BC-SIM-TR-013 STC
ICO1 REPORT
Issue 1.0

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Approvation

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Document change record

Issue	Revision	Date	Affected Pages	Change description
1	0	10/01/2021	All	First issue

1 Introduction

1.1 Scope

The present document has been issued to describe the Instrument Check Out Phase (ICO#1) Tests of STC, channel of the Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem (SIMBIO-SYS).

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-GAF-MA-002 rev.8_SIMBIO-SYS FM User Manual, 2017

[RD. 3] BC-SIM-TR-003 - STC NECP Report,
10.20371/INAF/TechRep/26

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

[RD.5] BC-SIM-TR-007 STC Delta-NECP REPORT Issue 1.0
10.20371/INAF/TechRep/71

[RD.6] BC-SIM-PL-002-Checkout_01_Test_Summary_Issue1_27Jun2019
10.20371/INAF/TechRep/64

[RD.7] BC-SIM-GAF-TR-113 rev.0_TEC Control Parameters Revision for Commissioning_F1

[RD.8] BC-SIM-TR-005 SIMBIO-SYS NECP Test Report,
10.20371/INAF/TechRep/42

[RD.9] BC-SIM-TR-010 SIMBIO-SYS Instrument delta NECP Test Report,
10.20371/INAF/TechRep/83

[RD. 10]BC-SIM-TN-001 FOPs_Decription_Issue1
10.20371/INAF/TechRep/15

[RD. 11] BC-SIM-TR-011 - EGSE ICO01 report
10.20371/INAF/TechRep/88

[RD.12]BC-SIM-TN-004_-_SIMBIO-SYS_FOP_update_after_NECP,
10.20371/INAF/TechRep/58

[RD.13]BC-SIM-TR-007 - STC D-NECP Report,
10.20371/INAF/TechRep/71

[RD. 14] SIMBIO-SYS delta NECP Interchannel Test Report
10.20371/INAF/TechRep/76

[RD. 15] 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. 16] Simioni, Emanuele, et al. "Geometrical distortion calibration of the stereo camera for the BepiColombo mission to Mercury." Space Telescopes and Instrumentation 2016: Optical, Infrared, and Millimeter Wave. Vol. 9904. International Society for Optics and Photonics, 2016.

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	HouseKepping
HRIC	High spatial Resolution Imaging Channel
ICO	Instrument CheckOut
IT	Integration Time
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	SpaceCraft

TC	TeleCommand
TEC	Thermo-Electric Cooler
TM	Telemetry
VIHI	VIsible and Hyper-spectral Imaging channel
XML	eXtensible Markup Language

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 3 – ICO#1 objective, with a brief description of the tests executed.
- Section 4 – "Functional Tests" description including commanding and HK interpretation and discussion.
- Section 5 – "Performance" description including commanding and HK interpretation and discussion.
- Section 6 –Attached Report files.
- Section 7 –Annexes codes and reading tables.

2 Definitions and assumptions

In this section the main physical and technical terms are defined.

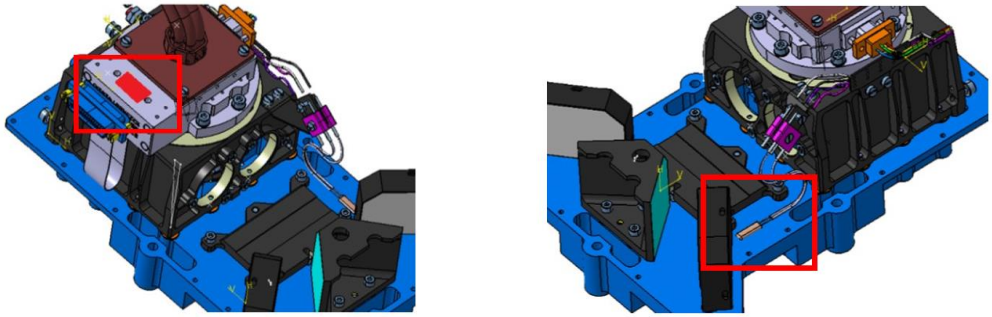
2.1 STC Sensors

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. 2].
The STC Temperature sensors are here described:

- TFPA1 and TFPA2 sensors 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 or Focal Plane Assembly (FPA) Package is located on the hot side of the FPA package.
- the Temp Channel-bw sensor or STC Optical Bench (OB) is located on the back side of the folding mirror of STC channel "Ch-Low".



(a) (b)

Figure 1 In (a) the location of the "STC Temperature Channel-fw" (NSS21043) temperature sensor (red rectangle). As highlighted in the 3D CAD model (no pictures are available, it is not present in the original CAD model), 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, as shown in the 3D CAD model (no picture available).

More details on the Sensors positions are reported in [RD. 3].

2.2 BepiColombo CF Sensors

Trend of the STC Cold Finger (CF) temperature sensor identified as MPO-TEMP-SIMBIO-STC-CF by ESA and THT-B6T136 by Thales (see [RD. 4]) are reported in d-NECP STC report [RD.5] because heating phase was the same for ICO#1 and d-NECP.
During operative phase the CF can be described by a carry wave with a mean of 5° , an amplitude of 0.2°C and a period of 15 minutes.
Switch off phase at the end of ICO1 had a duration of 60 minutes.

3 STC-ICO1 Tests

As reported in [RD.6] ,the ICO1 SIMBIO-SYS Phase had the scope to verify the health status of the instrument at channel and system level after 6 months after launch. Few functional and performance tests are planned to monitor the evolution of some key instrument parameters.
During Functional Tests, differently from NECP phase (see [RD. 3]) the switch on of the Channels was performed after the update of the optimized parameters

(see [RD.7]) for the gentle activation of the TEC (to avoid peak of the TEC current in the case of difference of temperature greater than 10K).
See **Table 2** for more details on the tests performed.

