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Solar Orbiter Mission Operations Report #30

Period [28 December 20 - 03 January 21]

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APPROVAL

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CHANGE LOG

Reason for change	Issue Nr.	Revision Number	Date
Updated with reporting for new time period	30	0	**04/01/2021**

CHANGE RECORD

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New issue	04/01/2021	All	all

Note: no change record is kept for this document since every new issue corresponds to a new reporting period.

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1SUMMARY OF ACTIVITIES

This report covers one nominal week of cruise with the end of LTP 2 and the start of LTP 3 (end of STP 127 and full STP 128).

The VGAM navigation campaign is now over. See appendixes for the last navigation report. TCM +1w was executed on 02/01. Its performance will be analysed in the coming days.

STIX was isolated and switched off following a SpW error on 01/01. This will be looked into with the STIX team in the coming days.

DoY	Date	Activity
363	28/12/2020	***STP 127 (continuation)*** NNO/MLG/CEB passes
364	29/12/2020	CEB/MLG pass
365	30/12/2020	MLG pass WOL
366	31/12/2020	MLG pass SA rotation from 56 to 60 deg
001	01/01/2021	***STP 128/LTP 3 start*** MLG/CEB pass STIX SpW error leading to STIX isolation and switch off
002	02/01/2021	MLG pass TCM +1w
003	03/01/2021	MLG pass

At the end of the reporting period (DoY 003, 03/01) Solar Orbiter was at:

- 228.7 million km from the Earth (1.53 AU); the one-way signal travel time was 12 min 43 sec (763 sec). Earth distance decreasing since 28/09 (1.79 AU reached)
- 101.7 million km from the Sun (0.68 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 @ 148.9 bar (PT1)
    - PT2 (between pressure regulator and latch valves 1/2) @ 16.9 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) @ 16.4 bar
    - PT7 (between pressure regulator and latch valves 1/2) @ 16.9 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 +1w was executed. See annexes for latest navigation details.

2.1.2 *Mechanisms*

- SADE
  - SADE A ON and IN-USE
  - SADE B OFF
  - SA @ 60 degrees since 366.02.22. The next scheduled rotation is on 023.09.14 (23/01) to 70 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.

After the update of the SWA heater set-points (Thermal Control Line #50) to [4,5] in PM RAM on DOY 329, the set-points were updated correspondingly in SGM EEPROM as well during the NNO/311 pass on DOY 351.

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:

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.

CSW 3.1.2 PM A and B images 0 and 1 are on board (delayed TC files) since 20/12/2020.

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
Nothing to report.

EUI
Nothing to report.

MAG
Nothing to report.

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
On 01/01, the autonomous LUT failed to be applied.
A SpW error lead to the isolation of STIX and its switch off.
Both issues are to be investigated with the STIX team. SOL_SC-71 was raised.

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.

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

On 30/12 the MCS software was no longer running on the backup MCS server SOLMCB.
It looks like the system was rebooted on 30 December around 20:48Z.
This was a priori not scheduled. The reason for the reboot is being investigated. The MCS SW will be restarted once the machine is confirmed healthy.

4 SPECIAL EVENTS

None

5 ANOMALIES

The following Anomaly Reports were raised in the reporting period:

Spacecraft

SOL_SC-71 [STIX] SpW Link Error FDIR and switch off

Ground Segment

None

Non Conformance Reports

None

6 FUTURE MILESTONES

This is the timeline of future milestones:

Milestone	Date	Comment
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: (4) TCM at VGAM1 -3d (24/12/20 – DoY 359) -> not needed (5) TCM at VGAM1 -6h (26/12/20 – DoY 361) -> not needed (6) TCM at VGAM1 +1w (01/01/21 – DoY 001) -> executed; performance analysis is pending Note: (4) and (5) are contingency slots
LTP3	DoY 001, 01/01/21	LTP 3 runs till 28/06/2021 00:00
CSW 3.1.2 upload	STP 131 DoY 017, 17/01/21 20:52 to DoY 024, 24/01/21 21:10	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 (5)

Email from Frank Budnik, 29/12/2020

This is the final report on the navigation for the Venus swing-by #1.

