BC-SIM-TR-009
SIMBIO-SYS delta NECP Interchannel Test Report

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1. Introduction

1.1. Scope

This document contains the results and the discussion on the interchannel tests performed during the delta-Near Earth Commissioning Phase (dNECP) for the Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem (SIMBIO-SYS) described in [RD.1].
The dNECP was requested by the SIMBIO-SYS team to verify the behaviour of the instrument during the execution of the NECP tests [RD.2]. In particular, SIMBIO-SYS repeated the Interchannel test limiting to the "Orbit Test" whose results in NECP did not confirm the correct operation of the instrument.

1.2. Reference documents

[RD.1] BC-SIM-PL-003_-_SIMBIO-SYS_Delta_NECP_Test_Summary_Issue1_Revision0, 10.20371/INAF/TechRep/66

[RD.2] BC-SIM-TR-005_-_SIMBIO-SYS_NECP_Test_Report_Issue1_Revision0, 10.20371/INAF/TechRep/42

[RD.3] BC-SIM-TN-003_-_Reports_and_Note_Layout_and_Flow, 10.20371/INAF/TechRep/36

[RD.4] BC-ALS-TN-00099 MPO PFM Monitoring Thermistors Location

[RD.5] BC-SIM-TR-002_-_HRIC_NECP_report, 10.20371/INAF/TechRep/32

[RD.6] BC-SIM-TR-003_-_STC_NECP_report, 10.20371/INAF/TechRep/26

[RD.7] BC-SIM-TR_004_Issue1_VIHI_NECP_REPORT

[RD.8] BC-SIM-TN-002_-_STC_Strategy_Observation, 10.20371/INAF/TechRep/35

[RD.9] BC-SIM-GAF-TN-113 rev.0_TEC Control Parameters Revision for Commissioning_F1

[RD.10]BC-SIM-TN-004_-_SIMBIO-SYS_FOP_update_after_NECP, 10.20371/INAF/TechRep/58

[RD.11]BC-SIM-TR-006_-_EGSE_dNECP_report, 10.20371/INAF/TechRep/70

[RD.12]BC-SIM-TR-007_-_STC_dNECP_report, 10.20371/INAF/TechRep/71

[RD.13]BC-SIM-TR-008_-_VIHI_dNECP_report

1.3. Acronyms

ASW	Application SoftWare
ACK	Acknowledgement
CF	Cold Finger
dNECP	delta Near Earth Commissioning Phase
FPA	Focal Plane Assembly
FOP	Flight Operation Procedure
HK	Housekeeping
HRIC	High spatial Resolution Imaging Channel
ME	Main Electronics
NECP	Near Earth Commissioning Phase
OBCP	On-Board Control Procedure
PDOR	Payload Direct Operation Request
PE	Proximity Electronics
SIMBIO-SYS	Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem
SSMM	Solid State Mass Memory
STC	STereo imaging Channel
S/C	Space-Craft
TC	TeleCommand
TEC	Thermo-Electric Cooler
VIHI	VIsible and Hyper-spectral Imaging channel

1.4. Document format and repository

This document is compliant with the SIMBIO-SYS Report and Note Layout and Flow [RD.3] and will be archived both on the INAF Open Access repository and the SIMBIO-SYS team Archive.

1.5. Document organization

This document is organized in sections whose topics are listed as follows:

- Section 2 – SIMBIO-SYS thermal environment description, with a brief description of the aboard units and sensors used to control the operative temperature of the instrument during the test
- Section 3 – Interchannel test results and discussion
- Section 4 – Some conclusions on the dNECP activities are reported

2. SIMBIO-SYS thermal environment description

The SIMBIO-SYS thermal environment is controlled by means of the Space-Craft (S/C) dedicated Cold Fingers (CFs) and several thermal sensors which are described in the following subsections.

2.1. SIMBIO-SYS CF sensors

In the following table the list of CF temperature sensors for the three channels is reported. To note that all sensors are fixed on the S/C CF.

Channel	Sensor name	ESA ID	THALES ID
HRIC	MPO-TEMP-SIMBIO-HRIC-CF	NRUD2079	THT-B6T133
STC	MPO-TEMP-SIMBIO-STC-CF	NRUD2087	THT-B6T136
VIHI	MPO-TEMP-SIMBIO-VIHI-CF	NRUD2091	THT-B6T137

Table 1: CF sensors of the SIMBIO-SYS channels together with their reference to ESA and Theles Alenia nomenclature (see [RD.4] for details)

For more details on their positions see [RD.4].

2.2. SIMBIO-SYS thermal sensors

For the monitoring of its thermal behaviour, the SIMBIO-SYS instrument is equipped by the following sensors:

- **HRIC**

PACKET ID: YSS40001		
Param ID	**Param Name**	**Unit**
NSS11040	Temperature FPA1	K
NSS11041	Temperature FPA2	K
NSS11042	Temperature PE	K
NSS11043	Temp TIRD filter	K
NSS11044	Temp FPA package	K

Table 2: Main HRIC temperature sensors

See [RD.5] for more details on their definition and position.

- **STC**

PACKET ID: YSS40002		
Param ID	**Param Name**	**Unit**
NSS21040	Temperature FPA1	K
NSS21041	Temperature FPA2	K
NSS21042	Temperature PE	K
NSS21043	Temp FPA_Package	K
NSS21044	Temp OpticalBench	K

Table 3: Main STC temperature sensors.

See [RD.6] for more details on their definition and position.

- **VIHI**

PACKET ID: YSS40003		
Param ID	**Param Name**	**Unit**
NSS31040	Temperature FPA1	K
NSS31041	Temperature FPA2	K
NSS31042	Temperature PE	K
NSS31062	Temp Spectrometer	K
NSS31063	Temp Calibration unit	K

Table 4: Main VIHI temperature sensors.

See [RD.7] for more details on their definition and position.

3. SIMBIO-SYS Interchannel Test

3.1. SIMBIO-SYS Orbit Test

3.1.1. Test description

The aim of this test was the identical repetition of the ORBIT_TEST to verify the anomalies of data loss identified during the NECP (see Issue 5 in [RD.2]).
In particular the test lasts about 1 hour with:

1. **HRIC**: 3 FPAN acquisitions each with different Repetition Times (RT)=1.115s, 2s and 2.5s and nominal compression (i.e., IBR=32)
2. **STC**: continuous acquisitions in Global Mapping mode (see [RD.8] for details) with different Integration Time (IT), different RT, with variable filters cross-track dimensions (from 128 px to 640 px) and nominal compression (i.e., IBR032) for the 9 different sections of the orbit
3. **VIHI**: continuous acquisitions changing the IT and the RT for 8 different sections of the orbit

To note that STC commanding was defined on the basis of [RD.8] simulating sections of orbits with an IT defined by Hapke Model of the planetary surface and with an RT guaranteeing an overlapping of the 10% between consecutive acquisition. Cross track detection was defined to test the maximal variation of the parameter.

3.1.2. Commanding

Being the ORBIT_TEST the last test to be executed in dNECP (see [RD.1] for details), the only channel still in OFF state was the HRIC one. So, before executing the orbit simulation, it was necessary to switch-on the channel and, as done for the other channels, to upload its new optimized parameters for the Thermo Electric Cooler (TEC) soft start (see [RD.9] for details).
After that, the test has been performed through the execution of a PDORs named: "PDOR_BPSS00073_SIMBIOSYS_ORBIT_test_noME" (see attachments of [RD.1]).

A detailed timeline of the test is shown in Table 5.

Timing	FOP ID	FOP Name	HRIC block	STC sector	VIHI sector
00:00:00	ASSF307A	STC SciSurfNomnl GM v02	-	1	-
00:00:02	ASSF512A	VIHISciMode Var IT v02 **(*)**	-		1
00:04:02	ASSF512A	VIHISciMode Var IT v02	-		2
00:09:00	ASSF307A	STC SciSurfNomnl GM v02	-	2	
00:12:02	ASSF512A	VIHISciMode Var IT v02	-		3
00:12:04	ASSF101A	HRICSciShortIntFPAN v03	80 acq		
00:14:00	ASSF307A	STC SciSurfNomnl GM v02	-	3	
00:17:00	ASSF307A	STC SciSurfNomnl GM v02	-	4	
00:17:02	ASSF512A	VIHISciMode Var IT v02	-		4
00:22:00	ASSF307A	STC SciSurfNomnl GM v02	-	5	
00:24:02	ASSF512A	VIHISciMode Var IT v02	-		5
00:24:04	ASSF101A	HRICSciShortIntFPAN v03	80 acq		
00:35:00	ASSF307A	STC SciSurfNomnl GM v02	-	6	
00:39:00	ASSF307A	STC SciSurfNomnl GM v02	-	7	
00:39:02	ASSF512A	VIHISciMode Var IT v02	-		6
00:42:00	ASSF307A	STC SciSurfNomnl GM v02	-	8	
00:46:00	ASSF307	STC SciSurfNomnl GM v02	-	9	
00:49:00	ASSF368A	STC STOP Science v01	-		
00:50:02	ASSF512A	VIHISciMode Var IT v02 **(*)**	-	-	7
00:53:02	ASSF512A	VIHISciMode Var IT v02 **(*)**	-	-	8
00:53:04	ASSF101A	HRICSciShortIntFPAN v03	1 acq	-	

00:59.02	ASSF514A	VIHI STOP Science v01	-	-	

Table 5: Timeline of the ORBIT_TEST test with the references to the commanded FOPs (see [RD.10] for more details). TCs rejected by the Application SoftWare (ASW) are indicated with a '' sign.*

As described in the following section not all the Telecommands (TCs) were accepted by the Application SoftWare (ASW). The resulting database derived by means of the Electric Ground Segment Equipment (EGSE) telemetry-to-raw pipeline is reported in Table 6, Table 7 and Table 8 (see [RD.11] for details).

EGSE_TC#	1st acq (UTC)	Duration (s)	# acq
1	2019-06-06T09:21:30.017799	238	80
2	2019-06-06T09:33:30.018767	118	80
3	2019-06-06T10:02:30.017559	2	1

Table 6: Resulting database of the ORBIT_TEST test for the HRIC channel.

EGSE_TC#	1st acq (UTC)	Duration (s)	# acq
1	2019-06-06T09:09:26.017059	541	44
2	2019-06-06T09:18:27.217523	301	26
3	2019-06-06T09:23:28.167990	186	18
4	2019-06-06T09:26:33.928013	296	34
5	2019-06-06T09:31:29.728638	782	102
6	2019-06-06T09:44:31.559990	239	30
7	2019-06-06T09:48:30.660741	183	21
8	2019-06-06T09:51:33.255908	241	25
9	2019-06-06T09:55:34.131684	169	16

Table 7: Resulting database of the ORBIT_TEST test for the STC channel.

EGSE_TC#	1st acq (UTC)	Duration (s)	# acq
5	2019-06-06 09:13:28	480	2400
6	2019-06-06 09:21:28	300	1874
7	2019-06-06 09:26:28	420	1750
8	2019-06-06 09:33:28	900	5624
9	2019-06-06 09:48:28	660	6600

Table 8: Resulting database of the ORBIT_TEST test for the VIHI channel.

3.1.3. Test outcome

Figure 1 and Figure 2 report the sensors temperature and TEC current evolution for the HRIC channel during the test while using the new uploaded parameters for the TEC "soft" activation.

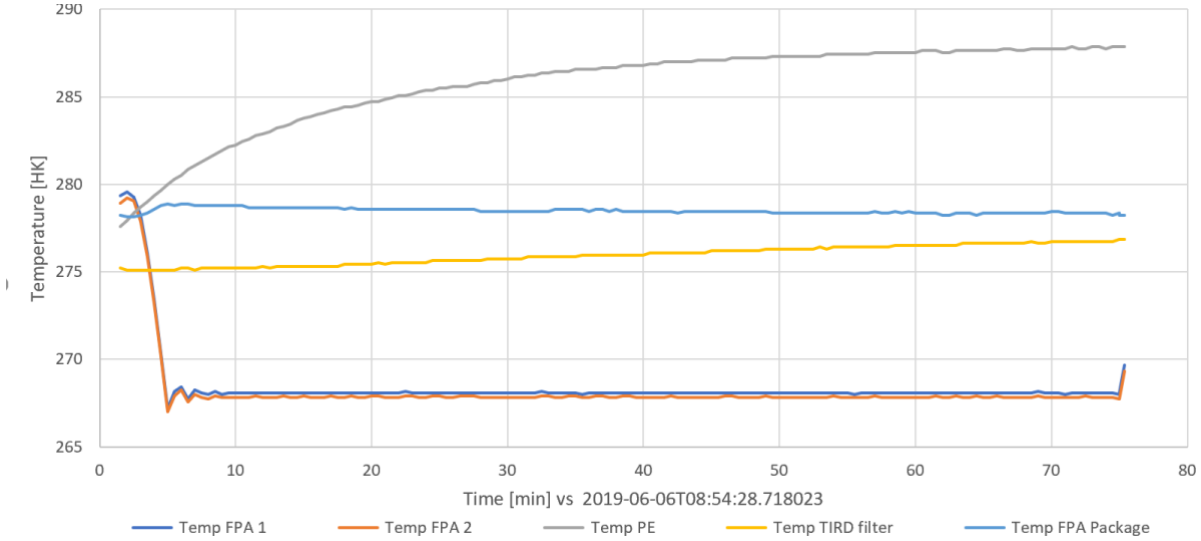

Figure 1: HRIC Temperatures evolution over the Orbit Test.

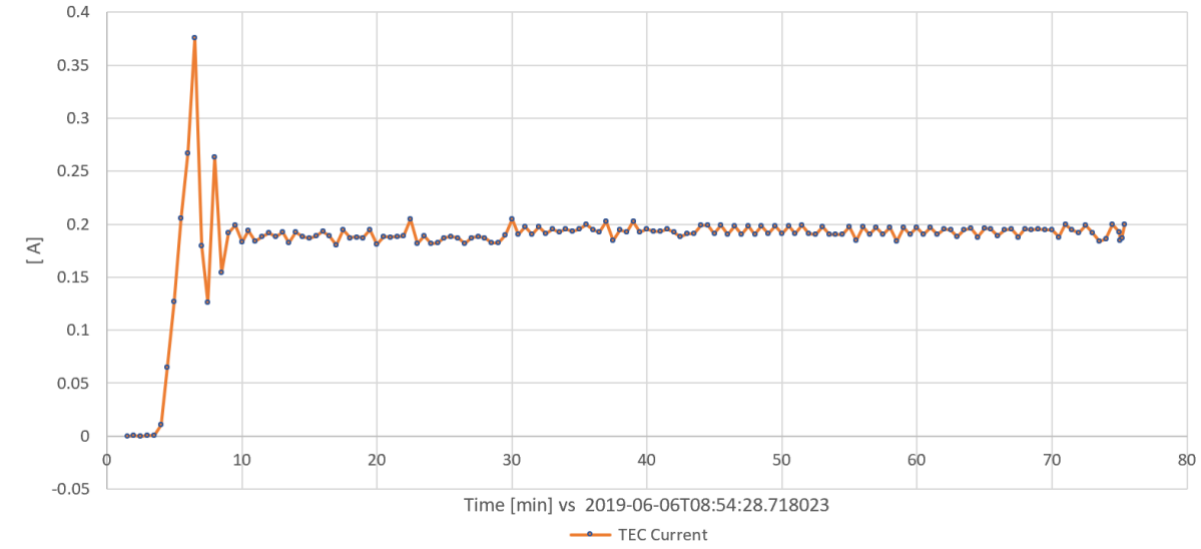

Figure 2: HRIC Tec current evolution over the Orbit Test.

In Figure 2, at the beginning of the plot, it can be seen that with the new values, no Out-Of-Limit (OOL) in the current profile occurred (i.e., no peak). Nevertheless, **a non-nominal oscillation in the current profile was generated**.

Figure 3 and Figure 4 report the sensors temperature and TEC current evolution for the STC channel during the test.

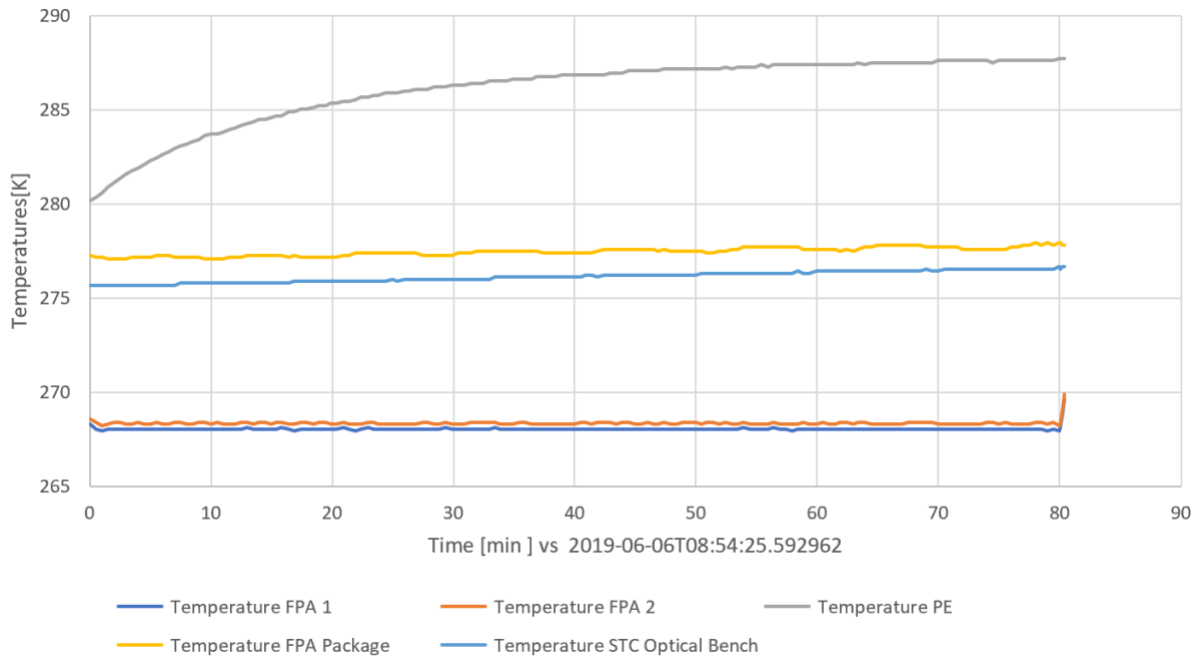

Figure 3: STC Temperatures evolution over the Orbit Test.

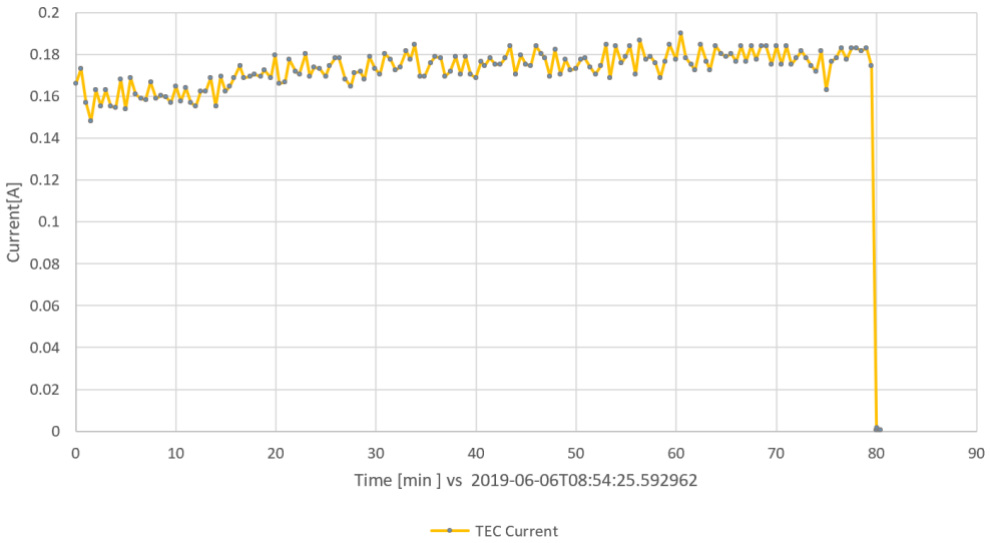

Figure 4: STC TEC current evolution over the Orbit Test.

Differently from the case of the HRIC channel, their behaviour is nominal, but it must be considered that the STC channel was already in on state since it came from its performance test executed earlier. In fact, also the STC channel experienced **an unwanted oscillation in the TEC current profile** after its switch-on (see [RD.12] for details).

Figure 5, Figure 6 and Figure 7 report the sensors temperature and TEC current evolution for the VIHI channel during the test.

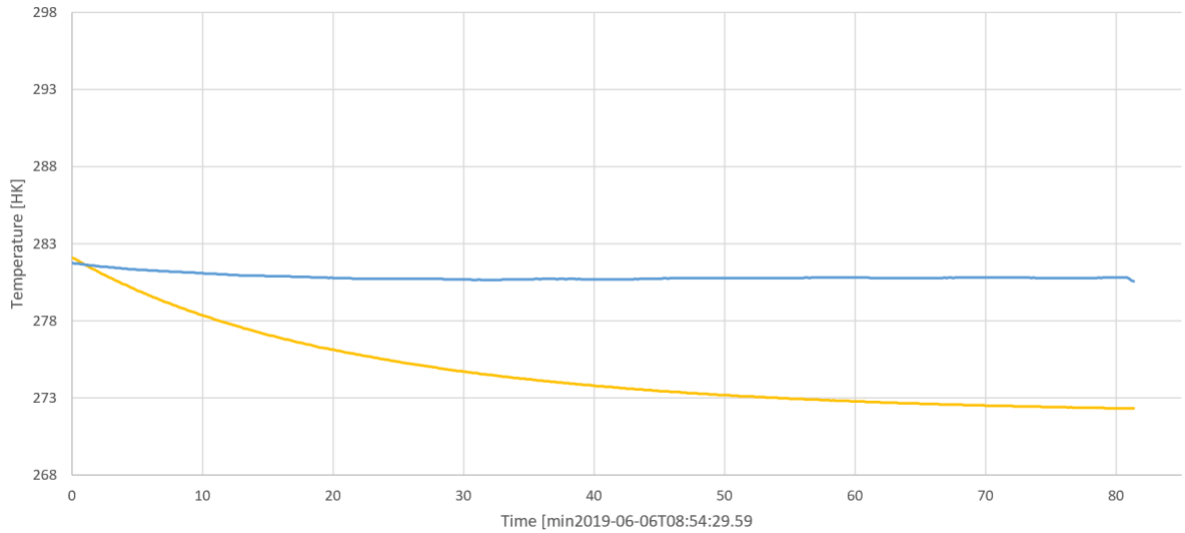

Figure 5: VIHI radiator and PE Temperature evolution over the Orbit Test.

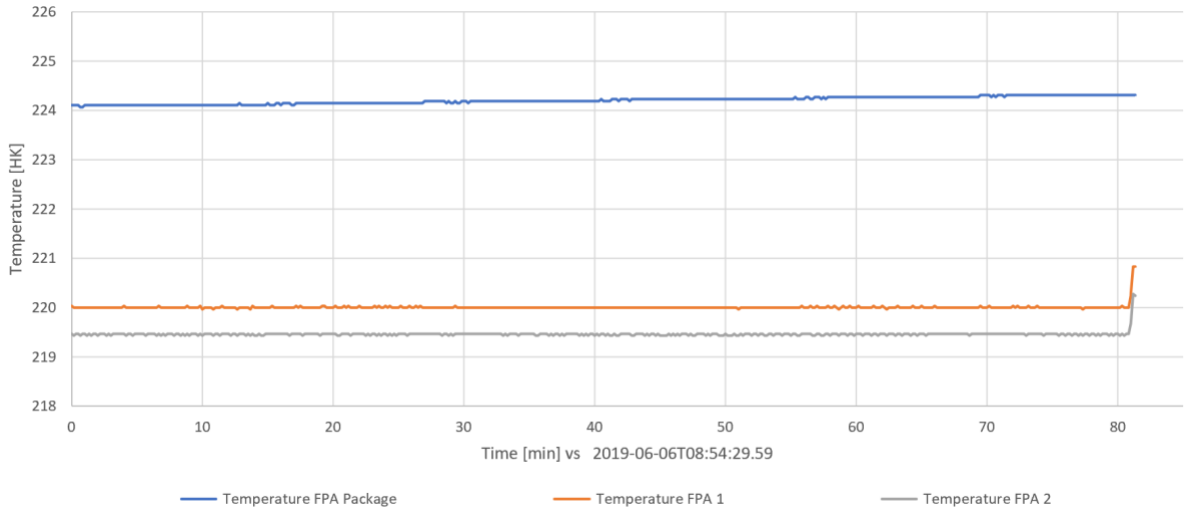

Figure 6: VIHI other temperatures evolution over the Orbit Test.

