to the uncontrolled attitude, communication degraded and the last detection of the carrier was on September 23, 2016.

Behind Observatory Status – From the last telemetry received on September 18, 2016 and the telemetry assessment review held on February 24, 2017, main bus voltage is low, 3 out of 11 battery cells are bypassed, and attitude remains uncontrolled, rotating about its principal axis of maximum moment of inertia. While likely all ~42 kg of hydrazine remains and is frozen, both pressure transducers are not functioning. EA mode is enabled and autonomy is disabled. The battery charge rate is C/10. RF is configured for the +Z LGA at emergency data rates and the range of the expected best lock frequency (BLF) is known.

In July 2017, with collaboration with GSFC, the recovery plan was revised and 61 procedures were developed and tested. Significant improvements include:

- Using the –Z LGA as it provides 2 dB more than +Z LGA
- Recovering in C&DH standby mode to better protect the battery
- Minimize fault protection usage
- Close latch valves after each thrusting operation
- Refined autonomous momentum dump to re-establish 3-axis attitude control
  - Use IMUA as it will leave solar arrays Sun pointing
  - Power wheels on after momentum dump

After 2.5 months of daily recovery efforts that began on August 21, 2017, to date the downlink signal has not been detected by the DSN block V receivers or the RSR team. With significant support of the DSN, two different acquisition sequences are being utilized monthly to re-establish communications with STEREO Behind using a 70m track:

1. 1 kHz Frequency Segmented Sweep – consists an 18 kHz frequency range divided into 18, 1 kHz segments, each swept at a 1 kHz rate, stepping down in frequency and them back up again. During each segment, the MOC sends battery recovery commands on the first day and on the second and third days, carrier recovery commands. This was the acquisition sequence that originally detected the Behind downlink in August 2016.

2. 4 kHz Sweep with Search Pattern – The DSN created a diamond shaped search pattern with 7 steps of 0.037 deg, dwelling 10 min & 49 sec/step. There are two diamond patterns of 4 steps to cover the area of the estimated ephemeris error. The starting point is offset 0.02 deg for 100% uplink optimization. Repeating each diamond pattern accounts for the 30 minute RTLT. This search pattern acquisition sequence is once a day for three consecutive days with battery recovery commands at each step during the first day and on the second and third days, sending carrier recovery commands at each step.

In December 2017, the DSN refined their telemetry extraction process from low signal levels and was able to deliver 18 new frames from the BEHIND recovery, all post momentum dump. While nothing new was discovered, much of the following observations confirm what was known:

- Battery temperature was at 52.72 deg C (upper telemetry limit), probably higher due to an overcharge condition
- Latch valve telltales appear to be functioning
- Last-minute commands sent to shed main bus load were received as the main bus current dropped about 6A
- The IMU was flagged invalid throughout the period
- The star tracker was tracking and enabled throughout
- After all commanded thruster firing had terminated the angle between the angular momentum vector and sun vector steadily increased at ~0.03 deg/min. This tends to further support the hypothesis that something was being expelled.