Test name	Monitoring	UTC first Image
STC Functional Test	PE,TEC, memory, acquisition, capability	2019-06-07T08:23:50.014551
STC Performance Test	DC Verification	2019-06-07T09:03.00.014480

Table 2 Table of the Tests as reported in [RD.6].

4 STC Functional Test

4.1 Test description

During ICO#1 the STC functionality has been verified by means of dedicated Functional Test procedures with the aim of verifying:

- o PE, TEC and detector activation
- o memory/registers status
- o science acquisition capability

The STC functionality will be tested by means of the following TCs sequence:

- PE switch-on
- Detector switch-on
- TEC switch-on (optimized TEC parameters)
- Test of the reading and writing of a specific memory address
- The following science acquisitions:
  - o a ten of GM compressed acquisitions with low RT,
  - o a ten of GM compressed acquisitions with high RT,
  - o a ten of CM compressed acquisitions with low RT,
  - o a ten of CM compressed acquisitions with high RT
- TEC switch-off
- Detector switch-off
- PE switch-off

4.2 Commanding

During NECP (see [RD. 3]), ESA performed the SIMBIO-SYS heating procedure by means of TT-FCP-005 (a general version of SS-FCP-015). During the first test on HRIC channel, the TEC soft-start parameters have not been defined (by default) as expected by SIMBIO-SYS Team. This fact generated a peak anomaly on the TEC current (Issue 1 detailed in [RD.8]). Consequently, the TEC nominal

parameters (reported in [RD. 2]) were updated and all the consequent tests for all the channels went ahead with no other problems detected.
The TEC soft-start parameters were than optimized by the Prime (see [RD.7]).

During the switch on of the ME, before the beginning of the ICO#1, the new parameters were updated substituting the nominal values with the optimized ones. Differently from other uploaded parameters (i.e. VIHI Bias Detector parameters which remain in the PE RAM until the PE is switched off) when the TEC parameters have been uploaded, they are written in the CPCU RAM, so they remain available up to the next SIMBIO-SYS switch off (see [RD. 2] Section 8.3.1.10 and 8.3.1.16).
The summary of the parameters used for STC in the two phases is reported in following table.

Name	Data-kind	Meaning	NECP Phase Nominal	ICO1 Phase
NP	[16 bit uint]	Proportional gain	77	128
NI	[16 bit uint]	integral gain	33	229
N_E	[16 bit uint] (only 12 lsb's may be not zero)	PI operation threshold	112 (10K)	34(3K)
NSS	[16 bit uint] (only 14 lsb's may be not zero)	Soft start Ramp slope	12289	5
BSS o BSTART	[2 bits]	- bit 15= 0/1 : anti- windup ON/OFF; - bit 14= 0/1 : P-only/ramp soft start	11	11
T_REF	[16 bit uint]	Reference FPA commanded temperature (only 12 lsb's may be not zero)	2799 (268 K)	2799 (268 K)

Table 3 *TEC Soft-Start parameters*

Once the ME was switched on (with the updated parameters) all the functional test were commanded by a new version of FOP SS-TST-020 (old version details can be found in [RD. 10]; the updates can be found in
[RD. 11] BC-SIM-TR-011 - EGSE ICO01 report

10.20371/INAF/TechRep/88
[RD.12]). All science TCs planned were nominally executed. The summary of the TCs and the consequent images dataset generated is reported in **Table 4** and ***Table 5*** .

Timeline	Relative	TC	Scope	Notes
0:00:00	00:00:00	ZSS00329	Set HK to 1 s	
0:00:05	00:00:05	ZSS17210	Send SIMB STC Detector On/Off	Switch On STC PE (Channel) (to restore after ASW update with correct TEC initialization). TEC set point: 268K
0:00:10	00:00:05	ZSS17203	Send SIMB STC Thermal Control On/Off	
0:00:15	00:00:05	ZSS17206	Send SIMB STC Read Addr	Read memory present status
0:00:30	00:00:15	ZSS17206	Send SIMB STC Read Addr	
0:00:35	00:00:05	ZSS17207	Send SIMB STC Write Addr	Test Writing Memory
0:00:40	00:00:05	ZSS17204	Send SIMB STC Confirm Command	
0:00:45	00:00:05	ZSS17207	Send SIMB STC Write Addr	Test STC science test pattern
0:00:50	00:00:05	ZSS17204	Send SIMB STC Confirm Command	
0:15:50	00:15:00	ZSS17202	Start STC Science (GM Mean)	Science
0:16:10	00:00:20	ZSS17202	Start STC Science (GM Max)	

0:18:20	00:02:10	ZSS17202	Start STC Science (CM-Mean)	
0:18:30	00:00:10	ZSS17202	Start STC Science (CM-Max)	
0:18:54	00:00:24	ZSS17209	Send SIMB STC Stop Science	End test.
0:18:59	00:00:05	ZSS00329	Set HK to 10 s	

Table 4 *Timeline of the Functional Tests with the references to the commanded ZSS (see [RD. 11] BC-SIM-TR-011 - EGSE ICO01* report 10.20371/INAF/TechRep/88 [RD.12*] for more details).*

The resulting database derived by EGSE telemetry to raw pipeline is reported in **Table 5**. All science TCs were in continuous mode.

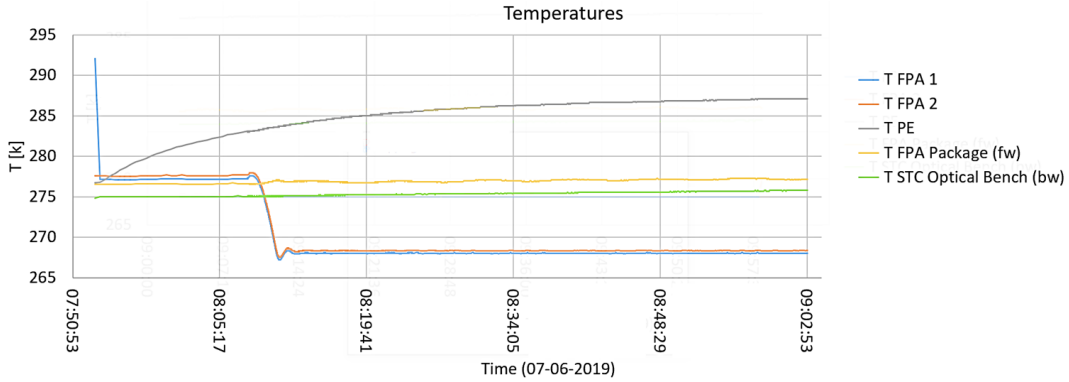
EGSE_NTC [#]	First_Acq [UTC]	Duration [s]	NACQ [#]	DimX [px]	IT [ms]	RT [s]	Windows
1	2019-06-07T08:23:50.014551	18	10	896	0.096	2	GM
2	2019-06-07T08:24:10.014474	123	11	896	1.4976	12. 3	GM
3	2019-06-07T08:26:25.313911	4.4	12	896	5.2992	0.4	CM
4	2019-06-07T08:26:30.113884	22.5	12	896	37.7952	2.05	CM

Table 5 *Resulting database of the ICO1 Functional Test. All TCs were commanded with the CBD = 64x64 and, nominally, the IBR was set to 32 for the GM and 63 for the CM.*

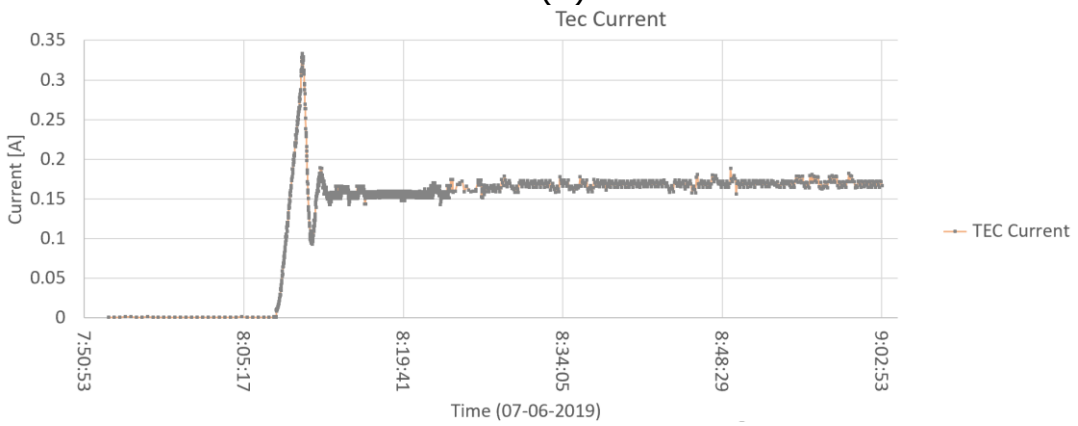
The four TCs were commanded respectively at 08:23:50, 08:24:10,08:26:20, 08:26:30. Note that third one was executed with a delay of 5.3 sec. This is an expected delay due to the granularity (12.3s) of the ME introduced through previous TC by the RT (Defined as Issue-3 in System Level report [RD.9] and highlighted in [RD.5]).

4.3 HKs interpretation and discussion

New parameters updated allowed the "gentle" activation of the STC TEC introducing a graceful cool-down and so avoiding a possible OOL current peak. The new parameters nevertheless generated non-nominal oscillations on the current profile of STC (and HRIC) as showed by **Figure 2**b and as was already relieved in previous mission phase D-NECP both during Channel (see [RD.13])and InterChannels test (see [RD. 14]).



(a)



(b)

Figure 2 Temperatures (a) and TEC current values (b) evolution over the Functional Tests of ICO1. For HK description details see **Table 1**.

We recommend, to avoid this kind of event, the use of the nominal and not risky nominal parameters reported in **Table 3**.

4.4 Images Analysis

Science data acquired during Functional Tests has no anomalies from an operational point of view.
A first reduction of the dataset is shown in **Figure 3**. The image shows, for each acquisition, the mean value of the windows included in the 4 TCs. Right y-axis (yellow) reports the distance between each acquisition and the previous one.
As expected for the firsts two TCs (GM) the signal results nominally constant for all the 3 windows considered (WINX+PANH+PANL). In the case of the CM the reset-issue (see [RD. 15]) brings to a not constant level of the dark in the case of high times between the acquisitions.

The issue will be resolved during the Scientific Phase of the Mission by mitigating the dark subtracting the mean value of the Win-X guaranteeing to have a correct measurement of the dark both at the beginning or at the end of the acquisition sequences.
The reduction of the dynamic range will be avoided thanks to an ad hoc operation strategy inspected during d-NECP phase [RD.5] and in planning in the next ICOs phases.

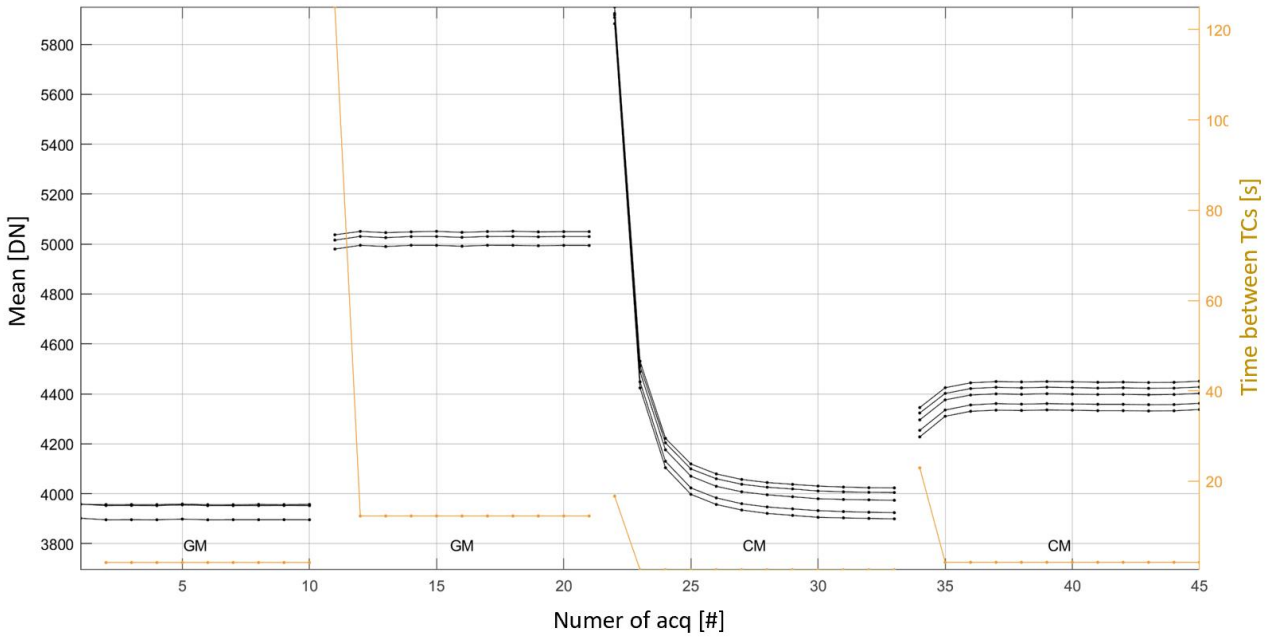


Figure 3 The figure reports the reduction in mean of the images of the Functional tests. Right y-axis (yellow) report the distance between each acquisition and the previous one.

5 STC Performance Test

5.1 Test description

During ICO#01 the STC performance has been verified by means of minimal Performance test procedures with the aim of verifying of DC behavior for the nominal IT and Repetition Time (RT). Same ITs and RTs were commanded during NECP phase ([RD. 3]).

5.2 Commanding

This test has been performed through the execution of 1 pre-defined PDORs named:

- "PDOR_BPSS_C_SS_SIMBIOSYS_stc_nominal_test_00151.BC".

See [RD.6] for more details.

The PDOR execute the acquisition of sets of 10 images in two acquisition modes (Global Mapping and Colour Mode):

- in the case of GM, the DC has been measured for minimal RTs (7s) foreseen in the GM phase and for a lower RT (0.45s).
- In the case of CM, the DC was for maximal RTs (5s) foreseen in the CM targeting phase and for a lower RT (0.25s).

These choices can be justified by the necessity to acquire the DC both in nominal configuration and in high data rate (where reset issue should have less effect) in manner to complete investigate the behavior of the RVS detector for different RT.
These assumptions divide the PDOR in four phases (see the timeline in Table 6.). Each phase commands the integration of 21 different integration times in manner to obtain for the GM and the CM two different dark curves for the low and high repetition time defined.

Timeline	Fop Names	Mode	NTCs	Min IT	Max It	RT
			[#]	[ms]	[ms]	[s]
00:00:00	ASSF307/317	GM	21	0	9600	Where possible 0.45
00:04:58	ASSF307/317	GM	21	0	9600	Where possible 7
00:30:39	ASSF308/318	CM	21	0	9600	Where possible 0.25
00:35:06	ASSF308/318	CM	21	0	9600	Where possible 5

Table 6 Timeline of the 4 phases TCs of the PERFORMANCE TEST with the references to the commanded FOPs (see

[RD. 11] BC-SIM-TR-011 - EGSE ICO01 report

10.20371/INAF/TechRep/88

[RD.12] for more details).

All phases command 21 TCs with different ITs. In the same phase the RT commanded is constant a part for the stellar integration times (FOP-317 and 318). Table reports the relative time respect the first TC of the test and the FCPs commanded, for more details see

[RD. 11] BC-SIM-TR-011 - EGSE ICO01 report

10.20371/INAF/TechRep/88

[RD.12].

The resulting database derived by EGSE telemetry to raw pipeline is reported in Table 7. Different colours are applied for the different tests (see Table 6) included in the ICO.

