BC-SIM-TR-031 STC ICO4 REPORT
Issue 1.0

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Approvation

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Change Log

Issue	Revision	Date	Affected Pages	Change description
0	0	01/07/2020	All	Draft

1 Introduction

1.1 Scope

The present document has been issued to describe the ICO#4 (Instrument Check Out Phase) 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 - Version 2,
(10.20371/INAF/TechRep/179)

[RD. 2]BC-SIM-GAF-MA-002 rev.8_SIMBIO-SYS FM User Manual, 2017

[RD. 3] EGSE PL-00X-Checkout_04
(10.20371/INAF/TechRep/205)

[RD. 4]BC-SIM-PL-00X-Checkout_04_Test_Summary
(10.20371/INAF/TechRep/204)

[RD. 5]BC-SIM-TN-001 FOPs_Decription_Issue1
(10.20371/INAF/TechRep/15)

[RD. 6] BC-SIM-TR-003_STC_NECP_Report_v1_OA_INAF
(10.20371/INAF/TechRep/26)

[RD. 7] BC-SIM-TN-004_-_SIMBIO-SYS_FOP_update_after_NECP,
(10.20371/INAF/TechRep/58)

[RD. 8] BC-SIM-TN-008_-_SIMBIO-SYS_FOP update after ICO#02
(10.20371/INAF/TechRep/162)

[RD. 9] BC-SIM-TR-003 - STC NECP Report
(10.20371/INAF/TechRep/26)

[RD. 10] BC-SIM-TR-013_-_STC_ICO#01_report
(10.20371/INAF/TechRep/89)

[RD. 11] BC-SIM-TR-007 STC Delta-NECP REPORT
(10.20371/INAF/TechRep/71)

[RD. 12] BC-SIM-TR-019 -STC ICO2 Report
(10.20371/INAF/TechRep/138)

[RD. 13] BC-SIM-TR-00X -STC ICO3 Report

[RD. 14] BC-SIM-TR-018_-_HRIC ICO2 Report
(10.20371/INAF/TechRep/100)

[RD. 15] BC-SIM-TR-007 STC Delta-NECP REPORT
(10.20371/INAF/TechRep/71)

[RD. 16] BC-SIM-TR-028 SIMBIO-SYS ICO#03 Interchannel Test Report
(10.20371/INAF/TechRep/197)

[RD. 17] BC-SIM-GAF-TR-113 rev.0_TEC Control Parameters Revision for Commissioning_F1

[RD. 18] 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.

[RD. 19] 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

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
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

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 – Definitions and assumptions
- Section 3 – ICO4 objective, with a brief description of the test executed.
- Section 4 – “Functional test” description including commanding and HK interpretation and discussion.
- Section 5 – “Performance Test” description including commanding and HK interpretation and discussion.
- Section 6 – “Interference test” description.

Section 7 – Description of the test reports in attachment to Section 8.

2 Definitions and assumptions

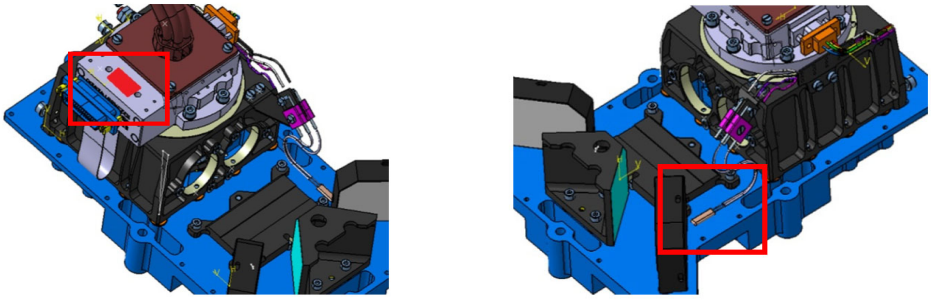
In this section the main physical and technical terms are defined.

2.1 STC Sensors

Param.	Param. Name	Unit	Calibration
NSS21040	Temperature FPA1	K	CSSP0020TM
NSS21041	Temperature FPA2	K	CSSP0021TM
NSS21042	Temperature PE	K	CSSP0022TM
NSS21043	Focal Plane Assembly (FPA) (ex Temp channel fw)	K	CSSP0023TM
NSS21044	STC Optical Bench (OB) (ex Temp channel bw)	K	CSSP0024TM
NSS21050	PE 3.3V Measured	V	CSSP0025TM
NSS21051	TEC Current	A	CSSP0026TM

Table 1 Main SIMB STC Housekeeping (Packed ID YSS40002) including temperature sensors of STC on the FPA, PE, the backside of the detector and the STC OB as Reported in [RD. 2].

The position of the temperature sensors are shown in Figure 1 (a,b) extracted by [RD. 2] .
The STC Temperature FPA1 and FPA2 sensors, hereafter abbreviated with TFPA1 and TFPA2 respectively, are located close to the detector surface (see **Figure 2**). 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. 3], 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. 3] 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/FPA Package” (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/ STC Optical Bench ” (NSS21044) temperature sensor, as shown in the 3D CAD model (no picture available).

More details on the Sensors positions are reported [RD. 6].

3 STC-ICO4 Tests

As reported in [RD. 4] ,the ICO4 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. See Table 2 for more details.

Test name	Monitoring	UTC first Image
STC FUNCTIONAL TEST	PE,TEC, MEMORY, ACQUISITION, CAPABILITY	2020-12-14T22:01:40.039499
STC Performance Test	DC Verification	2020-12-14T22:20:00.036256
Interference Test	Interference throw the three channels	2020-12-14T23:41:00.039425

Table 2 Table of the Tests as reported in [RD. 4].

