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Solar Orbiter Mission Operations Report #25

Period [26 October 20 - 23 November 20]

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APPROVAL

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CHANGE LOG

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- SolO MOR
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1SUMMARY OF ACTIVITIES

This report covers four nominal weeks of cruise in LTP 2 (STPs 119 to 122).

A deicing slew was successfully executed on 04/11. A repetition of the slew had been requested following the star tracker issues during commissioning earlier this year. The star trackers were commanded out of the loop during the operation. A few points are nevertheless pending discussions with Airbus.

During STP 122, an extra checkout window took place for the remote sensing payloads, with following main goals:
- Repetition of some past remote sensing characterization /calibration campaigns that had not worked as expected or needed extra investigation
- EMC characterization of switch-ON/OFF activities and synoptic campaigns scheduled in LTP3 and in the nominal science phase
- Extra alignment campaign between high-resolution instruments

In situ payloads (except SWA) were on in science modes during the checkout. MAG in burst throughout for EMC monitoring, EPD and RPW in coordinated burst modes for science.

Further issues with SWA are to be reported, with SWA OFF since 03/11. An attempt to switch the instrument on was unsuccessful on 10/11 (no TM was produced by the instrument). Ways forward are being investigated.

On the MOC end, work continues to focus on the VGAM on 27/12 and the 5 weeks navigation window starting on 30/11.

DoY	Date	Activity
300	26/10/2020	***STP 119*** CEB pass WOL
301	27/10/2020	SWA DPU reset
302	28/10/2020	CEB pass
303	29/10/2020	
304	30/10/2020	CEB pass
305	31/10/2020	WOL
306	01/11/2020	

DoY	Date	Activity
307	02/11/2020	***STP 120*** CEB pass WOL TCM
308	03/11/2020	MLG pass Solar Array relubrication OMM file cleanup SWA anomaly leading to SWA OFF SpW network overload led to SPICE heartbeat counter exceeding limit, in turn switching off SPICE
309	04/11/2020	WOL De-icing slew
310	05/11/2020	CEB pass WOL
311	06/11/2020	CEB pass
312	07/11/2020	WOL
313	08/11/2020	
314	09/11/2020	***STP 121*** CEB pass WOL
315	10/11/2020	CEB pass SWA switch on and switch off activity. No SWA TM was observed.
316	11/11/2020	CEB pass Solar array characterisation
317	12/11/2020	CEB pass ZFZT maintenance
318	13/11/2020	
319	14/11/2020	
320	15/11/2020	

DoY	Date	Activity
321	16/11/2020	***STP 122*** DDOR NNO/CEB CEB pass NNO pass WOL METIS switch off due to internal FDIR trigger (believed to be a glitch)
322	17/11/2020	DDOR MLG/CEB MLG pass
323	18/11/2020	CEB pass
324	19/11/2020	DDOR NNO/CEB NNO pass CEB pass EPD SW upload
325	20/11/2020	DDOR MLG/CEB NNO pass MLG pass
326	21/11/2020	MLG pass
327	22/11/2020	MLG pass

At the end of the reporting period (DoY 327, 22/11) Solar Orbiter was at:

- 248.4 million km from the Earth (1.66 AU); the one-way signal travel time was 13 min 49 sec (829 sec). Earth distance decreasing since 28/09 (1.79 AU reached)
- 136.2 million km from the Sun (0.91 AU). Sun distance decreasing since 13/10 (0.98 AU reached)

2 SATELLITE STATUS

2.1 Platform

2.1.1 *AOCS / propulsion*

The AOCS configuration at the end of the reporting period is:

- AOCS in NCM mode
  - with attitude control based on Wheels (all 4 Wheels)
  - using the gyro stellar estimator (GSE) on STEADY gains
  - with inertial reference attitude guidance

- AOCS Sensors
  - IMU A (all 4 Channels) ON and IN-USE
  - IMU B (all 4 Channels) OFF and all 4 Channels PRESELECTED