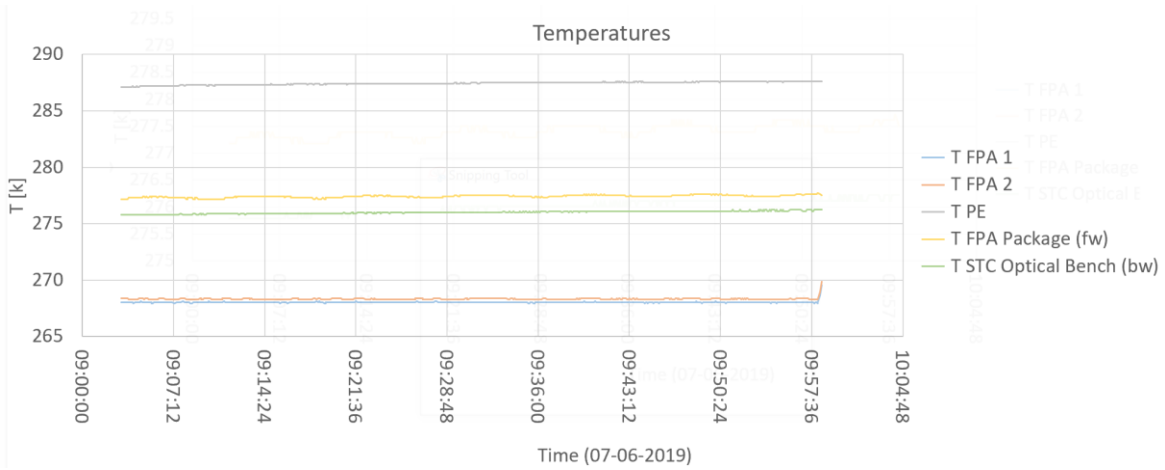
EGSE_NTC [#]	First_Acq [UTC]	Duration [s]	DimX [px]	IT [ms]	RT [s]	Windows
1	2019-06-07T09:03:00.014480Z	4.05	896	0	0.44998	GM
2	2019-06-07T09:03:07.014419Z	4.05	896	0.0096	0.44999	GM
3	2019-06-07T09:03:14.014327Z	4.05	896	0.0576	0.44999	GM
4	2019-06-07T09:03:21.014373Z	4.05	896	0.1056	0.44999	GM
5	2019-06-07T09:03:28.014205Z	4.05	896	0.192	0.45002	GM
6	2019-06-07T09:03:35.014251Z	4.05	896	0.288	0.45	GM
7	2019-06-07T09:03:42.014144Z	4.05	896	0.336	0.45001	GM
8	2019-06-07T09:03:49.014174Z	4.05	896	0.48	0.45001	GM
9	2019-06-07T09:03:56.014128Z	4.05	896	0.576	0.45001	GM
10	2019-06-07T09:04:03.014082Z	4.05	896	0.96	0.45	GM
11	2019-06-07T09:04:10.014098Z	4.05	896	2.4	0.45	GM
12	2019-06-07T09:04:17.014113Z	4.05	896	3.36	0.44999	GM
13	2019-06-07T09:04:24.014036Z	4.05	896	4.8	0.45001	GM
14	2019-06-07T09:04:31.014113Z	4.05	896	9.6	0.45	GM
15	2019-06-07T09:04:38.013960Z	4.05	896	30	0.45	GM
16	2019-06-07T09:04:45.014067Z	4.05	896	150	0.44999	GM
17	2019-06-07T09:04:52.013914Z	4.05	896	270	0.45	GM
18	2019-06-07T09:04:59.013945Z	7.02	896	480	0.78	GM
19	2019-06-07T09:05:09.013853Z	11.3	896	960	1.26	GM
20	2019-06-07T09:05:24.013914Z	45.9	896	4800	5.1	GM
21	2019-06-07T09:06:17.018537Z	89.1	896	9600	9.9	GM
22	2019-06-07T09:07:58.018230Z	63	896	0	7	GM
23	2019-06-07T09:09:10.017833Z	63	896	0.0096	7	GM
24	2019-06-07T09:10:22.017634Z	63	896	0.0576	7	GM
25	2019-06-07T09:11:34.017328Z	63	896	0.1056	7	GM
26	2019-06-07T09:12:46.016991Z	63	896	0.192	7	GM
27	2019-06-07T09:13:58.016807Z	63	896	0.288	7	GM
28	2019-06-07T09:15:10.016395Z	63	896	0.336	7	GM
29	2019-06-07T09:16:22.016165Z	63	896	0.48	7	GM
30	2019-06-07T09:17:34.015828Z	63	896	0.576	7	GM
31	2019-06-07T09:18:46.015538Z	63	896	0.96	7	GM
32	2019-06-07T09:19:58.015201Z	63	896	2.4	7	GM
33	2019-06-07T09:21:10.015018Z	63	896	3.36	7	GM
34	2019-06-07T09:22:22.014727Z	63	896	4.8	7	GM
35	2019-06-07T09:23:34.014375Z	63	896	9.6	7	GM
36	2019-06-07T09:24:46.014161Z	63	896	30	7	GM
37	2019-06-07T09:25:58.013870Z	63	896	150	7	GM
38	2019-06-07T09:27:10.018569Z	63	896	270	7	GM
39	2019-06-07T09:28:22.018324Z	63	896	480	7	GM
40	2019-06-07T09:29:34.017988Z	63	896	960	7	GM
41	2019-06-07T09:30:46.017697Z	63	896	4800	7	GM
42	2019-06-07T09:31:58.017376Z	89.1	896	9600	9.9	GM
43	2019-06-07T09:33:39.017008Z	2.25	896	0	0.25	CM
44	2019-06-07T09:33:44.016963Z	2.25	896	0.0096	0.25	CM
45	2019-06-07T09:33:49.017024Z	2.25	896	0.384	0.24999	CM
46	2019-06-07T09:33:54.017008Z	2.25	896	0.768	0.25	CM
47	2019-06-07T09:33:59.016978Z	2.25	896	1.92	0.24999	CM
48	2019-06-07T09:34:04.016932Z	2.25	896	2.88	0.25	CM
49	2019-06-07T09:34:09.016917Z	2.25	896	3.36	0.24999	CM
50	2019-06-07T09:34:14.016840Z	2.25	896	3.84	0.25	CM
51	2019-06-07T09:34:19.016886Z	2.25	896	4.8	0.25001	CM
52	2019-06-07T09:34:24.016794Z	2.25	896	5.28	0.25001	CM
53	2019-06-07T09:34:29.016871Z	2.25	896	7.2	0.25	CM
54	2019-06-07T09:34:34.016825Z	2.25	896	9.6	0.24999	CM
55	2019-06-07T09:34:39.016764Z	2.25	896	12.48	0.25	CM