During Functional Tests, differently from NECP phase (see [RD. 6]) the switch on of the Channels was performed after the update of the optimized parameters for the gentle activation of the TEC (to avoid peak of the TEC current in the case of difference of temperature greater than 10K).

3.1 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 (see [RD. 11] for a detailed description of the sensors and their positions).
STC CF temperature is shown in Figure 2 where , for the sake of completeness , we report the trends of the CF of all the three channels of SIMBIOSYS. HKs were acquired with a sample rate of 1 minute.

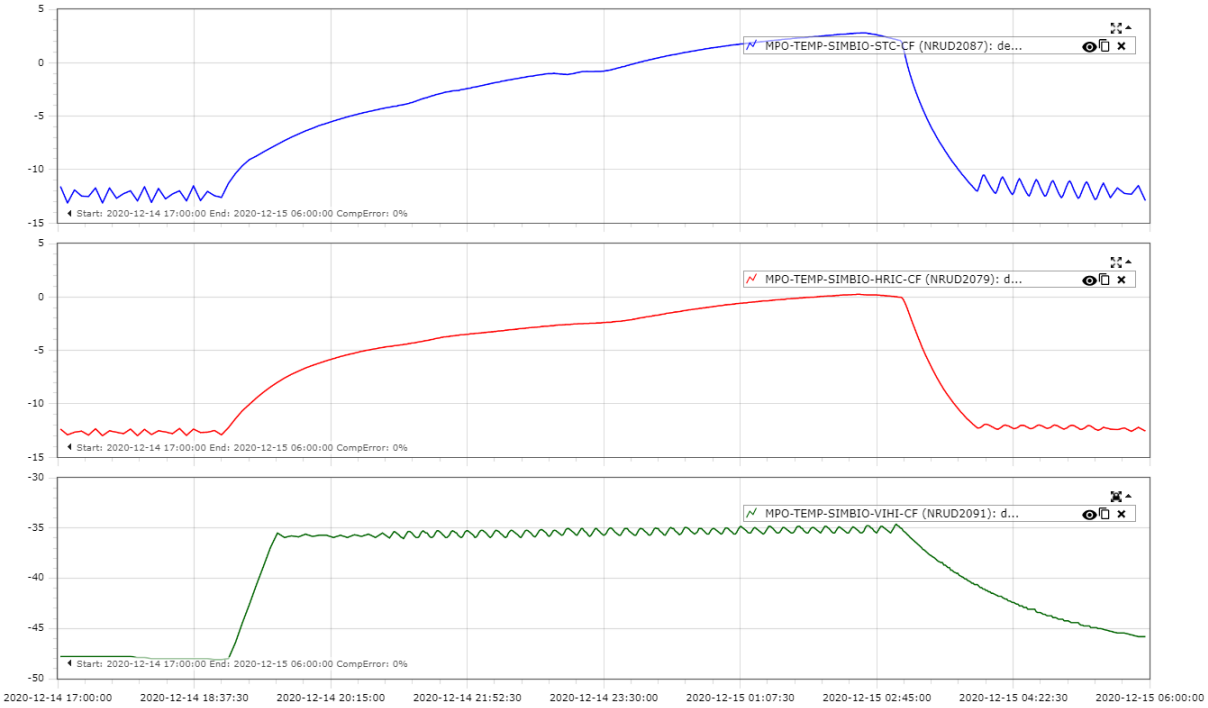


Figure 2 Measurement for STC (blu), HRIC (green) and VIHI (green) Cold Fingers during ICO4 phase. Temperature is reported in °C.

If for VIHI channels the temperatures threshold were reached, in the case of the imaging cameras Cold Fingers were not stabilized before the beginning of the test.

Differently by other ICOs the nominal heater of STC was switched on for all the test phase with the attempt to reach the 5°C temperature; the redundant line was instead switched off for all the test as shown in **Figure 3**. This misalignment derives by a not nominal procedure of the thermal settings due to the passage from real-time operations to planning-driven operations.