  - ACC (all 4 Channels) OFF

  - FSS A (XP and ZM) ON and IN-USE, with FSS A XP having SUN Presence
  - FSS B (XP and ZM) OFF

  - STR A OFF since 05/06 (DoY 157), health set to 2
  - STR B ON (NEAT mode) and IN-USE since 05/06 (DoY 157), health set to 3

  AOCS Actuators

  - RW 1-4 ON and IN-USE used for Attitude Control since DoY 042 and LEOP day 1
  - RW Momentum Target Levels @ 18/-18/-18/18 Nms
  - CPS B OFF and PRESELECTED, CPS A OFF

- AOCS Flags
  - Sun Distance flag set to NEAR since 10/11/2020 (DoY 315)
  - Flyby flag set to NO FLYBY since launch

- AOCS HK and TM mode configuration: Default since DoY 052 (21/02/2020)

- Propulsion system
  - Valves in default configuration (all TLVs + LFLV closed, except for LFLV 3+4)
  - The propulsion system is configured in regulated mode since launch
  - The pressure relief function is activated when needed
  - Pressure levels
    - HE tank pressure @ 149.0 bar (PT1)
    - PT2 (between pressure regulator and latch valves 1/2) @ 17 bar
    - NTO tank pressure @ 16.5 bar (PT3)
    - MMH tank pressure @ 16.5 bar (PT4)
    - PT5 (before latch valves 3/4 for MON) @ 16.5 bar
    - PT6 (before latch valves 3/4 for MMH) @ 16.5 bar
    - PT7 (between pressure regulator and latch valves 1/2) @ 17 bar

  - Pressure relief function was updated back to 40 days on 21/10 DoY 295 in RAM only; duration unchanged and at 8 cycles. SGM RAM values unchanged (18 days/8 cycles).

The TCM on 02/11 (48.2 mm/s) showed a 1 mm/s underperformance (-2% in size) and a direction error of 0.42 degree.

2.1.2 *Mechanisms*

- SADE
  - SADE A ON and IN-USE
  - SADE B OFF
  - SA @ 0 degrees since 243.04.19. The next scheduled rotation is on 329.19.25 (24/11) to 30 degrees.

During the de-icing slew, the solar array movement took longer than expected and a solar array movement timeout occurred. The subsequent movement back to the nominal position completed without any issue. Additionally, the MY solar array position deviation reached 0.253 degrees shortly before the end of the steer. This is within 0.05 degrees of the SA FDIR miss-alignment limit. Similar behavior was observed during NECP. AR SOL_SC-69 was raised.

This needs further discussion with Airbus.

- HGA APME
  - HGA Deployment Status = TRUE
  - HGA selected as PRIME Antenna (PM and SGM RAM)
  - APME A OFF and PRESELECTED
  - APME B OFF

- MGA APME
  - MGA Deployment Status = TRUE
  - MGA is selected as PRIME Antenna (SGM RAM) since DoY 058
  - APME A OFF and PRESELECTED
  - APME B OFF

2.1.3 *TT&C*

The performance of the subsystem is nominal

- TRSP-1 X-band up and down via HGA, 4 kbps uplink, downlink bit rate is selected according to the used ground station
- TWTA-1 is in use, RF power nominal (from Helix Current telemetry reading)
- TRSP-2 back-up uplink is configured for X-band reception at 7.8 bps via LGA-1 since DoY 178 26/06/2020. LGA-1 is the better antenna till at least end of LTP 3.
- TWTA-2 is OFF and in cold redundancy
- MGA is selected as safe mode antenna since DoY 058.
- PN ranging is fully validated and used by default since DoY 057 (26/02). This allows to currently be on the max TM bit rate.

DST 1 and 2 output power was reduced on 19/06 as the TWTA was in overdrive.

The change was also applied in SGM.

