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# **Solar Orbiter Mission Operations Report #27**

**Period [07 December 20 - 13 December 20]**

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# APPROVAL

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# CHANGELOG

Reason for change	Issue Nr.	Revision Number	Date
Updated with reporting for new time period	27	0	14/12/2020

# CHANGE RECORD

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## 1 SUMMARY OF ACTIVITIES

This report covers one nominal week of cruise in LTP 2 (STP 125).

SWA ground investigations continue. The instrument remains off with no further flight testing until these investigations are complete.

Following direct exposure of the EPD SIS B telescope to solar illumination during the de-icing maneuver early November 2020, the telescope performance is closely monitored. The status of the unit appears to be nominal. This may lead to new operational constraints. The topic will be addressed in the coming days.

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

<b>DoY</b>	<b>Date</b>	<b>Activity</b>
		<b><i>STP 125</i></b>
342	07/12/2020	NNO/MLG passes NNO/CEB DDOR WOL EPD EPT-HET 1 and 2 thermal lines 91 and 92 set point updates
343	08/12/2020	NNO/CEB passes MAG EEPROM update with ASW v320p
344	09/12/2020	NNO/MLG passes
345	10/12/2020	NNO pass
346	11/12/2020	NNO/CEB DDOR MLG/CEB DDOR MLG pass
347	12/12/2020	MLG pass
		<b><i>STP 126</i></b>
348	13/12/2020	MLG pass WOL  TCM -2w not needed

At the end of the reporting period (DoY 348, 13/12) Solar Orbiter was at:

- 237.0 million km from the Earth (158 AU); the one-way signal travel time was 13 min 09 sec (791 sec). Earth distance decreasing since 28/09 (1.79 AU reached)
- 121.2 million km from the Sun (0.81 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 @ 149.2 bar (PT1)
    - PT2 (between pressure regulator and latch valves 1/2) @ 17.1 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) @ 17.1 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 -2w was not required. See annexes for latest navigation details.

### 2.1.2 Mechanisms

- SADE
  - SADE A ON and IN-USE
  - SADE B OFF
  - SA @30 degrees since 329.19.25. The next scheduled rotation is on 358.08.56 (23/12) to 56 degrees.

AR SOL\_SC-69 is being discussed with Airbus (minor SA issues during recent de-icing maneuver).

- 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. The heat-up of 6 degC post slew was not enough.

The set points of the Thermal Control Line #50 (SWA Electronic box) were changed stepwise from [-15.0,-12.0] degC to [4.0,5.0] degC between 2020-328T00:00:00 and 2020-329T02:00:00 in order to acquire a more benign temperature of the SWA Ebox before the next attempt to switch the instrument ON.

Upon request from SWA, and after agreement on a dedicated ARB, the thresholds for the TCL#48 MY Panel Zone Heater were changed from originally [-15.5,-15.0] degC to [0.5, 1.0] degC in an attempt to increase the temperature of the SWA electronics Box.

Heater set-points were updated for EPD EPT-HET 1&2 thermal lines 91 and 92 to avoid big temperature drops when EPT-HET 1&2 are switched off.

The new heater set-points are:

EPT-HET 1 -20 -15

EPT-HET 2 -15 -10

### 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 4 days since 27/11 (DoY 332).

This is the configuration for the VGAM phase which is now set as follows (TC link TH1/TC link TH1 increase/TC link TH2):

PM RAM: 4d/12h/7d + 34h

SGM RAM: 4d/12h/4d + 34h

The TM generation mode is configured to NOMINAL.

The current DMS configuration is:

<b>Item</b>	<b>A</b>	<b>B</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**

EPD EPT-HET 1&2 thermal line set points were updated, see above.

After the de-icing manoeuvre from Nov 4-5 2020 the EPD team noticed an unexpected temperature spike of 20° in the SIS sensor. After analysis of the housekeeping data it was concluded that the ultra-thin entrance foil of the SIS-B telescope (pointing roughly anti sunward) was directly exposed to solar illumination during the manoeuvre. The current status of the unit appears to be nominal but the telescope performance is closely monitored. The need for new operational constraints is TBD and will be discussed in the coming days.

The MOC MCS reported 3 times one missing EPD packet on APID 828 VC 3 on 11/12/13-12, (no missing frames). This is being further investigated with the EPD team.

### **EUI**

Nothing to report.

### **MAG**

MAG EEPROM update with ASW v320p. The MDOR executed successfully and the received CRC matched the one provided by the MAG team. The new ASW will be enabled via IOR at MAG switch on after the CSW update in January.

### **METIS**

Nothing to report.

### **PHI**

Nothing to report.

### **RPW**

Nothing to report.

### **SWA**

Ground investigations continue. The instrument remains off for the time being.

### **SoloHi**

Nothing to report.

### **SPICE**

Nothing to report.

### **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 has started.

The (NNO) DDOR pass did not take place on 11/12 due to a late return to operations from a maintenance activity.

### 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

## **4 SPECIAL EVENTS**

None

## **5 ANOMALIES**

The following Anomaly Reports were raised in the reporting period:

### **Spacecraft**

None

### **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) -> Not needed.  (2) TCM at VGAM1 -2w (13/12/20 - DoY 348) -> <b>Not needed.</b>  (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

## **7 ANNEX 1, SOLAR ORBITER: NAVIGATION STATUS REPORT FOR THE VENUS SWING-BY #1 (2)**

### ***Email from Frank Budnik, 10/12/2020***

This is to report on the navigation status for the Venus swing-by #1 and in particular for the decision to execute or not TCM - 2w.

The orbit determination for the TCM-2w decision point has been performed on 10 December 2020 with a data-cutoff at the end of the New Norcia pass on that day. The data arc contains in total 33 Delta-DOR measurements, 12 from the Cebreros - Malargüe baseline and 21 from the Cebreros - New-Norica baseline.

For a prediction into the future the situation is summarised in the attached B-plane plot. The dashed green and red ellipses are the same as in the previous navigation report. The estimated impact point and associated 3-sigma error ellipse which are derived from the aforementioned OD for TCM - 2w is shown in blue. The distance from the target point is 9 km and the 3-sigma error ellipse semi axes size is 32 km x 16 km.

Since the difference from the impact to the target point is smaller than the error ellipse, TCM-2w will not be executed.

With this, the best estimate for the time of periapsis is on 27 December 2020 at 12:39:20 UTC with a 3-sigma arrival time error of 2 sec. The best estimate for the periapsis distance is 13 500 km with a 3-sigma error of 30 km.

The next report on the navigation status for the Venus swing-by #1 will be provided for the TCM-1w manoeuvre decision point on 17 December 2020.

## B-plane plot:

