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BC-SIM-TR-007 STC Delta-NECP REPORT

Issue 1.0

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1. Introduction

1.1.Scope

The present document has been issued to describe the Delta – Near Earth Commissioning Phase (dNECP) Tests of STC Stereo Camera.

1.2. Reference Documents

- [RD. 1] BC-SIM-TN-003_-_Reports_and_Note_Layout_and_Flow, [10.20371/INAF/TechRep/36](#)
- [RD. 2] BC-SIM-TR-005 SIMBIO-SYS NECP Test Report [10.20371/INAF/TechRep/42](#)
- [RD. 3] BC-SIM-GAF-MA-002 rev.8_SIMBIO-SYS FM User Manual, 2017
- [RD. 4] STC FPA Delivery Review Board (DRB) Data Package FM (BC-SIM-RVS-DP-021)
- [RD. 5] BC-SIM-TR-003 - STC NECP Report [10.20371/INAF/TechRep/26](#)
- [RD. 6] BC-ALS-TN-00099 MPO PFM Monitoring Thermistors Location
- [RD.7] BC-SIM-PL-003_-_SIMBIO-SYS Delta NECP Test Summary I1 Rev0 [10.20371/INAF/TechRep/66](#)
- [RD. 8] BC-SIM-TN-004_-_SIMBIO-SYS_FOP_update_after_NECP, [10.20371/INAF/TechRep/58](#)
- [RD. 9] BC-SIM-TR-XXX-EGSE dNECP [10.20371/INAF/TechRep/70](#)
- [RD. 10] SIMIONI, E., et al. CMOS detectors: lessons learned during the STC stereo channel preflight calibration. In: *International Conference on Space Optics—ICSO 2016*. International Society for Optics and Photonics, 2017. p. 105622M.
- [RD. 11] BC-SIM-TN-002_-_STC_Strategy_Observation ([10.20371/INAF/TechRep/35](#))

1.3.Acronyms

ACK	Acknowledgment
ADC	Analogical Digit Converter
APID	Application Process IDentifier
ASW	Application SoftWare
CM	Color Mode
CSV	Comma Separated Values
DSNU	Dark Signal not Uniformity
FOP	Flight Operation Procedure
FPA	Focal Plane Assembly
HK	Housekeeping
HRIC	High spatial Resolution Imaging Channel
ICO	Instrument Checkout
IT	Integration Time



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ME	Main Electronics
NECP	Near Earth Commissioning Phase
OBCP	On-Board Control Procedure
OB	Optical Bench
OBSW	On Board Software
PDOR	Payload Direct Operation Request
PDS	Planetary Data System
PE	Proximity Electronics
PNG	Portable Network Graphics
PSC	Packet Sequence Control
RT	Repetition Time
SIMBIO-SYS	Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem
SSC	Source Sequence Count
SSMM	Solid State Mass Memory
STC	STereo imaging Channel
S/C	Space-Craft
TC	TeleCommand
TEC	Thermo-Electric Cooler
TM	Telemetry
VIHI	Visible and Hyper-spectral Imaging channel
XML	eXtensible Markup Language



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1.4.Document Format and Repository

This document is compliant with the SIMBIO-SYS Report and Note Layout and Flow [RD. 1] 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 –Delta NECP objective, with a brief description of the test executed.
- Section 3 – “All FPA test” description including commanding and HKs interpretation and discussion.
- Section 4 – “Hot Pixel Test” description including commanding and HKs interpretation and discussion.
- Section 5 – “Mitigate Test” description including commanding and HKs interpretation and discussion.
- Section 6 – “Orbit Test” description including commanding and HKs interpretation and discussion.
- Section 7 – Description of the test reports in attachment to Section 8.

2. Definitions and assumptions

In this section the main technical terms are defined. Thermal sensors at channel level are described in Section 2.1. Considering the TEC-INIT and TFPA SETPOINTS Issues (Issue 1-2 Section 4.2 of [RD. 2]) occurred during the NECP on the Thermo Electric Cooler (TEC) activation, the next section will report the STC Cold Finger (CF) Temperature sensor and a brief analysis of their behavior after heating activation during dNECP phase.

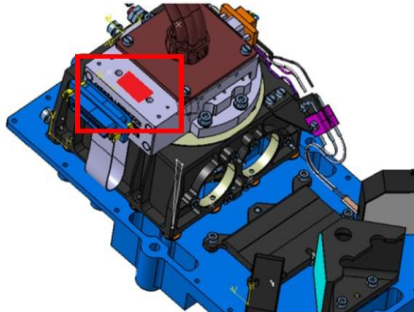
2.1. STC Sensors

Param.	ID	Param. Name	Packet ID	Packet name	Unit	Calibration
NSS21040	STC	Temperature FPA1	YSS40002	SIMB STC Housekeeping	K	CSSP0020TM
NSS21041	STC	Temperature FPA2	YSS40002	SIMB STC Housekeeping	K	CSSP0021TM
NSS21042	STC	Temperature PE	YSS40002	SIMB STC Housekeeping	K	CSSP0022TM
NSS21043	STC	Temp channel fw	YSS40002	SIMB STC Housekeeping	K	CSSP0023TM
NSS21044	STC	Temp channel bw	YSS40002	SIMB STC Housekeeping	K	CSSP0024TM
NSS21050	STC	PE 3.3V Measured	YSS40002	SIMB STC Housekeeping	V	CSSP0025TM
NSS21051	STC	TEC Current	YSS40002	SIMB STC Housekeeping	A	CSSP0026TM

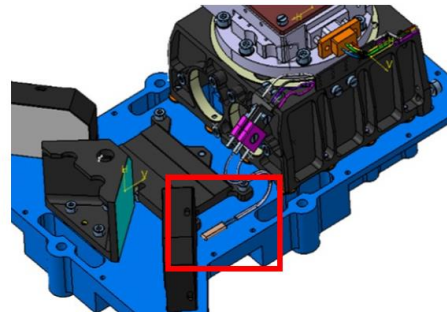
Table 1 Main temperature sensors of STC on the FPA, PE, the backside of the detector and the STC OB as Reported in **RD1**.

The position of the channel temperature sensors are shown in Figure 1 (a,b) extracted from [RD. 3]. The STC Temperature sensors are here described:

- FPA1 and FPA2 sensors, hereafter abbreviated with TFPA1 and TFPA2 respectively, are located close to the detector surface. Their measures indicate an increase in the temperature when the detector is switched on and then a lowering after the TEC switching on; their temperature values are also used as a feedback for interpreting the TEC behavior.
- The Temp Channel-fw sensor, defined as the Focal Plane Assembly (FPA) Package in EGSE [RD. 4], is located on the hot side of the FPA package, thus it is expected to have values corresponding to instrument temperature;
- the Temp Channel-bw sensor, defined as STC Optical Bench (OB) in EGSE [RD. 4], is located on the back side of one folding mirrors as in Fig. 1 (b) and gives a measure of the OB temperature in the front part of the STC channel “Ch-Low”.



(a)



(b)

Figure 1 In (a) the location of the “STC Temperature Channel-fw” (NSS21043) temperature sensor (red rectangle). This sensor is placed onto the FPA package, in the same position where the corresponding sensor is placed on the HRIC FPA. In (b) the location of the “STC Temperature Channel-bw” (NSS21044) temperature sensor, More details on the Sensors positions are reported in [RD. 5].

2.2.BepiColombo CF Sensors

This section shows the trend of the STC Cold Finger (CF) temperature sensor named MPO-TEMP-SIMBIO-STC-CF and identified as MPO-TEMP-SIMBIO-STC-CF by ESA and THT-B6T136 by Thales (see [RD. 6]).

2.2.1. Sensor Position

The position is shown in the following figure.

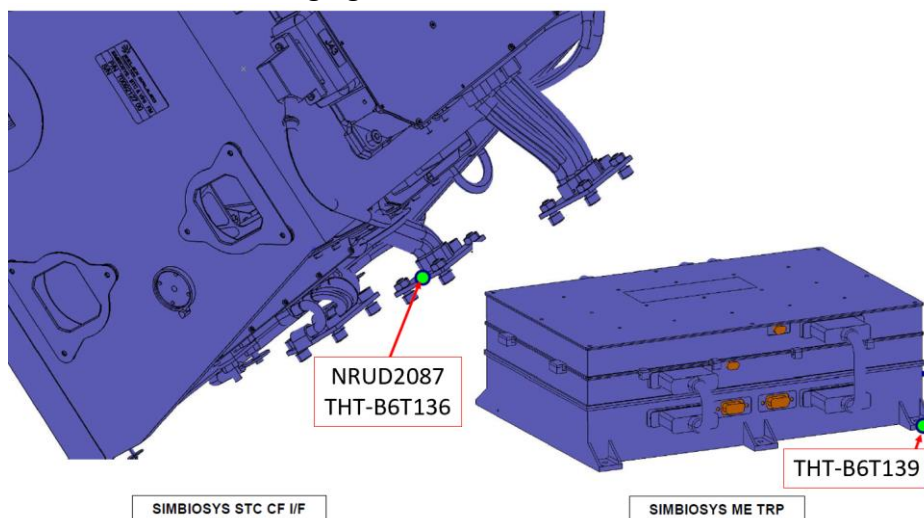


Figure 2 On the left the MPO-TEMP-SIMBIO-STC-CF (NRUD2087 , here THT-B6T136) as reported by [RD. 6].

2.2.2. Data analysis

In this section we consider the temperature measured for the CF sensor defined in the previous section during the dNECP tests (i.e., between 05/06/2019 and 08/06/2019).

STC CF temperature is shown in **Figure 3**. HKs were acquired with a sample rate of 5 minutes.

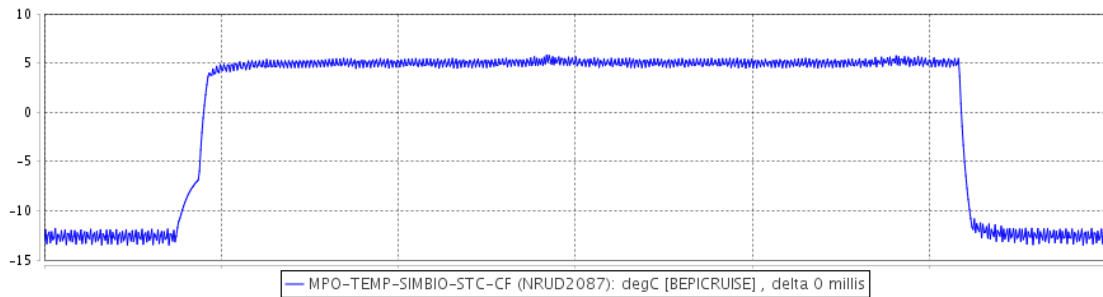


Figure 3 Measurement for STC CF during dNECP and ICO1 phase. Temperature is reported in °C.

Table 2 reports the main parameters of the CF temperature behavior divided by:

- Off phase (before the heating)
- Ramp phase (heating increasing the temperature)
- Operating phase (nominal heaters temperature)
- Switching off phase (descending phase after the heaters switch off)

		STC
Off phase	Mean T [°C]	-12.63
	Std T [°C]	0.5
Ramp	Duration [min]	140
	Time (05/06/2019)	08:33 to 10:53
	T Reached [°C]	3.8
	DeltaT [°C]	16.43
Operating phase	Carry wave	Period: 15 min Amplitude 0.2°C Mean: 5°
Switching off phase	Duration [min]	60
	Time (07/06/2019)	13:58 to 14:58
	T Reached [°C]	-12.4

Table 2 Table of the main parameters describing the CF temperatures in the different phases of the heating.

During the operating phase a carry wave was measured (in the limits of Nyquist frequency) due to the heating control.



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3. D-NECP Performance Tests

As indicated in [RD.7], in delta-NECP the STC performance has been verified by means of 3 Performance Tests:

- All FPA Test,
- Mitigate Reset Test
- Hot Pixel Test.
- In addition to these, a dedicated procedure which involves all the three channels (Orbit test) to simulate a generic orbit during the Global Coverage Phase (GCP) of SIMBIO around Mercury (for more details see the System Technical Report) was tested during the delta-NECP SIMBIO-SYS.

See **Table 3** for more details.

Test name	Monitoring	UTC first Image
STC All FPA Test	DARK AND DSNU IN ALL THE DETECTOR	20190606T065400015375
STC Mitigate-Reset Test	Dark offset behavior	20190606T070000017553
STC Hot-pixel Test	Hot pixels presence as function of spurious charge	20190606T070023593160
Orbit test	Inter-channels behavior	20190606T090926017059

Table 3 Table of the Tests as reported in [RD.7].

4. STC ALL FPA TEST

4.1. Test description

The aim of the test is the monitoring of the Dark Current (DC), the Dark Signal Non Uniformity (DSNU) and the ReadOut Noise (RON) by means of several acquisitions of large detector regions. The different regions have been defined with the aim of covering the whole detector.

Differently from what was commanded during the on-ground calibration phase, the STC DC was measured for fixed values of the Repetition Time (RT) to analyze the impact of low RTs (0.7s where possible or 1.2s) and high RTs (5 s).