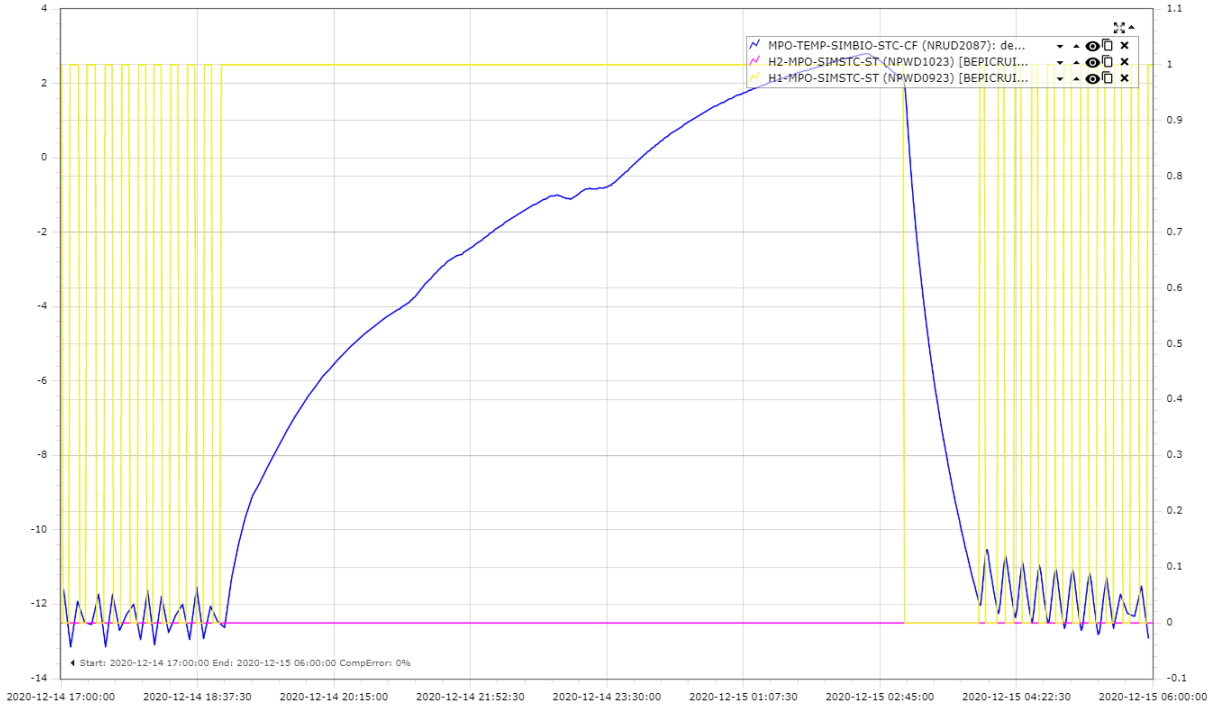


Figure 3 *On the right axis the Status (on/off) of the nominal (yellow) and redundant (pink) heaters of STC (and HRIC) overlapped to the CF temperature °C.*

4 STC Functional Test

4.1 Test description

During ICO#01 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
  - o 250 of WinX compressed acquisitions with high RT=2s
- TEC switch-off
- Detector switch-off
- PE switch-off

Differently by previous ICOs which commanded only the four TC of TST-020 (see)

[RD. 8] for details) Functional Test of ICO4 includes a 5th TC (science 005) to have a measurement of the low frequency behaviour with the other channel switched off. The commanded acquisition has a low IT (11 raw), a RT=2s and a IBR=8.

4.2 Commanding

As performed in all the previous ICO science ICO1(see [RD. 10] for details) during the switch on of the ME, before the beginning of the ICO, STC TEC 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 tests were commanded by a sequence of the FOP SS-TST-020 ([RD. 7]) followed by a Science TC. 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).
0:00:10	00:00:05	ZSS17203	Send SIMB STC Thermal Control On/Off	TEC set point: 268K
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)	
0:16:10	00:00:20	ZSS17202	Start STC Science (GM Max)	Science
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. 3] 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]	IBR	Windows
1	2020-12-14T22:01:40.039499Z	20	11	896	0.096	2	32	GM
2	2020-12-14T22:02:02.039514Z	123	11	896	1.4976	12.3	32	GM
3	2020-12-14T22:04:17.338998Z	2.4	7	896	5.2992	0.39999	63	CM
4	2020-12-14T22:04:20.138924Z	22.6	12	896	37.7952	2.05	63	CM
5	2020-12-14T22:05:50.038735Z	538	270	128	0.1056	2	8	WIN-X

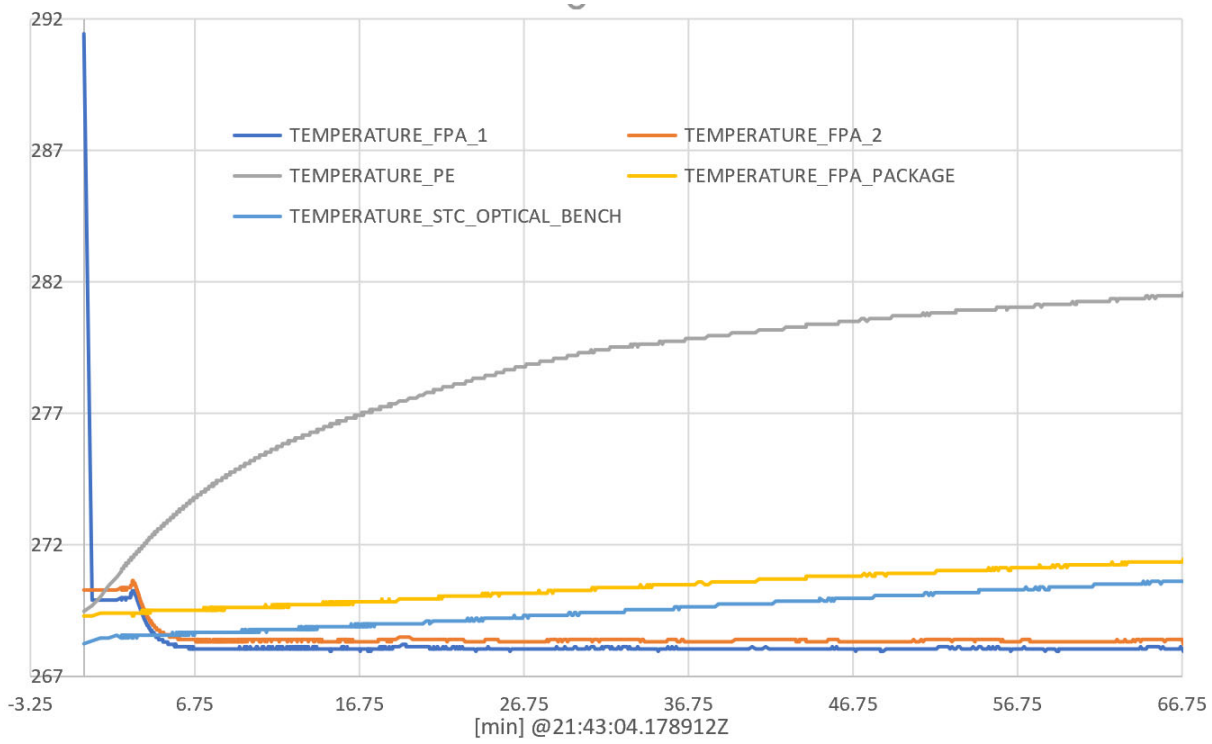
Table 5 Resulting database of the ICO4 Functional Test. All TCs were commanded with the CBD = 64x64