56	2019-06-07T09:34:44.016672Z	2.25	896	20.16	0.25002	CM
57	2019-06-07T09:34:49.016733Z	2.25	896	45.2256	0.25001	CM
58	2019-06-07T09:34:54.016641Z	2.25	896	150	0.25	CM
59	2019-06-07T09:34:59.016687Z	5.13	896	270	0.57	CM
60	2019-06-07T09:35:07.036676Z	7.02	896	480	0.78	CM
61	2019-06-07T09:35:17.016672Z	11.3	896	960	1.26	CM
62	2019-06-07T09:35:32.016580Z	45.9	896	4800	5.1	CM
63	2019-06-07T09:36:25.016289Z	89.1	896	9600	9.9	CM
64	2019-06-07T09:38:06.015998Z	45	896	0	5	CM
65	2019-06-07T09:38:58.015800Z	45	896	0.0096	5	CM
66	2019-06-07T09:39:50.015540Z	45	896	0.384	5	CM
67	2019-06-07T09:40:42.015264Z	45	896	0.768	5	CM
68	2019-06-07T09:41:34.015188Z	45	896	1.92	5	CM
69	2019-06-07T09:42:26.015050Z	45	896	2.88	5	CM
70	2019-06-07T09:43:18.014759Z	45	896	3.36	5	CM
71	2019-06-07T09:44:10.014560Z	45	896	3.84	5	CM
72	2019-06-07T09:45:02.014285Z	45	896	4.8	5	CM
73	2019-06-07T09:45:54.014224Z	45	896	5.28	5	CM
74	2019-06-07T09:46:46.013933Z	45	896	7.2	5	CM
75	2019-06-07T09:47:38.013765Z	45	896	9.6	5	CM
76	2019-06-07T09:48:30.013688Z	45	896	12.48	5	CM
77	2019-06-07T09:49:22.018280Z	45	896	20.16	5	CM
78	2019-06-07T09:50:14.018127Z	45	896	45.2256	5	CM
79	2019-06-07T09:51:06.017943Z	45	896	150	5	CM
80	2019-06-07T09:51:58.017744Z	45	896	270	5	CM
81	2019-06-07T09:52:50.017439Z	45	896	480	5	CM
82	2019-06-07T09:53:42.017408Z	45	896	960	5	CM
83	2019-06-07T09:54:34.017071Z	45	896	4800	5	CM
84	2019-06-07T09:55:26.016933Z	89.1	896	9600	9.9	CM

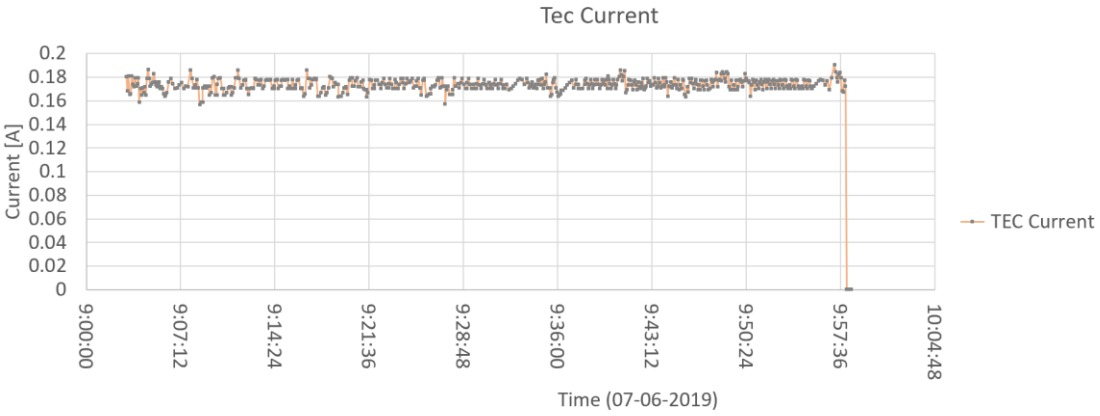
Table 7 Database derived by EGSE. All TCs commanded 10 acquisitions with IBR=0 and CBD=64x64.

5.3 HKs interpretation and discussion

Figure 4 shows the trends of the main temperature and current housekeeping (**Table 1**) of STC. The performance test was executed after the functional test without starting from a Stand-By mode of the instrument. No switch on were executed a during the performance test.



(a)



(b)

Figure 4 Temperatures and TEC current values evolution over the Performance Tests of ICO1.

5.4 Images analysis

The Science data acquired during Performance Tests has no anomalies from an operational point of view.
A first reduction of the dataset is shown in **Figure 5** (for the GM) and **Figure 6** (for CM). The images show for each acquisition the mean value of the windows included in the 4 TCs. Right y-axis (yellow) report the distance between each acquisition and the previous one.
The figure shows even the exponential models (see Section 7 for details) estimated for each set of acquisition. Each signal trend can be modelled by solving nonlinear least-squares curve fitting based on code described in Annex (Section 7) following the equation:

$$s_{(n_{acq})} = A - B\, e^{-\frac{\tau}{n_{acq}}}$$

where:

- s is the mean signal on the considered window.
- n_{acq} is the number of the consecutive acquisitions.
- $A \geq 0$ is the peak value in DN.
- $\tau > 0$ is the velocity term.
- $B \geq 0$ define the stabilization value to be considered as $A - B$.

The model guarantees a mean std of the residuals of 6.8 DN which reach the worst value of 24 DN in the case of maximal integration time commanded. The values are both in the limit of the RON.