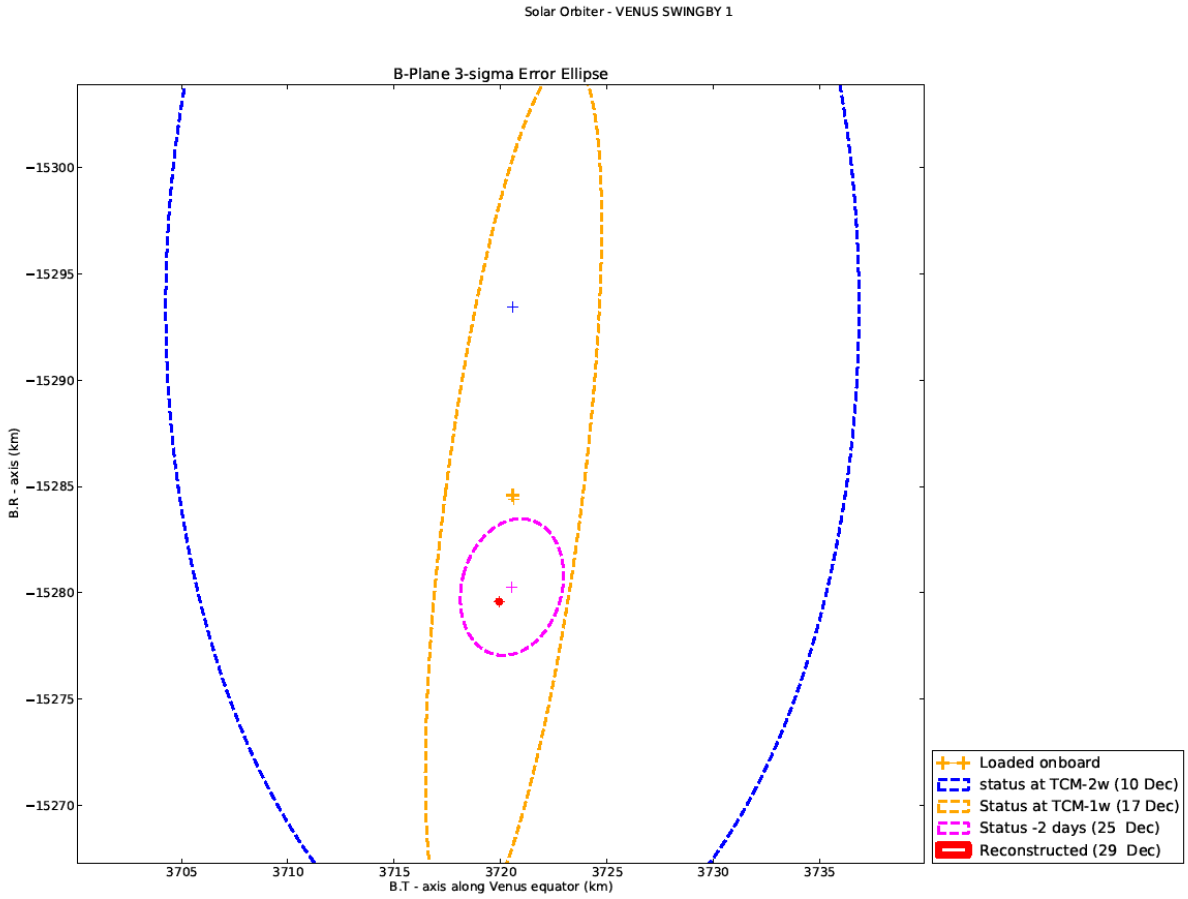
The orbit determination has been performed today with a data-cutoff at 07:04 UTC, close to the end of the New Norcia pass on 29 December 2020. The orbit reconstruction is shown in the attached B-plane plot together with the predictions made and reported on before the swing-by.

The reconstructed impact point and associated 3-sigma error ellipse are shown in red and they are located within all previously predicted error ellipses. The size of the 3-sigma error ellipse is 20 m x 2 m in semi-major and semi-minor axis, hardly discernible on the plotted scale.

The finally reconstructed parameters of the swing-by are:
- Periapsis time: 2020/12/27 12:39:19.863 UTC with a 3-sigma formal uncertainty of 0.004 sec. This is 0.09 sec later to what has been loaded on-board based on the orbit prediction made for the TCM-1w slot.
- Periapsis distance: 13488.592 km with a 3-sigma formal uncertainty of 0.001 km. This is 5 km lower to what has been loaded on-board based on the same aforementioned orbit prediction

The TCM+1w manoeuvre will be executed on 02/01/2021 and has a size of 16.4 cm/s. This will mark the completion of the navigation campaign.

B-plane plot:


Solar Orbiter - VENUS SWINGBY 1
B-Plane 3-sigma Error Ellipse
B.R - axis (km)
−15300
−15295
−15290
−15285
−15280
−15275
−15270
3705
3710
3715
3720
3725
3730
3735
B.T - axis along Venus equator (km)
Loaded onboard
status at TCM-2w (10 Dec)
Status at TCM-1w (17 Dec)
Status -2 days (25 Dec)
Reconstructed (29 Dec)