STEREO MOC Status Report
Time Period: 2017:289 - 2017:295

STEREO Ahead (STA) Status:

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

   - On day 293, during the DSS-14 support, turbo decoder lock was lost intermittently beginning at 1755z through 1804z. This anomaly resulted in the loss of 306 frames of real-time telemetry and SSR data.

   - On day 293, during the ESA Malargüe (DSS-84) support, the transmitter tripped off at 2052z, immediately after the initial sweep. The second uplink acquisition completed successfully at 2058z. As no monitor data is received from ESA supports, an indeterminate number of telemetry frames dropped at 2126z due to late transition from non-coherent to coherent downlink.

   - On days 293 and 294, the MOC was on portable generator power as commercial and backup generator power was disabled as high voltage required maintenance was performed on the power substation that feeds the building. Three DSN and one ESA supports were conducted satisfactory during this period. Note that as two high voltage breakers need to be refurbished, additional TBD substation maintenance will be scheduled.

   - On day 294, during the DSS-14 support, command bind dropped at 1850z when attempting to uplink Instrument Stored Command Buffer dump command. MOC command software indicates command was sent, but not acknowledged or radiated. All SSR data was received.

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

   - On day 292, fine pointing was lost intermittently beginning at 2104z through 293-0122z, briefly at 293-1818z, 294-1038z and again on 294-1521z for a total of 217 seconds over a ~2 day period due to wheel-speed avoidance failures and attitude transients from momentum redistribution. Fine

pointing was well within the 3-sigma prime mission requirement. The worst pointing performance was actually during the last several hours of day 292 when wheels 3 & 4 were at their lowest speeds during the period (<100 rpm) where one would expect to see the worst friction/drag effects. Peak pitch & yaw errors during the period were 22.3 & 15.9 arcsec, respectively. In total there were four periods where wheel avoidance failed. Despite the increased noise transients during the period, overall pointing performance remained quite good. These transients can occur with no gyro operations and are not indicative of any problem with the spacecraft G&C.

- The average daily science data return for Ahead was 4.5 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 289, during a 3.25 hour 4 kHz battery recovery search pattern support with DSS-14, no commands were transmitted during the support as the transmitter was declared red. See DR #G118560 for more information.

   - On day 290, during a 2.5 hour 4 kHz carrier recovery support with DSS-14, 260 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.

   - On day 291 during a 3.1 hour 4 kHz carrier recovery search pattern support with DSS-14, 320 commands were transmitted during the support for carrier recovery. No carrier was detected by either the DSN station or the radio science receiver team. All 7 points on the pattern were covered twice. Three commands must be received sequentially to power on the transmitter.

- On day 292, during a 2.5 hour 1 kHz battery recovery support with DSS-14, 189 commands were transmitted for battery state of charge recovery. Due to the duration of the support, only 21 of the 36 frequency segments were commanded.

- On day 293, during a 3.5 hour 1 kHz carrier recovery support with DSS-14, 361 commands were sent for transmitter carrier recovery. No carrier was detected by either the DSN station or the radio science receiver team. Due to the duration of the support and the increased commands for each step, only 19 of the 36 frequency segments were commanded. Three commands must be received sequentially to power on the transmitter.

- On days 293 and 294, the MOC was on portable generator power as commercial and backup generator power was disabled as high voltage required maintenance was performed on the power substation that feeds the building. One DSN support for Behind recovery was conducted satisfactory during this period. Note that as two high voltage breakers need to be refurbished, additional TBD substation maintenance will be scheduled.

- On day 294, 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.

- On day 295, during a 3.7 hour 4 kHz carrier recovery support with DSS-14, the SLE command bind was lost at 1311z. The MOT restored the command bind at 1418z and 240 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 star tracker and 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, 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. Necessary macro sequences have been tested to allow the peak power tracker in C&DH standby mode to protect the battery. These macro sequences will be loaded to EEPROM when the communications supports longer commands.

Based on G&C geometric analysis and GSFC modeling, daily recovery efforts began on August 21st, and will continue through November 5th. With significant support of the DSN, three 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. Frequency Segmented 1 kHz – To ensure command reception, the original faster frequency segmented acquisition sequence is used 2 days each week. This consists of 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 day, carrier recovery commands. This was the acquisition sequence that originally detected the Behind downlink in August 2016.

3. 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.