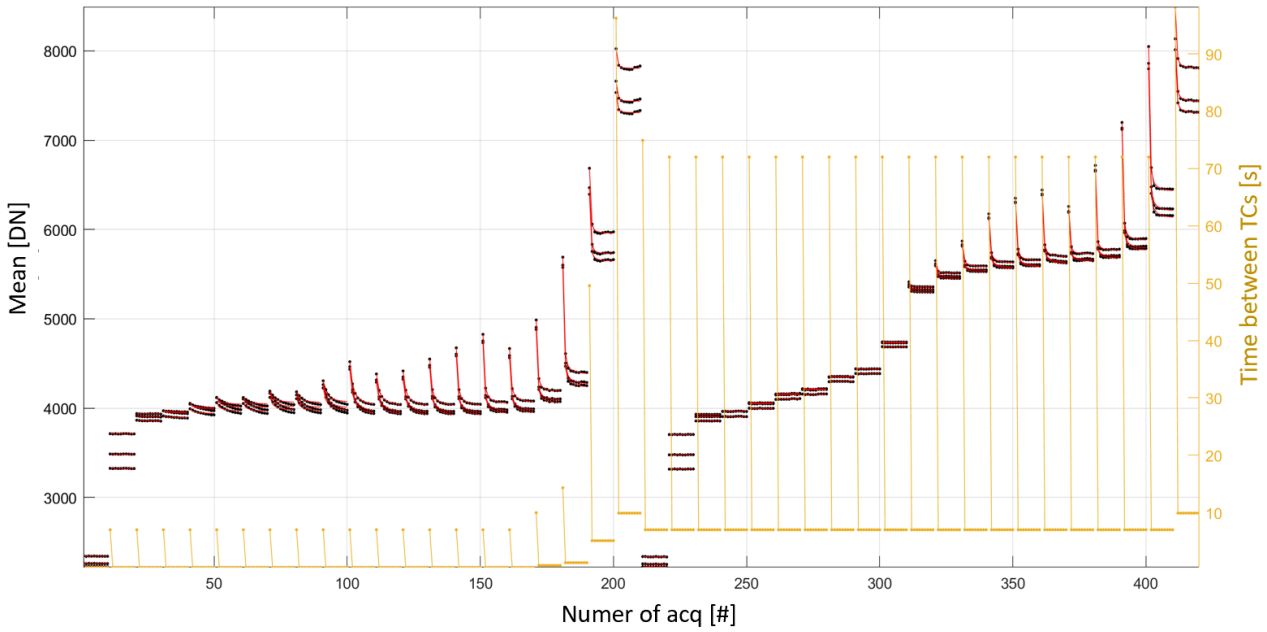


Figure 5 *The figure reports the reduction in mean of the images of the Performance tests for the GM. Red lines represent the exponential curves which model by non-linear fit each set of*

acquisition. Right y-axis (yellow) report the distance between each acquisition and the previous one.

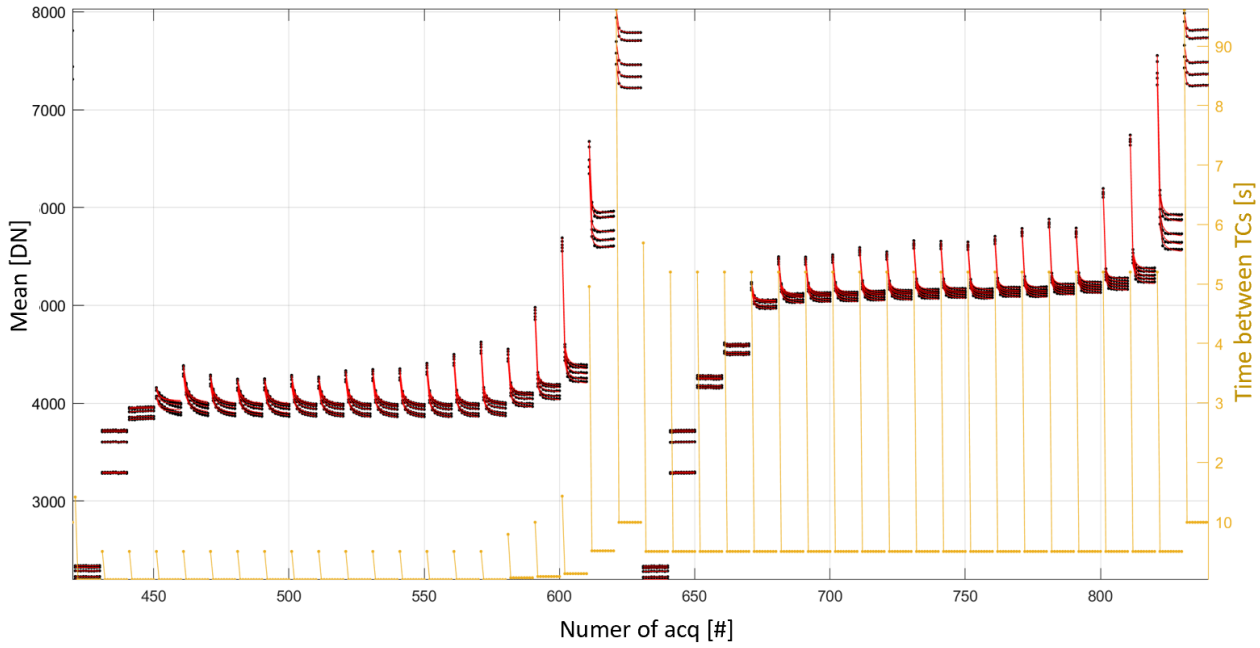


Figure 6 *The figure reports the reduction in mean of the images of the Performance tests for the CM. Red lines represent the exponential curves which model by nonlinear fit each set of acquisition. Right y-axis (yellow) report the distance between each acquisition and the previous one.*

As result of the exponential model it is possible to define the Dark Current curves for the two acquisition modes (GM in Figure 7 and CM in Figure 8) for the low and high repetition times commanded. Tests will be executed for each ICO in manner to measure the stability of the curves.