The four 4 TCs of TST-020 (see [RD. 7]) were commanded respectively at 22:01:40, 22:02:00, 22:04:10 and 22:04:20. **Note that third one was executed with a delay of 7.3 sec** (differently by the 5.3 measured in all the other ICOs) because in queue to another delay of 2 seconds introduced by

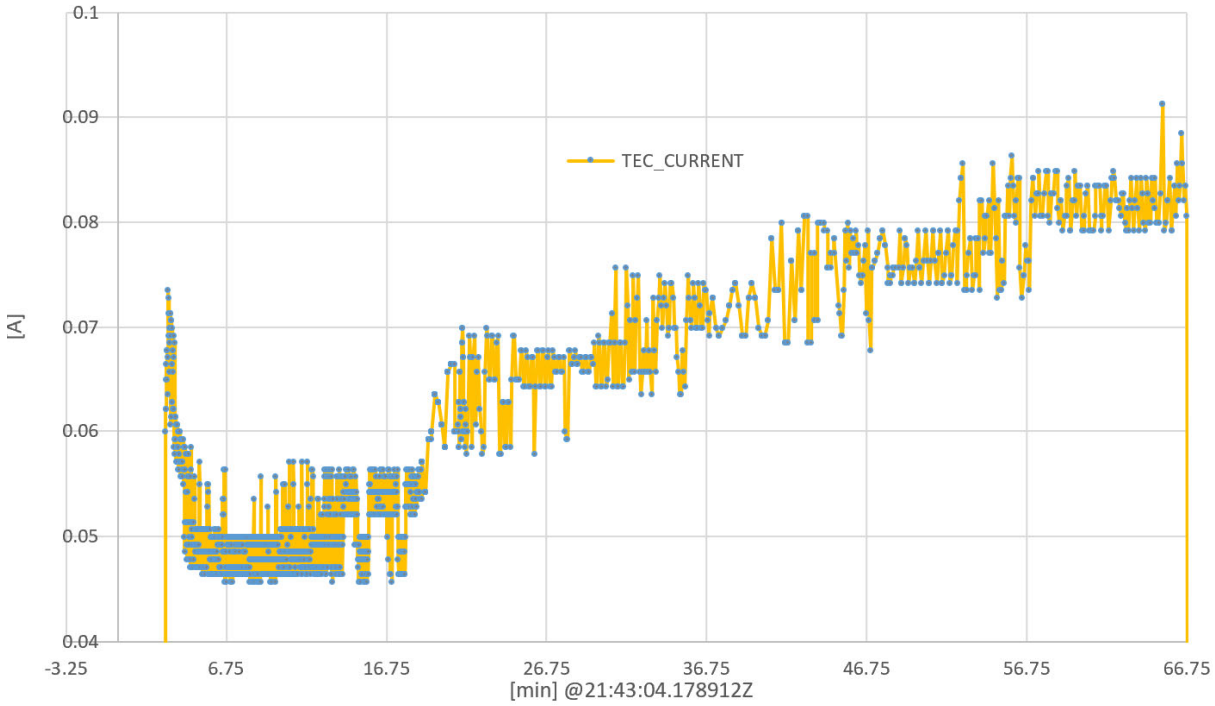
the previous one as reported in the Timing Report in attachment in Section 8. This is due to the granularity of the ME in Science mode (for details see [RD. 11]).

4.3 HKs interpretation and discussion

TEC parameters updated allowed the "gentle" activation of the STC TEC introducing a graceful cool-down and so avoiding a possible OOL current peak. The HKs confirm the behaviour of ICOs science ICO2 (see [RD. 12 for details) demonstrates the nominal (without oscillations or peaks) switch on of the TEC due to the upload performed in the last ICOs of the new TEC parameters. Figure 4b reports the instrumental HK of STC for the Functional and Performance test (eniding at 22:18:59) of ICO4.



(a)



(b)

Figure 4 *Temperatures (a) and TEC current values (b) evolution over the Functional and Performance Tests of ICO4. For HK description details see* **Table 1**.

4.4 Image 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 5. 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 peak-issue (see [RD. 19]) 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 winx guaranteeing to have a correct measurement of the dark both at the beginning or at the end of the acquisition sequences.