2.1.4 *Thermal*

The thermal configuration has been updated with CSW 3.1.1 loading which takes into account most changes since launch. The following changes (which will be included in CSW 3.1.2 under preparation) were applied during the safe mode recovery on 10/09:

TL044 (METIS Ebox)	updated to: -16.5°C / -16°C
TL045 (PHI Ebox)	updated to: : -16.5°C / -16°C
TL048 (MY RS zone)	updated to: : -15.5°C / -15°C
TL093 (EPD SIS)	updated to: : -24°C / -20°C
TL098 (MAG OBS)	updated to: : -90°C / -88°C

Post de-icing slew, FDIR triggered on EUI thermal line 60 due to a too cold temperature. Settings will need to be further fine-tuned. This is pending discussions with Airbus. The heat-up of 6 degC post slew was not enough.

2.1.5 *Power*

The subsystem is in its nominal configuration and performing nominally.

- PCDU A OFF
- PCDU B ON and in use

PCDU A and B EEPROM table updates took place in flight on 05/06.

PCDU-B SGM & PM RAM health is set to 3 since 03/07 (to make B the preferred choice and avoid changing the SCV config in SGM EEPROM).

2.1.6 *Data handling*

The subsystem is in its nominal hardware and software configuration.

The SSMM is ON and fully configured in 3 MM Configuration.

The TC Link Monitor is configured to a time-out of 7 days since 04/06 (DoY 157).
This is the configuration for cruise which is now set as follows (TC link TH1/TC link TH1 increase/TC link TH2):
PM RAM: 7d/24h/7d + 70h
SGM RAM: 7d/12h/7d + 34h

The TM generation mode is configured to NOMINAL.

The current DMS configuration is:

Item	A	B
OBC PM	Active	Off
OBC CSW Image Select	1	1
OBC CSW Version	3.1.1	3.1.1
OBC CSW RAM version	3.1.1	3.1.1
OBC EEPROM Segs	1 : Code 2: Data	1 : Code 2: Data
RM PAP Prog. Set	1 (PM-A Nominal)	1 (PM-A Nominal)
RM	Enabled	Enabled
SSMM SV	Active	Off
SSMM ASW Image	1	1
SSMM ASW Version	02.07.00	02.07.00
RIU	Active	Off
OMM	On and in use (slave)	On and in use (Master)

Updated eclipse files for SGM EEPROM A and B (unique eclipse in the mission is during the EGAM in Nov 2021) were commanded to the SC on 22/1120.

The SWA anomaly @ 2020.308.01.17 (AR SOL_SC-67), lead to SWA switch off. The CSW did not block S20 TCs to the failed unit as would be expected (SOL_SC-68). This lead to the SpW network being overloaded, the SPICE heartbeat counter being above limit, in turn switching off SPICE. Addressing what is believed to be a newly discovered CSW issue is pending discussions with Airbus.

2.2 Instruments

EPD
The EPD FSW update took place on DOY 324.
Due to an oversight in the sequence to command EPD to Safe, SpW Errors were triggered once EPD had transitioned to its safe state, resulting in the complete power down of EPD (REC_SpW2) and the disabling of the EPD MTL SSIDs (P_OFF).
The root cause for this has been understood (missing S20 handling in the procedure).
EPD could be recovered during the same pass and the remaining FSW update activity was successfully completed without further issues.

EUI
EUI generated once more several thousands of EDAC uncorrectable events on DoY 324, flooding the CEL. The burst of events issue will be addressed and fixed in the planned EUI SW update.

MAG
Nothing to report.

METIS
On 13/11, internal FDIR prevented the ramp up of the high voltage, which in turn triggered the platform FDIR on the HV value that called the recovery OBCP to switch the instrument off. The internal FDIR is understood to be a glitch and the FDIR thresholds to be revisited.

PHI
PHI required several non-nominal activities during the reporting period:

- Switch on/download data/switch off to investigate fully corrupted images by a noise pattern, the origin of which is still not understood
- Addressing bad processing on 16/11 due to processing steps taking longer than anticipated leading to overlaps with next commands
- On 18/11, clashing commands which produced a queue of non-finished processes requiring a power cycle of PHI
- Fixing further such clashes in the MTL

RPW
Nothing to report.