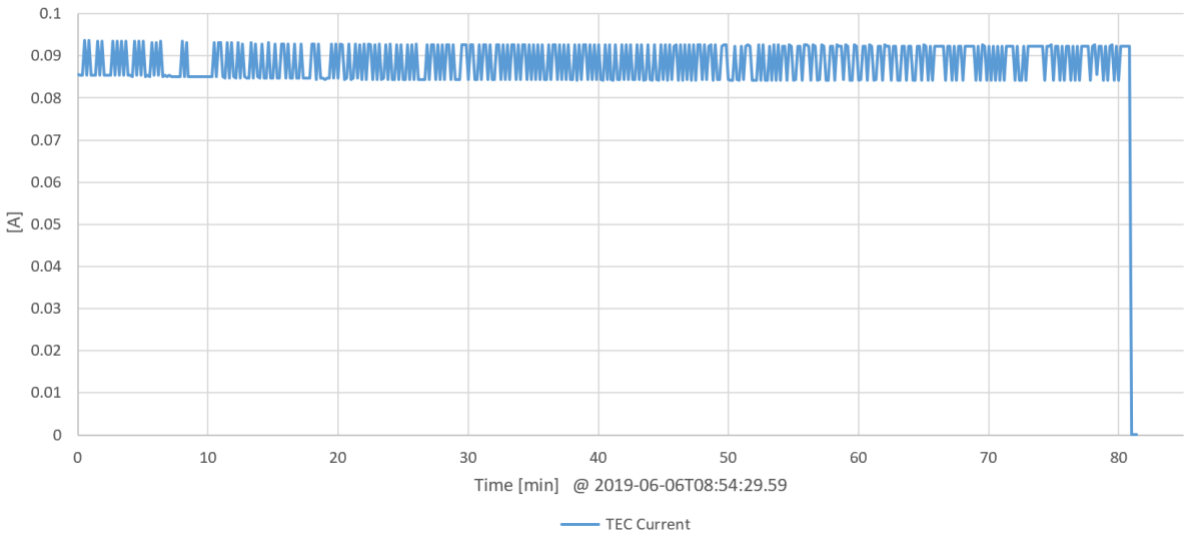

Figure 7: VIHI TEC current evolution over the Orbit Test.

As per STC and differently from the case of the HRIC channel, their behaviour is nominal, but it must be considered that the VIHI channel was already in on state since it came from its performance test executed earlier. In fact, also the VIHI channel experienced **an unwanted oscillation in the TEC current profile** after its switch-on (see [RD.13] for details).

Apart from the HRIC TEC issue, for **both HRIC and STC channels the execution of the test has been nominal** with no errors and all commanded data received correctly.

In the case of VIHI channel, **same anomalous behaviour** occurred:

- Three out of eight acquisition missing
- No rejected TCs
- No error messages from ME

3.1.4. Test discussion

The on-ground analysis of the H/Ks and TCs issued to the VIHI channel pointed out that the anomalous behaviour of the channel was due to a wrong configuration of the numbers of the commanded rows while applying

a 2x spectral binning: in practice, the effective number of rows, after binning, resulted lower than the compression box dimension.
The error was not detected by the onboard ASW that should have rejected the command instead of sending an execution ACK. **The execution of the timeline continued with no error events from SIMBIO-SYS** indicating the test was completed with no errors.
More details are reported in [RD.11].

4. Conclusions

A dNECP test session has been defined to complete/repeat some tests that presented some problems during NECP; in particular the ORBIT_TEST has been repeated to verify the issue 5 of [RD.2].
As described in the above paragraphs, apart from the HRIC TEC issue, for both HRIC and STC channels the execution of the test has been nominal with no errors while some anomalies were observed for the VIHI channel.
From the data analysis, it has been derived that, since the VIHI operative sequence in the test was the same used in NECP, **its data loss experienced during NECP was due to the wrong configuration of the used TCs**.

Waiting for the new release of the ASW that will take into account for the issue revealed, proper "flight rules" will be implemented as checks in the Operation Simulator to avoid future issues with the timelines.

In the meantime, **issue 5 of [RD.2] regarding the data loss can be considered definitively closed**.

Finally, apart from the issues raised on the channels operativity, the test demonstrated that **the onboard ASW is capable to manage the data throughput** to/from the channels while operating in a standard Global Mapping science phase.