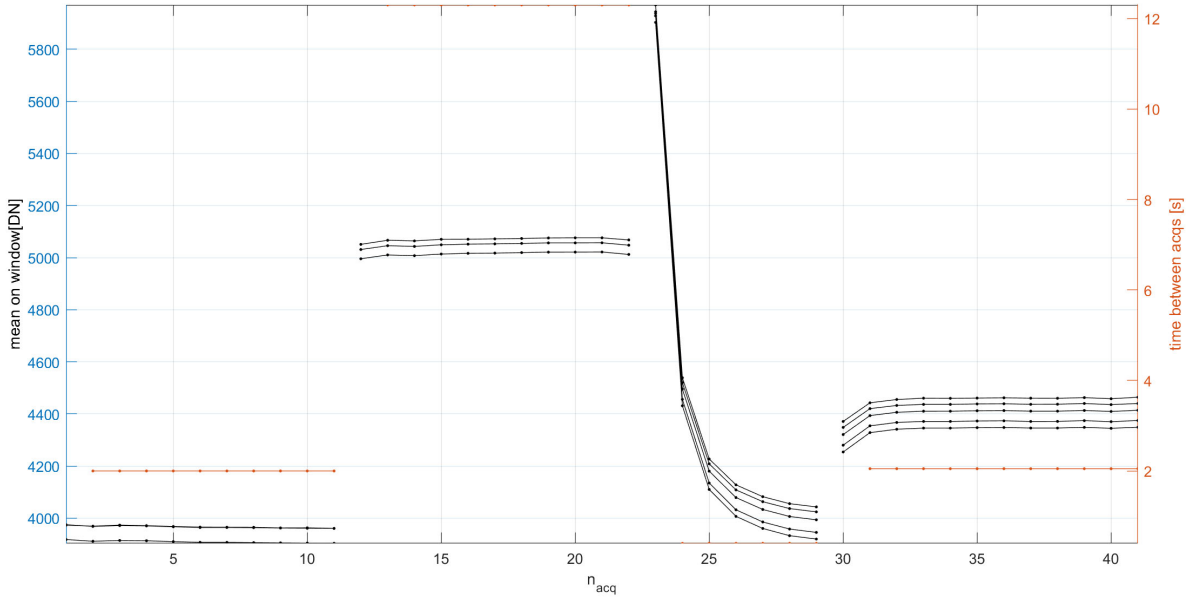


Figure 5 *The figure reports the reduction in mean of the images of the TST-020 FCP (including the first 4 TC of the Functional tests. Right y-axis (yellow) report the distance between each acquisition and the previous one)*

The TST-Results plotted in Figure 5 can be compared with the same plots provided in all the other ICOs (for details see ICOs between 1 and 3 reported in [RD. 10,[RD. 12, [RD. 13]). It is clear that the 3rd TC differently by the other test do not provide the same number of acquisitions because a short delay in between the execution by satellite and the acceptance by ME made the TC cross the limit of the previous RT (12.3s) and a delay of other 12.3s was introduced by ME.

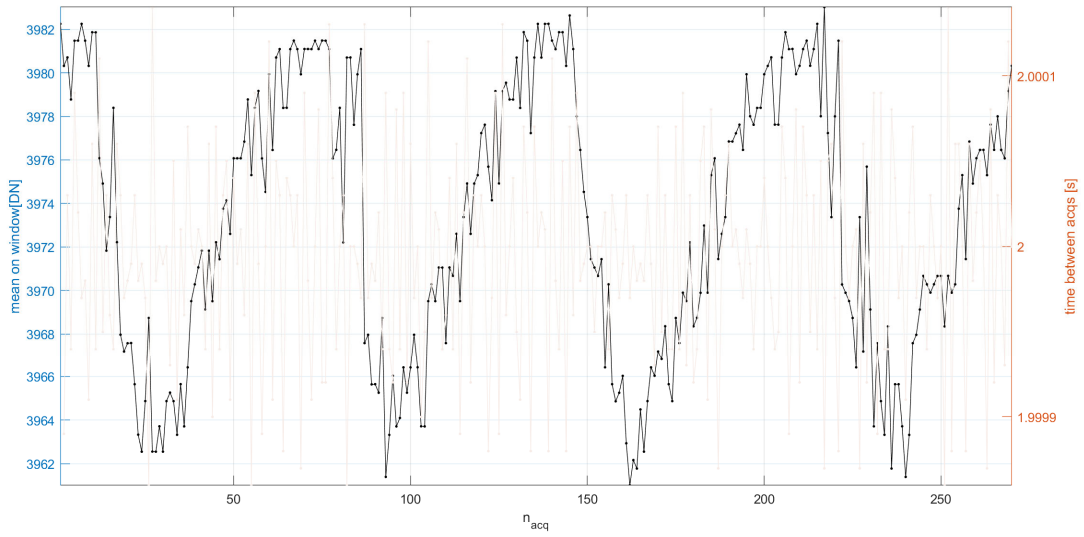


Figure 6 *The figure reports the reduction in mean of the images of the last TC of Functional tests. Right y-axis (yellow) report the distance between each acquisition and the previous one)*

Last TC of the functional reports is shown in Figure 6. The TC, commended to have a test of the STC DC with a RT=2s without the interference of other channels. The test confirms the presence of a carry wave with an amplitude of $\pm$10 DN on the DC. The carry wave has highlighted previously by HRIC channel (see [RD. 14]) present during ICO4 a period of 2.37 min is highlighted by the test.
It should be considered the fact that the test should not be comparable with others ICOs because of the not nominal heating procedure as reported in Section 3.1.
In any case Mitigation Calibration strategy assumed by STC makes null the impact of this spurious signal on the DC reduction.

5 STC Performance Test

5.1 Test description

During ICO#04 the STC performance has been verified by means of minimal Performance test procedures with the aim of verifying of DC behaviour for the nominal IT and Repetition Time (RT).
The Performance Test is divided in 3 different tests oriented to the evaluation of the DC measurement for:
- **GM mode**: with maximal commendable RT and nominal one,
- **Blooming tests**: effect of the IT and RT on a specific region of the detector
- **Mitigate test**: a strategy operation test called Mitigate (repeated after the fail of [RD. 11]).
The phases are shortly described in next section.

5.2 Commanding

This test has been performed through the execution of 1 pre-defined PDORs named:
SIMBIO-SYS_STC_ICO#04_Performance.BC (SPOT ID BPSS00697)
See [RD. 4] for more details.

The PDOR executes 6 different tests oriented to the evaluation of the DC measurement in GM mode, effect of the IT and RT on a specific region of the detector (Blooming tests) and a strategy operation test called Mitigate (repeated after the fail of [RD. 11]). The timeline of the test is reported in Table 6.

