

MCS activities (since start of PSP activities)

This does not cover activities prior to the start of the PSP.

There are a number of short periods ( $< 2$  hours) where MCS was stowed or frozen pointing in unusual directions for other S/C activities. These are not explicitly called out. They may have slight perturbations in calibration quality for up to 2 hours afterwards (due to thermal perturbations).

Many of the activities are correctly indicated in the geometry and are only included to help find/avoid the related data. The use of the database observation type flags can easily pull out the types of observations of interest.

Reduced scanning involves only performing limb scanning with the nadir position moved to  $10^\circ$  below the limb and blackbody calibrations (also with the nadir position moved to  $10^\circ$ ). Note that when starting reduced scanning, there may be buckshot observations (and solar calibrations) during the first two hours.

06/09/24 MCS powers on

Note that the instrument took  $\sim 48$  hours to thermally stabilize, this may impact the instrument calibration. Other changes to the thermal control generally created smaller perturbations.

S/C pointing may not have been as accurate as later due to older ephemeris on board. This does not affect the quality of the geometry, but may affect the utility of the observations.

06/09/25 First thermal update: use a narrow control band.

06/09/26 First seasonal update:

Seasonal updates occurred from 06/09/24 through 07/01/05, but are not explicitly called out. Due to the seasons covered, apart from the first update the only seasonal update was to move the location of the solar target calibrations (this sometimes impacted the timing or coverage of the buckshot regions).

06/09/28 Second thermal update (change to OBA control temperature and additional power to the blackbody): Possible impact to calibration over the next 24 hours.

06/10/02 Off nadir day: During this day, the other instruments commanded very frequent rolls, resulting in a significant number of gaps in coverage.

06/10/03 Update to pointing to improve limb tracking. This takes into account the error in the instrument pointing and the change in MRO orbit.

06/10/09 Start of solar conjunction

No seasonal updates were performed during this time (next seasonal update after 06/10/05 was 06/11/03). Also, the S/C pointing drifted more than usual (the MCS geometry is correct). Also, several significant data gaps occurred during conjunction due to loss of data during playback.

06/11/02 End of conjunction; Onboard pointing was updated. Conjunction data playback started.

06/11/02 Blackbody calibration sequence improved.

06/11/03 Seasonal update post-conjunction and change to perform buckshot patterns on every other orbit (instead of every orbit).

06/11/05 Electra test day. Loopback and unusual scanning was used extensively this day. Note that the blackbody was changed back to the pre-conjunction version as part of this activity.

06/11/07 Change to the post-conjunction blackbody calibration.

06/11/09 Flatfield calibration: During this S/C activity, MCS spent part of the time operating in a pushbroom nadir mode. The calibration may need to be done manually due to the unusual calibration scheme.

06/12/11 First position error

Additional position errors occurred from here through 06/12/19. During this time, there may be inaccuracies in the geometry information (pointing off by up to 4 steps or  $0.404^\circ$ ). The team is working on properly flagging and/or fixing the geometry information.

06/12/12 through 06/12/14 Stowed (with two 1 minute exceptions).

06/12/15 through 06/12/19 Stowed

06/12/19 through 06/12/23 Stowed

06/12/23 Started reduced fore-limb scanning.

07/01/04 Started full scanning.

07/01/16 Position errors started occurring

Additional position errors (including some errors  $> 10^\circ$ ) occurred from here through 07/01/25. The geometry information may not be correct (see previous comment).

07/01/18 Start reduced fore-limb scanning. ( $< 4$  hours of scanning)

07/01/19 Start reduced aft-limb scanning.

07/01/21 through 07/01/24 Stowed

07/01/24 Add interleaved azimuth scanning.

07/01/25 Stow due to position errors

07/02/09 Stare at the limb. The calibration of this data is in progress.

07/03/14 MCS powered off due to S/C safe mode entry.

07/03/20 MCS powered on briefly (~10 minutes) no science data

07/03/22 MCS powered on briefly (~10 minutes), stowed the entire time

07/03/22 MCS powered on stowed

07/03/28 MCS returns to limb staring

07/05/14 Electra testing involving two loopback sessions.

07/05/15 Electra testing involving two loopback sessions and pointing at azimuth 270.

07/05/16 Electra testing involving two loopback sessions and pointing at azimuth 165.

07/05/21 Electra testing involving two loopback sessions, MCS was pointing at the aft limb for an orbit (surrounding the loopback sessions).

07/05/31 Return to scanning attempt. This was ~1 orbit of very slow limb and space (78 s cycle) with 4 blackbodies (space, blackbody, space; long views of each). Stowed for ~1 hour and then returned to limb staring (position error in moving to limb staring). Long slews started regularly causing small gaps in data (1 to 5 missing packets)

07/06/14 Second return to scanning attempt. Used a slower slew speed for ~20 minutes (20 degree slews between limb and space). Resulted in 4 position errors and then being stowed for ~3 hours then started very slow limb and space only. 3 errors over the next ~5 hours (extending to 07/06/15).

07/06/21 Changed to scanning 20 degrees between limb and space (valid space due to parked S/C solar arrays).