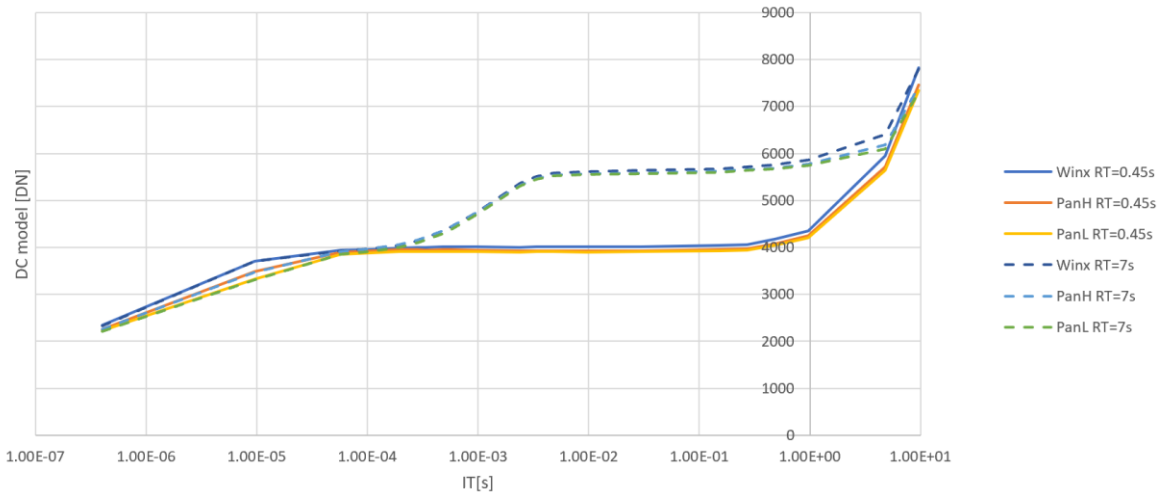


Figure 7 *The figure reports the reduction by exponential model of the images of the Performance tests for the GM. Continuous lines represent the DC for the first TC (low RT) while dotted line represent the DC for the 2nd TC (high RT).*

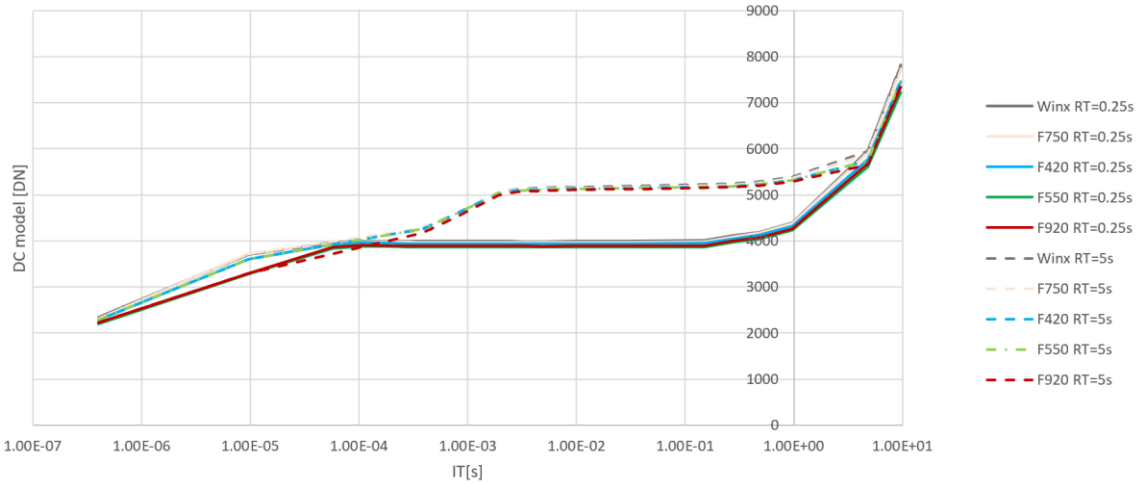


Figure 8 *The figure reports the reduction by exponential model of the images of the Performance tests for the CM. Continuous lines represent the DC for the first 3TC (low RT) while dotted line represent the DC for the 4nd TC (high RT).*

6 Attached documents

In this section the attached documents are enumerated with corresponding links. Documents represent two kind of report: the former traces the HKs and the main fast reduction of all the acquisitions (Performance Report). The latter indicates the Timing Issue linked to the SC and ME delays to each TCs. It covers the time between 2019-06-07T06:34:58.590 (beginning of the ICO1 phase) and 2019-06-07T10:49:53.589 (last TC of the ICO1 phase). Fast reading tables are reported in Annex section. For more details a deeper description is reported in [RD.5].

ICO1	02_ICO1_20201110_report	📎

Table 8 Performance report file**s** attachment covering the period including first ICO.

20210127_TimingReport	📎

Table 9 Timing Report file attachment covering the period including first ICO.

7 Annexes

7.1 Fitting Method

Curve fitting used to model the signal decay is based on ontrust-region-reflective algorithm (implemented by MATLAB function lsqcurvefit.

```
xdata = [1:nacq]-1; %1xnacq vector | the number of each acquisition
ydata = signal;     %1xnacq vector | the mean value of the signal on the window
%Model described by the 3 parameters in the vector 1x3 x
fun = @(x,xdata)x(1)-x(2)*exp(-x(3)./xdata);

x0 = [mean(ydata),1,1];    %starting parameters value
lb = [0,0,0];              %low value limit for each parameter
ub = [Inf,Inf,Inf];        %high limit for each parameter
%start parameter fitting
[x res]= lsqcurvefit(fun,x0,xdata,ydata,lb,ub);

mod=x(1)-x(2)*exp(-x(3)./xdata); %resulting model

r_mode=std(ydata-mod);           %residuals
sol1=x(1)-x(2);                  %asymptotic solution
```

7.2 Performance Report

From the xml files, which include the HKs data, a series of useful quantities have been extracted. The report attached to Table 8 (see Attached Documents Section) includes all the following parameter for each acquisition:

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 10 Columns description of the Performance Report file

7.3 TIMING LOG Report

This report (in attachment at **Table 9**) allows to check the delay time between the commanded timeline and the executed one due to granularity of the TC at satellite level and to the management of the TC by SIMBIO-SYS ME.
The report is based on the crossing of two documents:

- STACK report: xml file provided by ESOC
- LOGEVENT: provided by EGSE reporting the acceptance and execution time by SIMBIO-ME.

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

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 the three channels 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 11.

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 the three channels 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 11 Table reports names, description and source of all the columns of the TimingLog file.