SWA
SWA suffered a further DPY reset on 27/10. On 03/11, at switch on, the SWA heartbeat timeout triggered, leading to SWA switch off. SWA did not produce any TM at switch on. It is unclear if this is in relation with ground AR SOL-280 (SVT1A), whereby the SWA DPU missed the time-sync TC and so did not start sending TM. That would trigger the HB monitor.
An attempt to switch on SWA on 10/11 was not successful. Once more the instrument did not generate TM. Further steps are being discussed and defined.

SoloHi
Nothing to report.

SPICE
SPICE was unexpectedly switched off on 03/11. See previous sections for more information. The recovery took place promptly, followed by the execution of the LUT updates which were completed successfully.

STIX
Nothing to report.

Decontamination heater status
Current status:

- SPICE OU = ON
- SPICE CE = ON
- METIS = OFF
- EUI OU = OFF

3 GROUND FACILITIES

3.1 Ground Stations

During the reporting period mission operations have been conducted with the three ESA stations.

Station coverage has increased, including several DDORs in view of the VGAM navigation window which is about to start.

3.2 Control Centre

SolO MCS SW version D3.19.6 is used on all operational machines since 20/11/2020.
This version uses:

- GFTS SW version 3.3.3 since 16/10
- EDDS SW version 2.4.0 on 07/07 (with latest stream client now available)
- NIS SW version 5.3.1 since 21/10
- FARC SW version 3.2.1

Version 3.19.1 MOC testing was completed on 26.10.
Further patches were needed as follows:

- D3.19.2 on 29/10 to address EDDS/DARC issues (The PDG Gen process was crashing around once per minute on SOLLTA immediately after installation of BSMCS D3.19.1)
- D3.19.3 on 04/11 to address OBQM (on board queue model) crashes when disabling SSIDs in the model
- D3.19.4 on 12/11 to further address OBQM SSID management and fix issues with loading CRFs with repeated groups
- D3.19.5 on 16/11 to fix S13 file transfers missing from the file transfer display
- D3.19.6 on 19/11 to fix verification issues of S13 delayed TC file commands

4 SPECIAL EVENTS

None

5 ANOMALIES

The following Anomaly Reports were raised in the reporting period:

Spacecraft

SOL_SC-67	SWA HB Timeout & SpW Errors @ switch on DOY 2020.308
SOL_SC-68	ssmmMgr::forwardTc does not check SCV_TM status for S20 TCs
SOL_SC-69	EvID 36746 "SA Steering failed to reach file angle" during de-icing & misalignment

Ground Segment

None

Non Conformance Reports

None

6 FUTURE MILESTONES

This is the timeline of future milestones:

Milestone	Date	Comment
LTP2	DoY 181, 29/06/20	LTP 2 runs till 01/01/2021 00:00
TCM	DoY 307, 02/11/20	Available TCM slot will be used
VGAM navigation window	DoY 335, 30/11/20 00:00 To DoY 004, 04/01/21 00:00	Slots for possible Trajectory Control Manoeuvres around VGAM1 are fixed as follows: (1) TCM at VGAM1 -4w (30/11/20 - DoY 335) (2) TCM at VGAM1 -2w (13/12/20 - DoY 348) (3) TCM at VGAM1 -1w (20/12/20 - DoY 355) (4) TCM at VGAM1 -3d (24/12/20 – DoY 359) (5) TCM at VGAM1 -6h (26/12/20 – DoY 361) (6) TCM at VGAM1 +1w (01/01/21 – DoY 001) Note: (4) and (5) are contingency slots
VGAM	DoY 362, 27/12/20	
LTP3	DoY 001, 01/01/21	LTP 3 runs till 28/06/2021 00:00
TBC CSW 3.1.2 upload	TBC STP 131 DoY 017, 17/01/21 20:52 to DoY 024, 24/01/21 21:10	TBC CSW 3.1.2 upload to the SC This will be a full SW load, requiring all instruments off. The new SW will address the AOCS pointing stability issues
Conjunction	DoY 030 30/01/21 to DoY 042 11/02/21	limited access to the SC (TM and TC) With the Sun Earth SC angle < 5 deg