07/06/22 Returned to 5/31 scanning for ~1 orbit, resulted in 4 errors and then returned to 8 degree very slow limb and space scanning.

07/06/27 MRO performed a maneuver. During the maneuver, MCS was pointed in a sun-safe direction. The freeze location was mis-pointed until the next day

07/06/28 MCS performed 7 blackbody observations (at ~45 S and ~45 N, but used 8 degree slews to move to the blackbody). These generated 4 position errors and the instrument was stowed for 2 hours before returning to 8 degree scanning between limb and space.

07/07/04 One blackbody per day was added to the activities (approximately at the night side equator). This is a blackbody with a single long slew.

07/07/11 Three additional blackbodies were added to the orbit with the one blackbody. They are at the equator (day and night) and both poles.

07/07/17 Increased the frequency of blackbody observations to 4 per orbit (at the equator and both poles).

07/07/18 MCS was powered off by S/C fault protection.

07/07/23 MCS powered back on with the requirement to avoid all slews longer than 10 degrees. MCS returned to the pre-power off state (temperature control points etc.) and resumed scanning between limb and space two hours later. The instrument spent ~24 hours reaching thermal equilibrium.

07/07/26 Added one blackbody per orbit (night side equator crossing). This blackbody is done in 10 degree scans (to meet the slew constraints).

07/07/31 The limb view portion of the limb scan sequence was halved, resulting in a 45 second limb scan sequence.

07/09/24 MCS was powered off for approximately 2 hours (to install a S/C patch). MCS was then stowed for ~1.5 hours (waiting for the first equator crossing after powering on) before returning to the same scanning as prior to the power cycle.

07/10/01 Scanning was changed to perform 10 blackbody views per orbit and perform a single long slew to move from the limb to viewing the blackbody.

07/10/09 Added two solar target observations per orbit to the scanning to help calibrate A6. These are combined with a blackbody observation (for efficiency).

07/10/09 Added a view 10 degrees below the limb, on Mars, to the limb scan sequence.

07/10/15 The limb scan was changed to move the on planet view to 20 degrees below the limb. Also at this time, the positioning of the solar calibrations in the orbit was modified to improve the target illumination. At this point, seasonal adjustments to the timing of the solar calibration are being performed approximately every two weeks (but are not explicitly called out). After 20 minutes, the new scanning produced a position error and stowed the instrument.

07/10/16 Scanning resumed going only 10 degrees below the limb (the limb scan is identical to the one from 07/10/09).

07/10/23 Shortened the limb scan sequence (8 limb observations) and also shortened the blackbody and solar calibration sequences to reduce the impact. The roll sequence was also updated to again take the two overlapping observations.

07/11/07 MCS powered off due to S/C safe mode entry

07/11/16 MCS powered on and resumed scanning as prior to powering off. Note that S/C rolls were disallowed at this time, improving the quality of the MCS data.

07/11/29 MCS powered off due to S/C safe mode entry

07/12/04 MCS powered on but remained stowed (no commanding was performed). Thus the temperature controls and set points remained at the patch block or PROM default values.

07/12/11 Updated temperature controls and resumed scanning. The seasonal update was delayed for two more days.

07/12/23 Small rolls resumed. There are 5 large rolls on 08/01/03 and 08/01/04, but large rolls in general do not resume until 08/01/20 (see below).

08/01/16 A short FOV calibration sequence was added to every orbit at the day side (or ascending) equator crossing.

08/01/18 Returned to normal limb scanning (removing the FOV test sequence).

08/01/20 Resumption of large rolls.

08/02/06 Maneuver (MCS stowed) and relay pass (MER, MCS moved to “relay orientation”—limb to the side” and had a gap due to loopback).

08/02/09, 08/02/10, 08/02/12 one MER relay pass each day.

08/02/14 MCS powered off by S/C safe mode entry.

08/02/15 Brief diagnostic power on (on ~ 10 minutes), no scanning

08/02/18 MCS powered on, scanning resumed just before midnight (UTC).

08/02/21 Approximately 4 hours were spent staring at the side limb during Electra testing. MCS was in loopback during much of this time.

08/02/25 Added second FOV test (with an extended range) at day and night equator crossings each orbit.

08/02/27 Removed the FOV testing.

08/03/14 Multiple BER tests during a 1 hour period.

08/03/22 Several significant data gaps in a burst between 0:30 and 2:00

08/03/22 to 08/03/24 Three position errors over these two days.

08/03/23 Frozen for Phobos imaging

08/04/09 and 08/04/11 A set of BER tests each day.

08/04/13 A single position error occurred.

08/04/14 Another set of BER tests.

08/04/18 A series of position errors started to occur.

08/04/20 MCS stowed due to position errors.

08/04/21 MCS resumed scanning without an on-planet view

08/04/22 Single position error

08/04/24 Removed northern solar calibration view (contaminated)

08/04/24 Position errors in roll scan. Roll scan changed to remove second view (data to create profiles during large rolls is no longer available).

08/04/25 Additional position errors occurred. Scanning was changed to one blackbody per orbit and one solar calibration per day.

08/04/26 The instrument stowed due to excessive position errors.

08/04/28 4 hours of slow limb scanning, then stowed due to position errors.