Timeline	Phase Name	Mode	NTCs	Range	Description
			[#]	Science XXX-Science YYY	
00:00:00	Max RT	GM	4	001-004	Four sets of ten acquisition in GM with Max RT(12.3s)
00:07:57	Blooming low	Winx+Cust0	16	005-020	Acquisition of the Volcano window with RT=0.45
00:11:59	Blooming high	Winx+Cust0	5	021-025	Acquisition of the Volcano window with RT=7
00:17:58	Mitigate	CM	7	026	normal CM with peak
				027-028	2 winx acq followed by CM
				029-030	4 winx acq followed by CM
				031-033	10 winx acq followed by CM
00:19:10	Nominal	GM	5	033-037	Five sets of ten acquisition in GM with nominal RT
00:25:04	Blooming others	Winx+Cust0	7	038-044	Acquisition of the volcano window with RT=0.8,2,5,7

Table 6 *Timeline of the 6 phases TCs of the PERFORMANCE All phases commands different ITs*

The resulting database derived by EGSE telemetry to raw pipeline is reported in

PHASE	EGSE_NTC [#]	First_Acq [UTC]	Duration [s]	NACQ [#]	DimX [px]	IT [ms]	RT [s]	Windows
Max RT	1	22:20:00.036256	111	10	896	0.0004	12.3	GM
	2	22:22:03.035905Z	111	10	896	0.1056	12.3	GM
	3	22:24:06.035690Z	111	10	896	5.2992	12.3	GM
	4	22:26:09.035262Z	98.4	9	896	4800	12.3	GM
Blooming	5	22:27:59.735029Z	2.25	6	128	0.0004	0.45	WinX+Cust
	6	22:28:02.434980Z	4.05	10	128	0.0096	0.45001	WinX+Cust
	7	22:28:07.039991Z	4.05	10	128	0.0576	0.45	WinX+Cust
	8	22:28:12.040068Z	4.05	10	128	0.1056	0.45	WinX+Cust
	9	22:28:17.040006Z	4.05	10	128	0.336	0.44998	WinX+Cust
	10	22:28:22.040037Z	4.05	10	128	0.48	0.44999	WinX+Cust
	11	22:28:27.039991Z	4.05	10	128	0.96	0.44998	WinX+Cust
	12	22:28:32.039915Z	4.05	10	128	3.36	0.45	WinX+Cust
	13	22:28:37.039930Z	4.05	10	128	4.8	0.44999	WinX+Cust
	14	22:28:42.039930Z	4.05	10	128	9.6	0.44999	WinX+Cust
	15	22:28:47.039869Z	4.05	10	128	30	0.44999	WinX+Cust
	16	22:28:52.039808Z	4.05	10	128	270	0.45001	WinX+Cust
	17	22:28:57.039823Z	7.02	10	128	480	0.78	WinX+Cust
	18	22:29:05.039747Z	11.3	10	128	960	1.26	WinX+Cust
	19	22:29:18.039823Z	45.9	10	128	4800	5.1	WinX+Cust
	20	22:30:10.039777Z	89.1	10	128	9600	9.9	WinX+Cust
	21	22:31:59.039364Z	63	10	128	0.0004	7	WinX+Cust
	22	22:33:09.039180Z	63	10	128	0.1056	7	WinX+Cust
	23	22:34:19.039149Z	63	10	128	5.2992	7	WinX+Cust
	24	22:35:29.038798Z	63	10	128	39.9936	7	WinX+Cust
	25	22:36:39.038874Z	63	10	128	4800	7	WinX+Cust
Mitigate	26	22:37:58.038614Z	3.6	10	896	5.2992	0.4	CM
	27	22:38:14.038629Z	0.5	2	128	5.2992	0.49992	WinX
	28	22:38:15.038568Z	3.6	10	896	5.2992	0.39999	CM
	29	22:38:31.038568Z	0.75	4	128	5.2992	0.24998	WinX

	30	22:38:32.063485Z	3.6	10	896	5.2992	0.4	CM
	31	22:38:47.038568Z	1.8	10	128	5.2992	0.2	WinX
	32	22:38:49.038537Z	3.6	10	896	5.2992	0.4	CM
Nominal	33	22:39:10.038308Z	63	10	896	0.0004	7	GM
Nominal	34	22:40:20.038231Z	63	10	896	0.096	7	GM
Nominal	35	22:41:30.038124Z	63	10	896	5.2992	7	GM
Nominal	36	22:42:42.037894Z	63	10	896	39.9936	7	GM
Nominal	37	22:43:54.037879Z	63	10	896	4800	7	GM
Blooming lims	38	22:45:04.037573Z	7.2	10	128	0.384	0.8	WinX+Cust
Blooming lims	39	22:45:12.062613Z	7.2	10	128	0.48	0.8	WinX+Cust
Blooming lims	40	22:45:22.037588Z	18	10	128	0.384	2	WinX+Cust
Blooming lims	41	22:45:44.062567Z	18	10	128	0.48	2	WinX+Cust
Blooming lims	42	22:46:06.037511Z	45	10	128	0.384	5	WinX+Cust
Blooming lims	43	22:46:58.037374Z	45	10	128	0.48	5	WinX+Cust
Blooming lims	44	22:47:50.037282Z	63	10	128	0.48	7	WinX+Cust

Table 7 *Different colours are applied for the different tests (see Table 6) included in the ICO.*