The Integration Time (IT) = 0 and 500 (raw values corresponding to 400 ns and 4.8 ms), have been tested in 5 main configurations (each with for two different values of the RTs):

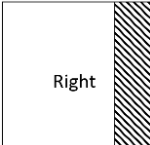
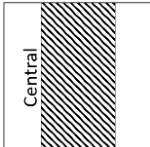
- “Left” side of the detector (the first 576 columns of the FPA). Hereafter “SurfBndLft”.
- “Right” side of the detector (the last 576 columns of the FPA). Hereafter “SurfBndRgh”.
- “Central” part of the detector (middle 1024 columns of the FPA). Hereafter “SurfBndCen”.
- “Half High” part of the detector (the first 1024 rows of the FPA). Hereafter “SurfHalfHi”.
- “Half Low” part of the detector (the last 1024 rows of the FPA). Hereafter “SurfHalfLO”

4.2. Commanding

During the switch on of the Main Electronics (ME), before the beginning of the Delta-NECP and the ALL_FPA TEST, the new parameters for the TEC soft start (see [RD.7] for more details) were uploaded.

After this, the test has been performed through the execution of a PDORs named: “PDOR_BPSS00142_SIMBIOSYS_all_fpa” (see attachments of [RD.7]).

A detailed timeline of the test is shown in **Table 4**.

Timing	ID FOPs	Name FOP	FPA Region	Parameters
00:00:00	ASSF322A	STC OUTF SurfBndLft v03		IT=0; RT=0.7s, Width= 576 px (*)
00:00:30	ASSF322A	STC OUTF SurfBndLft v03		IT=500; RT=0.7s, Width= 576 px (*)
00:01:00	ASSF322A	STC OUTF SurfBndLft v03		IT=0; RT=5s, Width= 576 px (*)
00:01:30	ASSF322A	STC OUTF SurfBndLft v03		IT=500; RT=5s, Width= 576 px (*)
00:02:00	ASSF323A	STC OUTF SurfBndRgh v03		IT=0; RT=0.7s, Width= 576 px (*)
00:02:30	ASSF323A	STC OUTF SurfBndRgh v03		IT=500; RT=0.7s, Width= 576 px (*)
00:03:00	ASSF323A	STC OUTF SurfBndRgh v03		IT=0; RT=5s, Width= 576 px (*)
00:03:30	ASSF323A	STC OUTF SurfBndRgh v03		IT=500; RT=5s, Width= 576 px (*)
00:04:00	ASSF321A	STC OUTF SurfBndCen v03		IT=0; RT=1.2s, Width= 1024 px
00:04:30	ASSF321A	STC OUTF SurfBndCen v03		IT=500; RT=1.2s, Width= 1024 px
00:05:00	ASSF321A	STC OUTF SurfBndCen v03		IT=0; RT=5s, Width= 1024 px
00:05:30	ASSF321A	STC OUTF SurfBndCen v03		IT=500; RT=5s, Width= 1024 px
00:06:00	ASSF324A	STC OUTF SurfHalfHi v03		IT=0; RT=1.2s
00:06:30	ASSF324A	STC OUTF SurfHalfHi v03		IT=500; RT=1.2s
00:07:00	ASSF324A	STC OUTF SurfHalfHi v03		IT=0; RT=5s

Timing	ID FOPs	Name FOP	FPA Region	Parameters
00:07:30	ASSF324A	STC OUTF SurfHalfHi v03	High	IT=500; RT=5s
00:08:00	ASSF325A	STC OUTF SurfHalfLO v03	Low	IT=0; RT=1.2s
00:08:30	ASSF325A	STC OUTF SurfHalfLO v03		IT=500; RT=1.2s
00:09:00	ASSF325A	STC OUTF SurfHalfLO v03		IT=0; RT=5s
00:09:30	ASSF325A	STC OUTF SurfHalfLO v03		IT=500; RT=5s

Table 4 Timeline of the ALL_FPA test with the references to the commanded FOPs ([RD.7] for more details). All TCs commanded 5 consecutive acquisitions. RTs are reported in seconds, ITs are reported in RAW format (IT=0 and 500, raw values corresponding to 400ns and 4.8 ms). 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 5**.

EGSE_NT C [#]	First_Acq [UTC]	Duration [s]	DimX [px]	IT [ms]	RT [s]	FPA Region
1	2019-06-06T06:54:00.015375	4.8	1024	0	1.2	Central
2	2019-06-06T06:54:30.015131	4.8	1024	4.8	1.2	
3	2019-06-06T06:55:00.014871	20	1024	0	5	
4	2019-06-06T06:55:30.019677	20	1024	4.8	5	
5	2019-06-06T06:56:00.014443	4.8	2048	0	1.2	High
6	2019-06-06T06:56:30.019112	4.8	2048	4.8	1.2	
7	2019-06-06T06:57:00.018974	20	2048	0	5	
8	2019-06-06T06:57:30.018699	20	2048	4.8	5	
9	2019-06-06T06:58:00.018424	4.8	2048	0	1.2	Low
10	2019-06-06T06:58:30.018134	4.8	2048	4.8	1.2	
11	2019-06-06T06:59:00.018027	20	2048	0	5	
12	2019-06-06T06:59:30.017752	20	2048	4.8	5	

Table 5 Resulting database of the ALL_FPA test. All TCs commanded 5 consecutive acquisitions with IBR=0 and CBD=128x128.

4.3.HKs interpretation and discussion

TEC activation with the new uploaded parameters allowed its “soft” start avoiding an Out Of Limit (OOL) current peak. Nevertheless, they generated a non-nominal oscillation on the current profile as showed by Figure 4.

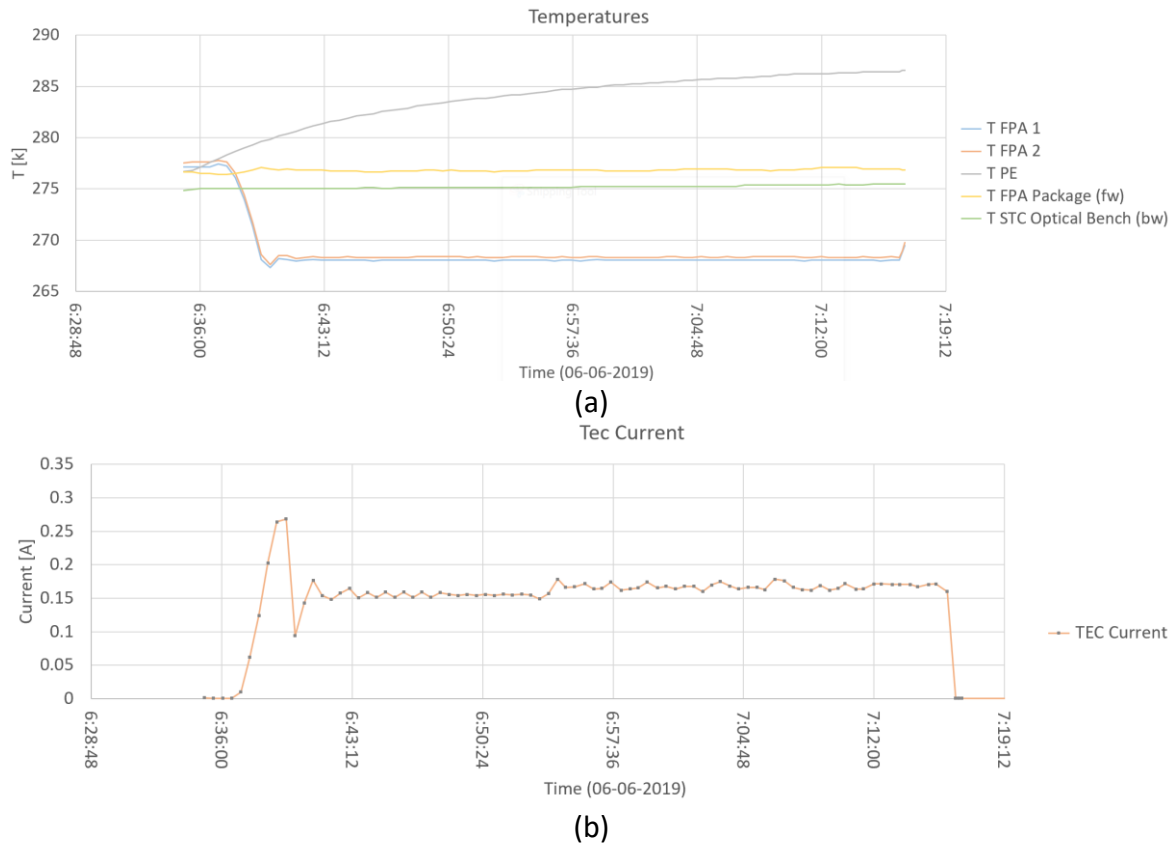


Figure 4 Temperatures (a) and TEC current values (b) evolution over the dNECP tests. For HK description details see Section 2.1.

From the analysis of the above-reported data, to avoid this kind of event, the nominal parameters for the TEC activation must be used, and additional study on the S/C thermal environment settings is necessary.

The images acquired during the test confirm the FPA status measured during STC on-ground calibration.

The ASW rejected the first 8 TCs due to an incompatibility of the input parameters not detected during the PDORs design. In more detail if it is commanded a frame window for which the dimension is such that **the number of both vertical or horizontal compression boxes is greater than 16** (see [RD. 3]), the acquisition is not rejected.

4.4. Anomalies Solution and future actions

Incompatibility rules will be updated in the on-ground PDOR/POR simulator.

5. STC HOT PIXEL TEST

5.1. Test description

The aim of the test is to control the spurious charge effect and the associated popcorn (burst noise) noise.

Differently from what commanded during the on-ground calibration phase, STC DC popcorn effect was measured for fixed values of the RT (i.e. 1s for low ITs and 12s for high ones).

The test considers different configurations to evaluate the:

- Effect of increasing the window Along Track (AT) dimension (for IT=0,4.8ms)
- Effect of increasing the window Cross Track (CT) dimension (for IT=0,4.8ms)
- Effect in using simultaneously all the 6 windows available for high ITs (1s,5s,10s) simulating STARS acquisitions.

The AT and the CT tests are shown in Figure 5.

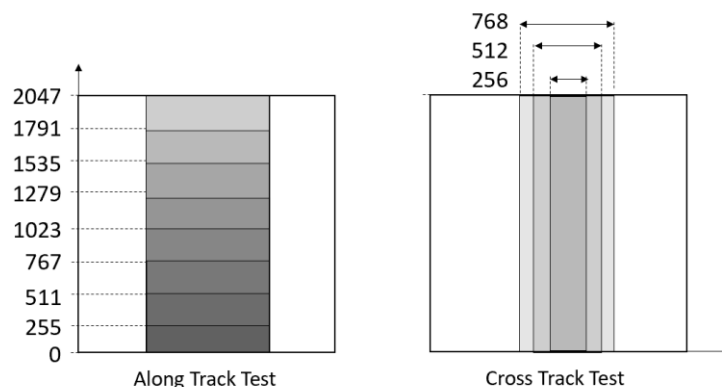


Figure 5 The figure shows the along track and the cross-track test for the measurement of the spurious. The images reports: in the case of the AT (left case), the last raw of each acquisition on the vertical axis, in the case of the CT (right case) the dimensions CT of the window.

5.2. Commanding

This test has been performed through the execution of a PDORs named:

“PDOR_BPSS00143_SIMBIO-SYS_hot_pixel_test” (see attachments of [RD.7]).

A detailed timeline of the test is shown in Table 6.

Timeline	FOP Name	Description	START STRIP	END STRIP	START ROW	STOP ROW	NPIX HOR	NPIX VER
0:00:00	ASSF300A	AT IT=0ms	9	24	0	255	1024	256
0:00:12	ASSF300A		9	24	0	511	1024	512
0:00:24	ASSF300A		9	24	0	767	1024	768
0:00:36	ASSF300A		9	24	0	1023	1024	1024
0:00:48	ASSF300A		9	24	0	1279	1024	1280
0:01:00	ASSF300A		9	24	0	1535	1024	1536
0:01:12	ASSF300A		9	24	0	1791	1024	1792

0:01:24	ASSF300A		9	24	0	2047	1024	2048
0:01:36	ASSF300A	AT IT=4.8ms	9	24	0	255	1024	256
0:01:48	ASSF300A		9	24	0	767	1024	768
0:02:00	ASSF300A		9	24	0	1279	1024	1280
0:02:12	ASSF300A		9	24	0	2047	1024	2048
0:02:24	ASSF300A	CT IT=0ms	11	22	0	2047	768	2048
0:02:36	ASSF300A		13	20	0	2047	512	2048
0:02:48	ASSF300A		15	18	0	2047	256	2048
0:03:00	ASSF300A	CT IT=4.8ms	11	22	0	2047	768	2048
0:03:12	ASSF300A		13	20	0	2047	512	2048
0:03:24	ASSF300A		15	18	0	2047	256	2048
0:03:36	ASSF350A	STELLAR 1s, 5s, 10s	9	24	6 filters		1024	1024
0:05:36	ASSF350A		9	24	6 filters		1024	1024
0:07:36	ASSF350A		9	24	6 filters		1024	1024

Table 6 Timeline of the 21 TCs of the HOT PIXEL TEST with the references to the commanded FOPs (see [RD. 8] for more details). All TCs commanded 10 consecutive acquisitions. For all the acquisitions RT was set to 1 s except for the stellar test where it was set to 12s. Table reports the FCP commanded, for more details see [RD. 8].

The resulting database derived by EGSE telemetry-to-raw pipeline is reported in Table 7.

