BC-SIM-TR-029
SIMBIO-SYS ICO#03 Test Report

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1. Introduction

1.1. Scope

This document will briefly report the results of the tests performed during the Instrument Checkout (ICO) # 03 for the Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem (SIMBIO-SYS) whose details are reported in [RD.1].

1.2. Reference document

[RD.1] BC-SIM-PL-005_-_SIMBIO-SYS_Checkout_03_Test_Summary_Issue1_Rev0, 10.20371/INAF/TechRep/172

[RD.2] BC-SIM-TN-003_-_Reports_and_Note_Layout_and_Flow_v2, 10.20371/INAF/TechRep/179

[RD.3] BC-SIM-TR-025_-_HRIC_ICO#03_report, 10.20371/INAF/TechRep/190

[RD.4] BC-SIM-TR-026_-_STC_ICO#03_report, 10.20371/INAF/TechRep/186

[RD.5] BC-SIM-TR-027_-_VIHI_ICO#03_report

[RD.6] BC-SIM-TR-028_-_SIMBIO-SYS_ICO#03_Interchannel_Test_Report_Issue1_Revision0, 10.20371/INAF/TechRep/197

[RD.7] SIMBIO-SYS Instrument CheckOut #02 Test Report, 10.20371/INAF/TechRep/146

[RD.8] BC-SIM-TN-008_-_ SIMBIO-SYS FOP update after ICO#02, 10.20371/INAF/TechRep/162

[RD.9] BC-SIM-GAF-IC-002_rev12

[RD.10] BC-SIM-GAF-MA-002 10 001 – SIMBIO-SYS User Manual

[RD.11] BC-SIM-TR-05 BC-SIM-TR-005 SIMBIO-SYS NECP Test Report, 10.20371/INAF/TechRep/42

[RD.12] BC-SIM-TR-010 SIMBIO-SYS Instrument delta NECP Test 10.20371/INAF/TechRep/83

[RD.13] BC-SIM-TR-015_-_SIMBIOSYS_ICO#01_Test_Report_Issue1_Revision0, 10.20371/INAF/TechRep/98

1.3. Acronyms

APID	Application Process IDentifier
ASW	Application SoftWare
CM	Color Mode
CSV	Comma Separated Values
FPA	Focal Plane Assembly
FOP	Flight Operation Procedure
HK	Housekeeping
HRIC	High spatial Resolution Imaging Channel
ICO	Instrument Checkout
ME	Main Electronics
NECP	Near Earth Commissioning Phase
OBCP	On-Board Control Procedure
PDOR	Payload Direct Operation Request
PDS	Planetary Data System
PE	Proximity Electronics
PNG	Portable Network Graphics
PSC	Packet Sequence Control
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.2] 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 – ICO#03 objectives, with a brief description of the performance and inter-channel tests executed.
- Section 3 – ICO#03 implementation, with a brief description of the Flight Operation Procedures (FOPs) and Payload Direct Operation Requests (PDORs) used to perform the required tests and a discussion on the obtained results. More details are reported in each channel report ([RD.3], [RD.4] and [RD.5]) and in the interference test report ([RD.6]).

2. ICO#03 Objective

The scope of the SIMBIO-SYS ICO#03 was to verify the health status of the instrument at channel level 18 months after launch. To do this, three kinds of tests were defined (see [RD.1] for details):

1. **Functional Tests**, to verify the functionality of all the SIMBIO-SYS units (i.e., ME, HRIC, STC, and VIHI) and their components (e.g., TECs, Detectors, etc.).
2. **Performance Tests**, to monitor the evolution of the performance of all the SIMBIO-SYS channels (i.e., HRIC, STC, and VIHI) with respect to the results obtained during the on-ground calibration campaign and the tests performed during the Cruise.
3. **Interchannel Tests**, to monitor the detector low frequency behaviour (see Open Issue #1 in [RD.7]) for both HRIC and STC cameras to identify possible mutual interference while operating in parallel and determine if the effect has internal (i.e., SIMBIO-SYS power unit) or external (i.e., S/C) origin.

3. Test Implementation

The SIMBIO-SYS ICO#03 tests have been executed June 24th, 2020. In this document, after a brief introduction on the foreseen tests, their results are summarized evidencing eventual issues, more deeply discussed in referenced Technical Notes ([RD.3], [RD.4], [RD.5] and [RD.6]).

All tests described in the following sections have been executed by means of proper FOPs, On-Board Control Procedures (OBCPs), and PDORs whose description can be found in [RD.1]. All the tests used the last version of SIBIOSYS FOPs (detailed in [RD.8]).

3.1. SIMBIO-SYS Functional Tests

3.1.1. HRIC Functional Test

3.1.1.1. Scope

The aim of this test is to check the channel functionality and its capability to perform some science acquisitions.

3.1.1.2. Results and discussion

The test has been executed as expected confirming the presence of a fluctuation in the detector reset level as seen in previous ICOs.
More details on the test results can be found in [RD.3].

3.1.2. STC Functional Test

3.1.2.1. Scope

The aim of this test is to check the functionality of the channel units and the capability to perform some science acquisitions.

3.1.2.2. Results and discussion

The test has been executed as expected confirming the presence of a peak issue while operating in the Color Mode (CM). More details on the test results can be found in [RD.4].