PHASE	EGSE_NTC [#]	First_Acq [UTC]	Duration [s]	NACQ [#]	DimX [px]	IT [ms]	RT [s]	Windows
Max RT	1	22:20:00.036256	111	10	896	0.0004	12.3	GM
	2	22:22:03.035905Z	111	10	896	0.1056	12.3	GM
	3	22:24:06.035690Z	111	10	896	5.2992	12.3	GM
	4	22:26:09.035262Z	98.4	9	896	4800	12.3	GM
Blooming	5	22:27:59.735029Z	2.25	6	128	0.0004	0.45	WinX+Cust
	6	22:28:02.434980Z	4.05	10	128	0.0096	0.45001	WinX+Cust
	7	22:28:07.039991Z	4.05	10	128	0.0576	0.45	WinX+Cust
	8	22:28:12.040068Z	4.05	10	128	0.1056	0.45	WinX+Cust
	9	22:28:17.040006Z	4.05	10	128	0.336	0.44998	WinX+Cust
	10	22:28:22.040037Z	4.05	10	128	0.48	0.44999	WinX+Cust
	11	22:28:27.039991Z	4.05	10	128	0.96	0.44998	WinX+Cust
	12	22:28:32.039915Z	4.05	10	128	3.36	0.45	WinX+Cust
	13	22:28:37.039930Z	4.05	10	128	4.8	0.44999	WinX+Cust
	14	22:28:42.039930Z	4.05	10	128	9.6	0.44999	WinX+Cust
	15	22:28:47.039869Z	4.05	10	128	30	0.44999	WinX+Cust
	16	22:28:52.039808Z	4.05	10	128	270	0.45001	WinX+Cust
	17	22:28:57.039823Z	7.02	10	128	480	0.78	WinX+Cust
	18	22:29:05.039747Z	11.3	10	128	960	1.26	WinX+Cust
	19	22:29:18.039823Z	45.9	10	128	4800	5.1	WinX+Cust
	20	22:30:10.039777Z	89.1	10	128	9600	9.9	WinX+Cust
	21	22:31:59.039364Z	63	10	128	0.0004	7	WinX+Cust
	22	22:33:09.039180Z	63	10	128	0.1056	7	WinX+Cust
	23	22:34:19.039149Z	63	10	128	5.2992	7	WinX+Cust
	24	22:35:29.038798Z	63	10	128	39.9936	7	WinX+Cust
	25	22:36:39.038874Z	63	10	128	4800	7	WinX+Cust
Mitigate	26	22:37:58.038614Z	3.6	10	896	5.2992	0.4	CM
	27	22:38:14.038629Z	0.5	2	128	5.2992	0.49992	WinX
	28	22:38:15.038568Z	3.6	10	896	5.2992	0.39999	CM
	29	22:38:31.038568Z	0.75	4	128	5.2992	0.24998	WinX
	30	22:38:32.063485Z	3.6	10	896	5.2992	0.4	CM
	31	22:38:47.038568Z	1.8	10	128	5.2992	0.2	WinX
	32	22:38:49.038537Z	3.6	10	896	5.2992	0.4	CM
Nominal	33	22:39:10.038308Z	63	10	896	0.0004	7	GM
	34	22:40:20.038231Z	63	10	896	0.096	7	GM
	35	22:41:30.038124Z	63	10	896	5.2992	7	GM
	36	22:42:42.037894Z	63	10	896	39.9936	7	GM
	37	22:43:54.037879Z	63	10	896	4800	7	GM
Blooming lims	38	22:45:04.037573Z	7.2	10	128	0.384	0.8	WinX+Cust
	39	22:45:12.062613Z	7.2	10	128	0.48	0.8	WinX+Cust
	40	22:45:22.037588Z	18	10	128	0.384	2	WinX+Cust

41	22:45:44.062567Z	18	10	128	0.48	2	WinX+Cust
42	22:46:06.037511Z	45	10	128	0.384	5	WinX+Cust
43	22:46:58.037374Z	45	10	128	0.48	5	WinX+Cust
44	22:47:50.037282Z	63	10	128	0.48	7	WinX+Cust

Table 8 *Database derived by EGSE. All TCs (dated 2020-12-14) commanded 10 acquisitions with IBR=0 and CBD=64x64.*

5.3 HKs interpretation and discussion

STC HKs are reported in Section 4.3 together with the one of the Functional Test. No anomaly was revealed.

5.3.1 GM tests

GM mapping tests measure the DC in GM commanding set of 10s acquisitions in two case:
-Five ITs with the nominal RT(7s)
-Four ITs with the maximum commendable RT(12.3s)
First acquisitions are performed to check the repeatability of the dark. The latter ones are performed to repeat the measurement rejected by ASW during ICO3 (see [RD. 13)

5.3.2 Blooming tests

5.3.3 Mitigate test

Mitigate Test phase validates the strategy to mitigate the DC Peak Offsett. The strategy considers the possibility of performing little windows acquisition with high repetition time before the well-known peak revealed in the all the functional tests science ICO1(see [RD. 10) to ICO3 (see [RD. 13)and shown in **Figure 5.**