EGSE_NTC	First_Acq	Duration	DimX	IT	RT	CB	Windows
[#]	[UTC]	[s]	[px]	[ms]	[s]	[YxX]	
1	2019-06-06T07:06:28.214616	9	1024	0	1	128x128	cust0
2	2019-06-06T07:06:38.214647	9	1024	0	0.99999	128x128	cust0
3	2019-06-06T07:06:50.014497	9	1024	0	0.99999	128x128	cust0
4	2019-06-06T07:07:02.019395	9	1024	0	1	128x128	cust0
5	2019-06-06T07:07:14.019288	9	1024	0	1	128x128	cust0
6	2019-06-06T07:07:26.019135	9	1024	0	1	128x128	cust0
7	2019-06-06T07:07:38.019166	9	1024	0	1	128x128	cust0
8	2019-06-06T07:07:50.018967	9	1024	0	1	128x128	cust0
9	2019-06-06T07:08:02.018967	9	1024	4.8	0.99999	128x128	cust0
10	2019-06-06T07:08:14.018815	9	1024	4.8	0.99999	128x128	cust0
11	2019-06-06T07:08:26.018799	9	1024	4.8	1	128x128	cust0
12	2019-06-06T07:08:38.018662	9	1024	4.8	1	128x128	cust0
13	2019-06-06T07:08:50.018646	9	768	0	0.99999	128x128	cust0
14	2019-06-06T07:09:02.018585	9	512	0	0.99998	128x128	cust0
15	2019-06-06T07:09:14.018478	9	256	0	0.99999	128x128	cust0
16	2019-06-06T07:09:26.018341	9	768	4.8	1	128x128	cust0
17	2019-06-06T07:09:38.018234	9	512	4.8	1	128x128	cust0
18	2019-06-06T07:09:50.018234	9	256	4.8	1	128x128	cust0
19	2019-06-06T07:10:02.018188	108	896	999.36	11.9999	128x64	all filters
20	2019-06-06T07:12:02.017317	108	896	4999.68	11.9999	128x64	all filters
21	2019-06-06T07:14:02.016598	108	896	9999.36	11.9999	128x64	all filters

Table 7 Database derived by EGSE. All TCs commanded 10 acquisitions with IBR=0.



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5.3.HKs interpretation and discussion

The test was performed correctly. All the data-bench is now in use to confirm the FPA status measured on-ground during STC calibration.

An anomaly was revealed (see [RD. 9]) in two frames that were corrupted in Science TC 008:

- `sim_img_stc_low_xxx_0_cust0_NNNNN_20190606T070750018967`
- `sim_img_stc_low_xxx_0_cust0_NNNNN_20190606T070751019044`

These frames resulted corrupted as the ones reported during NECP test DAY3 STC Performance Recovery (see [RD. 5] Section 9.4).

5.4.Anomalies Solution and future actions

The anomalies are due to a misalignment between Sequence Counter and Timing at ME level and they will be solved internally by EGSE pipeline.

6. STC Mitigate Reset Test

6.1.Test description

The aim of the test is the monitoring of the “offset” present in some of the images acquired with the STC detector.

As shown in Figure 6 and reported in [RD. 5] and [RD. 10] a well-known behavior of the STC-FPA called “peak behavior” is expected in some operation conditions.

Under limited ranges of the IT the reset procedure of the detector leaves a spurious signal uniformly distributed on all the FPA. This charge is then unloaded in the subsequent acquisitions. The issue is illustrated in Figure 11 which shows the signal measured by the detector (in part nominal and in part spurious) decreasing with time and stabilizing on a constant value after a certain number of images.

The STC Mitigate Reset Test is a test foreseen to try to mitigate this issue.

A series of acquisitions selected to feature the “peak behavior” are interleaved by fake detector reading in order to try to remove the detector reset anomaly.

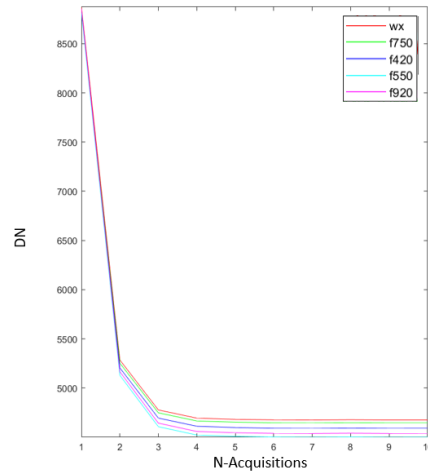


Figure 6 The expected behavior of the STC FPA for the long ITs.

Different tests were performed repeating the same “peak configuration” measured during NECP (see [RD. 5]) anticipated by the acquisition of the mitigate window (Window-X) with different RT and time distances (thanks to the OutFSurfX FCP [RD. 8]) .

6.2.Commanding

This test has been performed through the execution of a PDORs named:

- “PDOR_BPSS00140_SIMBIO-SYS_mitigate_test” (see attachments of [RD.7]).

A detailed timeline of the test is shown in **Table 8**.

TIME TC	TC-ID	FOP-NAME	RT[sec]	NACQ	SUB-TEST	FILTER	IT[raw]
0:00:00	ASSF308A	SciSurfNomnl CM	0.2	50	TEST 1	CM	4
0:00:25	ZZ172B2	STC Science 1 ms	2	10		CM	33809
0:00:59	ASSF320A	OutFSurf X	0.15	3	TEST 2	WINX	0
0:01:00	ZZ172B2	STC Science 1 ms	2	3		CM	33809
0:01:34	ASSF320A	OutFSurf X	0.15	7	TEST 3	WINX	0
0:01:35	ZZ172B2	STC Science 1 ms	2	10		CM	33809
0:02:09	ASSF320A	OutFSurf X	0.15	1	TEST 4	WINX	0
0:02:10	ZZ172B2	STC Science 1 ms	2	10		CM	33809
0:02:44	ASSF320A	OutFSurf X	0.9	2	TEST 5	WINX	0
0:02:45	ZZ172B2	STC Science 1 ms	2	10		CM	33809
0:03:19	ASSF320A	OutFSurf X	0.95	2	TEST 6	WINX	0
0:03:20	ZZ172B2	STC Science 1 ms	2	10		CM	33809
0:03:54	ASSF320A	OutFSurf X	0.98	2	TEST 7	WINX	0
0:03:55	ZZ172B2	STC Science 1 ms	2	10		CM	33809
0:04:29	ASSF320A	OutFSurf X	0.99	2	TEST 8	WINX	0
0:04:30	ZZ172B2	STC Science 1 ms	2	10		CM	33809
0:05:04	ASSF320A	OutFSurf X	0.495	3	TEST 9	WINX	0

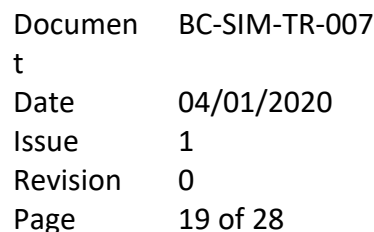


Table 8 Timeline of the 13 Tests of the MITIGATE RESET TEST with the references to the commanded FOPs (see [RD. 8] for more details). Asterisks indicate the TCs not executed by the on-board software. Read next session for more details. Table reports the FCP commanded, for more details see [RD. 8].

EGSE NTC	First_Acq	Duration	NACQ	DimX	IT	RT	CB	IBR	Window s
[#]	[UTC]	[s]	[#]	[px]	[ms]	[s]	[YxX]	[#]	
1	2019-06-06T07:00:00.017553	9.8	50	896	0.0384	0.2	64x64	63	CM
2	2019-06-06T07:00:25.017324	18	10	896	999.36	2	64x64	63	CM
3	2019-06-06T07:00:59.017080	0.3	3	128	0	0.14997	64x64	2	filterx
4	2019-06-06T07:01:00.017125	4	3	896	999.36	2	64x64	63	CM
5	2019-06-06T07:01:34.016728	0.9	7	128	0	0.15001	64x64	2	filterx
6	2019-06-06T07:01:35.066808	18	10	896	999.36	2	64x64	63	CM
7	2019-06-06T07:02:09.016545	0	1	128	0	NaN	64x64	2	filterx
8	2019-06-06T07:02:10.016591	18	10	896	999.36	2	64x64	63	CM
9	2019-06-06T07:02:44.016194	0.9	2	128	0	0.90015	64x64	2	filterx
10	2019-06-06T07:02:45.816258	18	10	896	999.36	2	64x64	63	CM
11	2019-06-06T07:03:19.015949	0.95	2	128	0	0.95009	64x64	2	filterx
12	2019-06-06T07:03:20.916034	18	10	896	999.36	2	64x64	63	CM
13	2019-06-06T07:03:54.015735	0.98	2	128	0	0.98007	64x64	2	filterx
14	2019-06-06T07:03:55.975864	18	10	896	999.36	2	64x64	63	CM
15	2019-06-06T07:04:29.015536	0.99	2	128	0	0.98993	64x64	2	filterx
16	2019-06-06T07:04:30.995593	18	10	896	999.36	2	64x64	63	CM
17	2019-06-06T07:05:04.015246	0.99	3	128	0	0.49499	64x64	2	filterx
18	2019-06-06T07:05:05.500353	18	10	896	999.36	2	64x64	63	CM
19	2019-06-06T07:05:39.014925	0	1	1024	0	NaN	128x128	2	cust0
20	2019-06-06T07:05:40.215014	18	10	896	999.36	2	64x64	63	CM
21	2019-06-06T07:06:00.214968	12	4	896	4.8	3.9999	64x64	63	CM



22	2019-06-06T07:06:16.214845	0	1	896	4.8	NaN	64x64	63	CM
23	2019-06-06T07:06:20.214739	0	1	896	4.8	NaN	64x64	63	CM
24	2019-06-06T07:06:24.214739	0	1	896	4.8	NaN	64x64	63	CM

Table 9 Database derived by EGSE. All TCs commanded 10 acquisitions with IBR=0.

6.3. HKs interpretation and discussion

The mitigate reset test has **not been conclusive** since all the sub-tests have no effect on the “peak behavior”. Most likely the test didn’t succeed in mitigating the off-set due to the null integration time commanded for the mitigate acquisitions.

Some telemetries anomalies were reported during the test. For a deeper analysis, it is necessary to consider the two sets:

- The first 10 Tests (executed but with some TCs delay)
- The last 3 Tests (not executed without any ACK)

6.3.1. Test 1-10

All the first sets of tests (1-10) were designed to measure the effect of the acquisition of the Window-X before the acquisition of the Color Mode (see for details [RD. 11] for high IT).

All the tests foreseen two TCs:

TC1: Acquire 1 or more Windows X with a defined RT.

TC2: Acquire after 1 second from the beginning of the test of the CM.

This strategy would have provided the result of acquire the mitigate window at different distance time from the CM acquisition. Unfortunately, due to the delays in the execution of the TCs, the CM window commands were not executed as the expected time (but in dependence of the previous execution) invalidating the test.

Figure 7 shows in a) a schematic representation of the commanding for the TESTS 1-2-4 (nominal behavior); In b) a schematic representation of the delayed execution of the TC2 (corresponding to all the other tests).

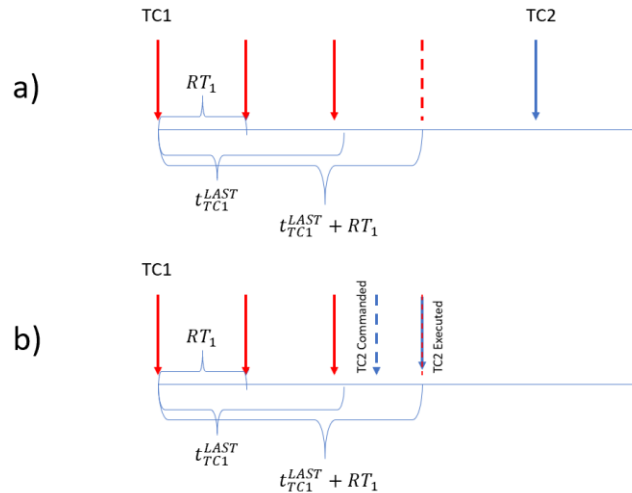


Figure 7 In a) a nominal commanding configuration where the second TC (TC2) is correctly executed after the first ones (TC1). The red arrows represent the acquisitions of the TC1 (in this case 3). The blue arrow represents acquisition executed by TC2. In b) the delayed configuration. When the TC2 is commanded before the $t_{TC1}^{LAST} + RT_1$ (dotted blue arrow) it is delayed and executed at the end of the RT cycle.

Defining as t_{TC1}^{LAST} the time of the last TC1 acquisition and as RT_1 its RT, the HKs analysis shows that if TC2 is commanded after $t_{TC1}^{LAST} + RT_1$, it is TC2 is executed normally. **In all the other cases the TC2 is delayed and it is executed at the first clock of the RT which correspond to $t_{TC1}^{LAST} + RT_1$.**

Table 10 shows, for each test, the Time Commanded for the TC2 with respect to the TC1 and the actual time of the execution.

