

STEREO MOC Status Report  
Time Period: 2018:106 - 2018:112

STEREO Ahead (STA) Status:

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

- On day 109, during the DSS-43 support, telemetry lock was lost intermittently between 0437z and 0443z. This anomaly resulted in the loss of 3 frames of SSR data.
- On day 109, during the DSS-55 support, telemetry lock was lost briefly at 1316z. This anomaly resulted in the loss of 4 frames of SSR data.
- On day 112, during the DSS-35 support, telemetry lock was lost intermittently between 0146z and 0220z and again between 0407z and 0418z. This anomaly resulted in the loss of 15,446 frames of real-time telemetry and SSR data. See DR #C113376 for more information.
- On day 112, during the DSS-55 support, telemetry lock was lost intermittently between 1034z and 1035z. This anomaly resulted in the loss of 5 frames of SSR data.

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

- On day 108 at 1420z, the 12<sup>th</sup> SECCHI GT Calibration Offpoint event was conducted.
- The average daily science data return for Ahead was 7.7 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 107, during a 3 hour 4 kHz battery recovery search pattern support with DSS-14, 320 commands were transmitted

during the support. All 7 points on the pattern were covered twice.

- On day 110 during a 3 hour 4 kHz carrier recovery search pattern support with DSS-43, 320 commands were transmitted during the support for carrier recovery. No carrier was detected by the DSN station. All 7 points on the pattern were covered twice. Three commands must be received sequentially to power on the transmitter.
- On day 112, during a 3.2 hour 4 kHz carrier recovery support with DSS-14, 320 commands were transmitted during the support. No carrier was detected by either the DSN station or the radio science receiver team after attempting to power on the TWTA for 30 minutes. Transitioned to battery recovery operations for the remainder of the support which consists of repeatedly sweeping a 4 kHz uplink range and sending commands for IEM switched power and PDU 1553 interface bus off.

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 21<sup>st</sup>, 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, 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
  - o Use IMUA as it will leave solar arrays Sun pointing
  - o 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 weekly to re-establish communications with STEREO Behind using a 70m track:

1. 4 kHz Sweep - consists of repeatedly sweeping a 4 kHz uplink frequency range for which the BLF was found during the first recovery attempt. Commands are sent to power on the transmitter for 30 minutes. If no carrier signal is detected, the transmitter is powered off and battery recovery commands are sent consisting power off the IEM switched power and PDU 1553 interface bus. This acquisition sequence is used 3 times each week.
  
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 used twice weekly during 3 hour supports, sending battery recovery commands at each step during the first day and on the second day, sending carrier recovery commands at each step.

Recently 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.