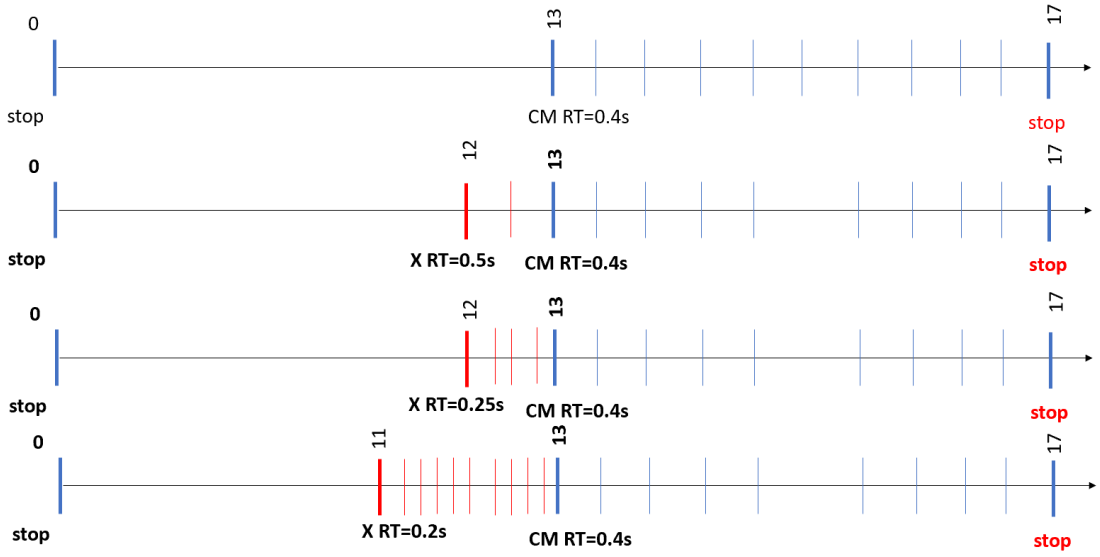


Figure 7 *Mitigate Tests performed to demonstrate the use of pre-use of high data rate to avoid peak in CM acquisitions*

The test foreseen four phases:

- in the first a CM acquisition with RT=0.4 is execute with a waiting time of 13 s (as performed during functional test) ,
- in the second the CM acquisition is anticipated by a Window-X acquisition with RT=0.5 (2 acquisitions) and same IT,
- in the third the RT of the mitigating is brought to 0.25s allowing 4 acquisitions
- in the last Window-X is acquired 10 times with a lowest RT of 0.2 s.

TABLE XII reports for each test described (including the functional one) the RT commanded for the TC previous of the CM, the waiting time before the CM sequence, the number of acquisitions performed to mitigate, the mean DC measured in the last frame of the previous TC, the peak measured in the first image of the CM (in DN) and the percentile of the peak resect the functional one (the highest).

The resulting effect of the different strategies on the Peak on the first CM acquisition is showed in **Figure 8.**

Note that for really high frequency mitigation (TEST4) the RT results lower then the one commanded for all the CM acquisitions (0.4s) and the result is a mitigation not only of the peak offset but even of the pedestal effect obtaining an increasing DC in the CM acquisitions.

Table 9 Mitigate Test performed during ICO4 phases with principal commanded parameters and measurements

Test	Previous TC			CM TC (RT=0.4)			
	RT	Nacq	Last DC	WT	WT da stop	Peak	Peak perc
	[s]	[#]	[DN]	[s]	[s]	[DN]	[%]
FUNC	12.3	#	5068	12.30		5970	100.0
TEST 1	7	#	6539	16.00	13	4215	9.6
TEST 2	0.5	2.00	5877	0.50	13	4233	10.5
TEST 3	0.25	4.00	5878	0.27	13.15	4049	1.0
TEST 4	0.2	10.00	5766	0.20	13	3985	-2.2

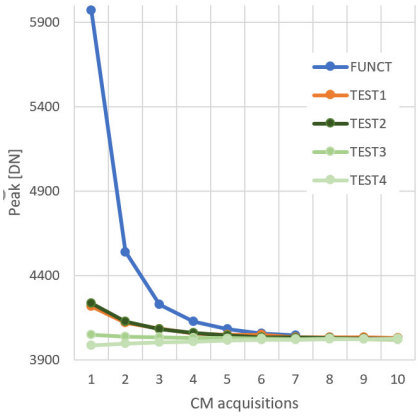


Figure 8 Peak offset measure don the first image of the CM acquisitions for all the mitigate test performed during ICO4. TESTs description is reported in Table 9.

The test demonstrates that a limited number of acquisitions of WinX before the CM one guarantee to avoid the peak effect reducing the DC additive level to the 10% with 2 acquisitions and to the 1% in case of 4.

Test1 is expected to have the same behavior of the functional test. With a WT of 16 s instead of 12.3s the peak result limited to the 9.6% of what expected.

6 Interference test

6.1 Test description

The aim of the test is the monitoring of dark low frequency behavior (see [RD. 12] for STC and [RD. 14] for HRIC channel) and the impact of the synchronic use of the HRIC channel on this effect. Previous analysis showed a carrier wave with an amplitude of 6DN and a period of 3 minutes on the mean signal of the STC and HRIC acquisitions.
Both low frequency and high frequency interference between the two channels have minimal impact on the DC (both comparable with the RON). In any case the effect is uniform on the FPA which means that the DC mitigation applied during images calibration will remove this bias without effect on the performances.
This phenomenon, measured for STC during the Orbit test (see [RD. 15]) required additive tests during ICO3 (see [RD. 16]) including the two imaging Channels.
During ICO4 we planned to perform interchannel test including even VIHI channel.
For more details, see following dedicated Interchannel Test Report.

7 Reports

In these section two reports are described. 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.

2.1. Performance report

From the xml files (attached to this report), a table-format report (for more details see [RD. 11]) has been derived that contains the following listed quantities:

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

2.2. 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 13**) 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. For more details see [RD. 11].
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).

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

8 Attached documents

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

Section	Description	Name Report	Link
4	Functional Test	05_ICO4_data_Functional_Test.xls	
5	Performance Test	05_ICO4_data_Performance_Test.xls	
6	Interference Test	05_ICO4_data_Interference_Test.xls	

Table 12 Performance report file attachment covering the period including 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	20210208_All_Phases_EVENTS_STACKs	

Table 13 Timing_Report file attachment covering the period including NECP phase and ICO4.