TEST NAME	TC1				TC2	
	RT [s]	NACQ #	t_{TC1}^{LAST} [s]	$t_{TC1}^{LAST} + RT_1$ [s]	TIME COMMANDED [s]	TIME EXECUTION [s]
TEST1	0.2	50	9.80	10.00	+25	+25
TEST2	0.15	3	0.3	0.45	+1	+1
TEST3	0.15	7.00	0.90	1.05	+1	+1.05
TEST4	0.15	1.00	0	0.15	+1	+1
TEST5	0.9	2.00	0.90	1.80	+1	+1.80
TEST6	0.95	2.00	0.95	1.9	+1	+1.90
TEST7	0.98	2.00	0.98	1.96	+1	+1.96
TEST8	0.99	2.00	0.99	1.98	+1	+1.98
TEST9	0.495	3	0.99	1.49	+1	+1.49
TEST10	1	1.	0	1.2	+1	+1.20

Table 10 Timeline of the first 10 Tests with the main parameters of the TC1 and TC2. In bold the Tests where the execution did not correspond to the commanding.

The result of this inconsistency between commanding and execution has invalidated the test.

6.3.2. Test 11-13

During the execution of the Tests 11-13, 3 TCs were ignored without giving any acknowledgment. The 3 TCs are indicated in **Table 11** with asterisks (*).

TIME TC [s]	TC-ID	RT [s]	NACQ #	NOTE	t_{TC}^{LAST} [s]	$t_{TC}^{LAST} + RT$ [s]
+00	ASSF308A	4	4		+12	+16
+15*	ASSF320A	0.2	#	TEST 11	#	#
+16	ASSF308A	4	1		+0	+4
+19*	ASSF320A	0.2	#	TEST 12	#	#
+20	ASSF308A	4	1		+0	+4
+23*	ASSF320A	0.2	#	TEST 13	#	#
+24	ASSF308A	4	1		+0	+4

Table 11 Timeline of the Tests 11-13 with the main parameters, the commanded times and the time of the last acquisitions. In bold the TCs rejected without ACK by onboard software.

Following the assumptions of 6.3.1 all of these faulty TCs were preceded by a TC with a high $t_{TC}^{LAST} + RT$ time and should have been delayed by the ASW. On the other hand, the following TCs was commanded at the same time.

A schematic simple representation of the involved TCs is showed in Figure 8.

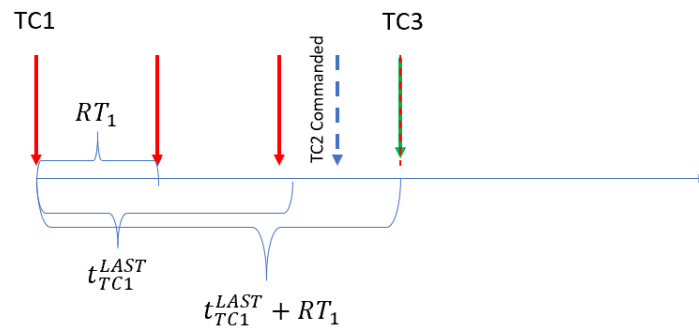


Figure 8 Timeline commanding configuration where the TEST 10-11-12. The red arrows represent the acquisitions of the TC1 (in this case 3). The blue arrow represents the commanded execution of the TC2 which, following the assumption of the 6.3.1 should be delayed to the dotted red line where TC3 is commanded and executed.

For example, first ASSF320A should be executed at +15s but the previous command has a $t_{TC}^{LAST} + RT$ equal to +16s. The result is that this TC should be delayed at +16s. On the other side another TC is commanded at +16s (ASSF308A).

The TCs have not been executed or gave any feedback because of an inconsistency between commanding and ME management of the TC in Science mode (see next Section for details).

6.4. ME interpretation and discussion

The "Science TC on Science TC" is executed at the end of the current repetition time.

This means that the execution time of a TC depends on previous one.

In particular the execution time of a TC (t_{ex}^N) can be calculated as the maximum between the commanded time t_{cm}^N and the first multiple of the previous RT^{N-1} after the execution time of the previous TC (t_{ex}^{N-1}).

$$t_{ex}^N = \max(t_{cm}^N, t_{ex}^{N-1} + k RT^{N-1}) \text{ where } k: t_{ex}^{N-1} + k RT^{N-1} > t_{cm}^N$$

This should be considered for all the three channels in particular in the following cases:

- During Stellar acquisition, when Integration Time and consequently Repetition Time are huge.
- During Global Mapping of STC and VIHI, when Repetition Times changes and a not correct commanding will bring to holes on the coverage.

6.4.1. Additive Remarks

After each repetition time,

- the software checks if there is another Frame Request to be sent, either with parameters from the previous Science TC, or from the new Science TC if any.
- If no more Frame acquisition has to be sent (number of acquisitions reached), the Mode Change report TM(5,1) is sent.

Repetition Time is added after each Frame Request even for the last Frame Request of a Science TC. Examples:

- if NbrAq=10 then there will be 10 Repetition time in the sequence and after the 10th RT the Mode Change report TM(5,1) is sent
- if NbrAq=1 then there will be 1 acquisition; at the end of the RT the Mode Change report TM(5,1) is sent.

In the case of Science mode -> Science mode

- There is no Mode Change Report TM(5,1) in case of Science TC on Science TC because to mode change (Science mode -> Science mode).
- **When ME receive a Science TC on Science TC, the Acceptance report TM(1,1) or (1,2) is sent immediately, but the Execution report TM(1,7) or (1,8) is sent at the end of the current Repetition Time.**



Same behavior is expected for STOP TC:

Even if the execution report of the Stop science is immediate, the mode changes back to Stand-by is done at the end of the RT.

In the case of several TC are sent in this delay time:

Several Stop TCs	First TC	Successful Acceptance/Execution reports (TM(1,1)/(1,7)) are sent immediately. The Stop is delayed until the next RT
	Other TCs	Successful Acceptance / Unsuccessful execution reports (TM(1,1)/(1,8)) are sent immediately
Several Science TCs	Last TC	After the Execution report of the last TC Science TM(1,7) is sent (at the next RT) only the last TC Science is executed.
	Other TCs	The acceptance report TM(1,1) is sent immediately for each TC. No Execution report are sent at all for the previous Science TC (no TM(1,7) or TM(1,8))

6.5. Anomalies Solution and future actions

Rules described will be implemented as checks in the Operation Simulator to avoid future issues with the timelines.

These limits have no impact on the nominal use of the STC Channel (i.e. GM and CM) where the rate of the TCs commanded is not comparable with the RT.

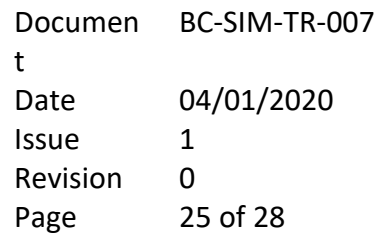
The mitigate test will be repeated in future ICO phase with an updated timeline.

The new release of the onboard software will be defined according to the problems related to the limits.

7. Orbit test

7.1. Test description

The aim of this test is the repetition of the Orbit Test performed during the NECP to verify the anomalies of data loss identified during the NECP.



A more detailed description of the Test will be reported at in Inter-channels Test Report.