08/04/29 Resumed slow limb/space scanning with no blackbody or solar calibration. Then started skipping steps 2092 and 2093 in EOCT (designed to help avoid position errors). This slightly degrades the tracking of the limb.

08/05/01 MCS froze for a spacecraft maneuver and stowed to upload new slew tables

08/05/01 BER test performed.

08/05/02 steps 2092 and 2093 returned to EOCT

08/05/03 Returned to standard limb scan length (16 s) and resumed blackbody and solar calibration views at the standard rate.

08/05/16 Position errors resumed. EOCT modified to remove limb views at steps 2087, 2092, 2093.

08/05/16 Due to use of high torque, most long slews (to/from blackbody) contain frame errors resulting in several missing packets. Calibration is still in work (due to gaps from frame errors).

08/05/22 A single position error occurred

08/05/24 A single position error occurred

08/05/25 MCS was powered off for PHX EDL. There was also a position error before powering off

08/05/26 MCS was powered on for ~6 hours after PHX EDL, but only scanned for 10 minutes before position errors caused the instrument to stow. MCS remained stowed until powered off.

08/05/27 MCS was powered back on. Scanning between limb and space resumed with one blackbody per day (at 55 S on the descending track) and without steps 2092, 2093 and 2087 in the EOCT. There is no solar target view in this scan pattern. Calibration of the data with one blackbody per day is still ongoing.

08/05/27 MRO relay support for PHX started on 08/05/26 and there are usually several relay passes per day going forward. Each pass involves MCS slewing to look at the side limb and has a period of loopback where no instrument data is received.

08/05/31 A single position error occurred.

08/06/02 A single position error occurred. The blackbody was moved to the ascending side of the orbit (around 20N to avoid relay passes). Frame errors again started to occur in blackbody sequences.

08/06/02 EOCT step 2088 was also removed (removal of 2087, 2088, 2092 and 2093).

08/06/04 First MCS/PHX joint science observations. During these, on certain orbits, MCS spends half the time while over the north pole looking cross track to another (varying) local time. The orbits and off track pointing are chosen so that the MCS view crosses PHX (and PHX is trying to take measurements at the same time). Each set of observations lasts up to 36 hours (most are ~24 hours) and involve as many as 11 orbits.

This activity revealed an instrument pointing and geometry issue in that the actual and expected pointing did not match when pointed off track (by up to 0.5 degrees). This issue was resolved for the third joint science observation by changing the effective location of the limb view.

08/06/07 and 08/06/08 A single position error occurred each day.

08/06/10 Second MCS/PHX joint science observation.

08/06/11 A single position error occurred.

08/06/12 A single position error occurred. Afterwards, the blackbody scan was slightly modified (the end location was moved from 2094 to 2101)

08/06/13 A single position error occurred. Afterwards, the blackbody scan was changed to move the blackbody view from step 1000 to step 1006 (to help reduce position errors).

08/06/22 Third MCS/PHX joint science observation. MCS experienced two position errors during the activity. This resulting in not being able to fully correct the pointing for later joint science observations.

08/07/01 Fourth MCS/PHX joint science observation.

08/07/05 Fifth MCS/PHX joint science observation.

08/07/10 Added one solar calibration per day (in the south) and moved the daily blackbody back to the night side.

08/07/14 Added a view 8.9 degrees below the limb to most limb scans (except for those in the northern polar region).

08/07/14 Sixth MCS/PHX joint science observation.

08/07/17 Added the 8.9 degrees below the limb view for the rest of the orbit.

08/07/18 Seventh MCS/PHX joint science observation. The 8.9 degrees view below the limb in the northern polar region stopped as a side effect.

08/07/18 (late) Again added the 8.9 degrees below the limb view in the northern polar regions.

08/07/21 Eighth MCS/PHX joint science observation. There were no on planet views in the northern polar region during the actual joint science orbits.

08/07/23 Changed the limb scan to move the 8.9 degrees below the limb view to 13.3 degrees below the limb.



08/07/26 A burst of 7 position errors started and resulted in the instrument being stowed the next day.

08/07/27 instrument stowed.

08/07/28 Scanning resumed, but the on-planet view was moved back to 8.9 degrees below the limb.

08/07/29 and 08/07/31 a single position error occurred each day.

08/08/01 Ninth MCS/PHX joint science observation. Views 8.9 degrees below the limb in track were included during the cross track observations.

08/08/01 The location of the space view was moved 5 steps further from the limb. This was done to help minimize the number of position errors by making the limb and space 88 steps apart.

08/08/02 The instrument was stowed due to a set of position errors.

08/08/04 Scanning resumed while removing step 2112 from the EOCT (this was aimed at not going to step 2200 on planet).

08/08/05 A single position error occurred.

08/08/05 Tenth MCS/PHX joint science observation. Views 8.9 degrees below the limb in track were included during the cross track observations.

08/08/06 A series of position errors caused the instrument to stow. Scanning was resumed later in the day after removing step 2111 from the EOCT.

08/08/07 A series of position errors again caused the instrument to stow. Scanning was resumed later in the day after removing step 2110 from the EOCT.