Column	Name	Description
A	ACQ NUM	Number of the acquisition science the first on of the test

B	TC	ID of the TC corresponding to the folder in simbio server (i.e. science001)
C	last_image	Boolean flag defining if the acquisition is or not the last of the TC considered.
D	start_obs	UTC time of the acquisition
E-J	name_WX	Names of the windows acquired as reported in the xml files.
K	start_obs_et_[s]	UTC time of the in seconds
L	IT_[s]	Integration time of the WIN1 acquisition as reported in xml files. It correspond to the Integration time (IT) for each image acquired for a specific telecommand
M	RT_mean_[s]	Repetition time evaluated as the mean time between the first and last acquisition of the TC. In case of 1 acquisition it is not evaluated.
N	WT_[s]	Waiting Time of an acquisition. Derived by the time distance since and the previous acquisition (even if associate to another TC).
O-S	TXXXX_[K]	Temperature HKs (FPA1, FPA2, Channel1, Channel2 and PE temperature) as reported in the xml file
T-AK	mean_Wx_[DN]	For each window acquired is reported the mean of the windows in DN.
	mean64_Wx_[DN]	For each window acquired is reported the mean of the last 64 column of the window in DN.
	DSNU_Wx	For each window acquired is the standard deviation (Dark Signal Non Uniformity (DSNU)) of the window in DN.

Table 12 Columns description of the Performance Report file

8.2. Timing report

In this section we describe the timing report that has been obtained combining the information relative to the TC used during the dNECP phase including their accepted and execution time and the FOP from which it derives.

This report (in attachment at Table 16) allows to check the delay time between the commanded and the executed timeline due to granularity of the TC at satellite level and to the management of the TC by SIMBIO-SYS ME.

The report (in attachment) covers the time between 2018-12-10T08:36:44.615 (beginning of the NECP phase) and 2019-06-06T10:08:26.589 (last TC of the dNECP phase).

The report is based on the crossing of two documents:

- **STACK report: xml file**
Provided by ESOC ,the STACK XML reports all the TC log information at satellite level. It includes Command Name (i.e. ZSS17102), Sequence Name (i.e. ASSF101A for HRIC SCIENCE), Release and Uplink Time and Execution Time. Note that Execution time correspond to the execution at satellite level which means the acceptance time at instrument level.
For each TC all the PSS commanded listed with their values.
The STACK XML does not report any information at instrument level such as the effect on the instrument or the actual execution time (if happened) of the TCs.
- **LOGEVENT**
Provided by EGSE (see for details) it reports the acceptance and execution time by SIMBIO-ME. The log event file reports (see [RD. 9] for more details) the telemetry



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associated to the EVENTS traced by SIMBIO-ME. As described [RD. 9] it includes the TM, the APID and the kind of event. The main event here considered are the Mode Change, Telecommand Accepted by ME, Telecommand Executed by ME, Execution Failure by ME. The event of Telecommand Accepted by ME corresponds to the Execution at satellite level. The LogEvent does not report any information about the FOP, the TC ids or the PSS coded in the procedure commanded. Each LogEvent TM is associated to a Sequence Number. The same sequence number is associated to the Acceptance and Execution TM of the same TC..

The TimingLog Report is an XLS file which merges the previously described documents hallowing the tracing of the timing information associated to each ZSS and their parameters.

The report includes information extracted by the two documents described in the previous section. Columns name , descriptions and sources are reported in **Table 13**.

Name	Description	Source
NAME_LOG_EVENT	Name of the LogEvent file	LOGEVENT
NAME_STACK_XML	Name of the ESOC STACK file	STACK
EVENTLOG_SEQ_NUMBER	Event sequence number associate to the ZSS an reported in the EventLog as described in previous paragraphs.	LOGEVENT
STACK_ROW	Row of the STACK file	STACK
FOP	FOP corresponding to the Sequence Name in the Stack file (see previous paragraphs).	STACK
ZSS	FOP corresponding to the Command Name in the Stack file (see previous paragraphs).	STACK
NOTES	Description of the ZSS (see previous paragraphs)	LOGEVENT
CHANNEL	Channel identify the Channel of the TC which means H for HRIC,S for STC,V for VIHI and M for the ME	
ISSCIENCE	Boolean flag true for the 6 TCs of SCIENCE and false everywhere else. Science TCs for he three channel are: ZSS17102, ZSS171B2 (for HRIC), ZSS17202, ZSS172B2 (for STC) ZSS17302,ZSS173B2 (for VIHI).	
ACCEPTED_TIME_LOGEVENT	Acceptance time by ME (see previous paragraphs).	LOGEVENT
FAILURE_TIME	Failure time (where happens) by ME (see previous paragraphs).	LOGEVENT
EXECUTED_TIME_LOGEVENT	Execution time by ME (see previous paragraphs).	LOGEVENT
EXECUTED_TIME_STACK	Execution time by satellite. It should correspond to ACCEPTED_TIME_LOGEVENT	STACK
ACCEPTED/ EXECUTED/ FAILED	Boolean report of the result of the execution	LOGEVENT
DELAY_IN_EXECUTION_s	Delay in time execution (in seconds) due to ME issues.	LOGEVENT
DELAY_IN_FAILURE_s	Delay in failure (in seconds where happens) due to ME issues.	LOGEVENT
RT_SEC	Where the FOP is a Science TC. Repetition Time commanded is here reported.	STACK
PSSDESCXXX/ PSSVALSXXX	For each PSS are reported the Description (including PSS id) and the value commanded	STACK

Table 13 Table reports names , description and source of all the columns of the TimingLog file.



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9. Attached documents

In this Section the attached documents are listed with the corresponding links.

Section	Description	Name Report	Link
[RD. 5].7	STC Performance Test	00_NECP_20200611_data_STC_Performance_Test.xls	
[RD. 5].8	NECP ORBIT TEST	00_NECP_20200611_data_STC_ORBIT_Test.xls	
[RD. 5].9	STC Outpass 2 recovery	00_NECP_20200611_data_STC_Outpass_2_recovery.xls	
4	STC ALL FPA TEST	20201002_01_dNECP_data_STC_All_FPA_Test.xls	
5	STC HOT PIXEL TEST	20201002_01_dNECP_data_hot_pixel_test.xls	
6	STC Mitigate Reset Test	20201002_01_dNECP_data_STC_Mitigate_Reset_Test.xls	
7	Orbit test	20201002_01_dNECP_data_Orbit_test.xls	

Table 14 Performance report file attachment covering the period including NECP (for details see [RD. 5]) and dNECP. The Log file is divided in sheets as EGSE structure in four different folder representing the different test.

Section	Description	Name Report	Link
8.2.3	Log of the Stack/LogEvent file for all the TC commanded	TimingReport_NECP_dNECP.xls file	

Table 15 Timing_Report file attachment covering the period including NECP phase and dNECP.