3.2. SIMBIO-SYS Performance Tests

3.2.1. HRIC Performance Test

3.2.1.1. Scope

The aim of this test is to perform several science acquisitions to evaluate the channel Dark Current (DC) performance after 1 and a half year from launch.

3.2.1.2. Results and discussion

The test was executed **with no errors**. The obtained data, once reduced by the scientific team, demonstrate the channel performances are in line with what expected because aligned with the one obtained during the on-ground calibration campaign and after the tests executed during NECP. More details on the test results can be found in [RD.3].

3.2.2. STC Performance Test

3.2.2.1. Scope

The aim of this test is to perform several science acquisitions to evaluate the channel DC performance after 1 and a half year from launch.

3.2.2.2. Results and discussion

As per the HRIC channel the obtained data demonstrate the channel performances are in line with what expected. As reported in [RD.4] 21 TC were rejected by Application SOftWare (ASW) for a Out-of-limit (not taken in account by operation team) of the STC Repetition Time (RT). This limit is reported on pag 186 of [RD.9] and it will be updated in the next ASW release. More details on the test results can be found in [RD.4].

3.2.3. VIHI Internal Calibration

3.2.3.1. Scope

The scope of this test was to repeat the test done during the ICO#02 with a verification of the VIHI functional capability together with the LED internal calibration performance.

3.2.3.2. Results and discussion

As indicated in the test definition reported in [RD.1], as done in previous ICOs, also the VIHI TEC has been switched-on using the nominal activation parameters reported (see [RD.10], while the S/C was guaranteeing a hotter thermal environment implementing higher thresholds for the heaters. With this new thermal configuration, **the TEC current profile was nominal, and all the test has been executed as expected**.
As per both cameras, the obtained VIHI data demonstrate the channel performances are in line with what expected. More details on the test results can be found [RD.5].

3.3. SIMBIO-SYS Interchannel Tests

3.3.1. HRIC/STC Interference Test

3.3.1.1. Scope

The aim of this test is to evaluate if the detector reset fluctuations present on both HRIC and STC channels are in phase or not and possible mutual interference.

3.3.1.2. Results and discussion

The test has been executed nominally with no errors and all commanded data received correctly.
In case of STC, detector signal has still a period around 3 minutes but with a little increment in amplitude.
In case of HRIC, the amplitude of the detector signal remains unchanged while the fluctuation period doubles.
Anyhow, the result of the test demonstrates that when the two cameras operate in parallel, they influence each other on the detector signal reset level. Nothing can be said about the origin of the effect (i.e., more tests are necessary).
More details can be found in [RD.6].

4. Conclusions

4.1. Summary

During the SIMBIO-SYS ICO#03, some tests have been executed to evaluate the instrument's health status and the evolution of its performance after 1.5 years cruise. With these tests, all the units (i.e., ME, HRIC, STC, and VIHI) have operated nominally, allowing us to check their operativity and performance. The obtained results demonstrate that all SIMBIO-SYS units and subsystems work nominally.

4.2. Open issues

During the execution of the ICO#03 tests, the following issues raised:

#	Name	Description	Occurrence	Connected ARs
1	STC-RT Limits	SIMBIO-SYS command failures in Cruise Checkout 3	STC Performance test	BC_SC-123
2	LFB-Interference	Cameras LFB changes while channel operates in parallel	HRIC/STC Interference Test	-

The status of the issues at the end of ICO#03 phase is reported in following table:

#	Name	Status at the end of the ICO#02
1	TEC-INIT	**Closed**: both HRIC and STC have to use the nominal TEC activation parameters while the S/C has to use new (higher) threshold for the heaters that controls the CF temperature.
2	SHUTTER	**Open**: (see [RD.11]) the error on the PE-ME SpW is not managed in the present version of the ME ASW but it will be fixed in the next one. The issue will be checked and resolved after the ME ASW update.
3	ME-GRANULARITY	**Open**: (see [RD.12]) it has been found that the ME granularity managing TC execution could be modified by the Repetition Time (RT) parameter of a Science TC determining that some

		TC can be accepted but not executed (see section 4.2 of [RD.13]).
4	ACK MISSING	**Open:** (see [RD.12]) it is understood that in the case of Science on Science mode (i.e., a Science or STOP TC is sent while the channel is already in Science mode) the new TC is accepted immediately (i.e., ACK sent) and it should be executed at the end of the RT of the previous one. If during this delay one or more additive TCs occurred, all of them are immediately accepted (i.e., ACKs sent) but only the last one is executed and even the "waiting one" is lost without any indication of that (i.e., no TM(1,8) received for all the TCs apart the last one that is executed).
5	PACKET SORTING	**Open**: (see [RD.12]) some science packets presented a wrong time tag determining a bad frame reconstruction. The reason for this issue is still under study.
6	LFB	**Open**: Both HRIC and STC channels reports a not expected fluctuation of the detector reset level (around the 0.1% of the dynamical range).
7	SpW-error	**Closed:** it has been verified the issue was unexpected but correctly manged by the ME ASW.
8	VIHI TEC-current	**Closed:** also the VIHI channel has to use the nominal TEC activation parameters while the S/C has to use new (higher) threshold for the heaters that controls the CF temperature.
9	STC-RT limits	**Open:** There is a limit in the DB between 30 and 4000 but STC-RT commanded was not in line with ASW limits (2460 raw).
10	LFB-Interference	**Open:** While operating in parallel, the LFB of the two cameras change in terms of amplitude and frequency. More tests are necessary to understand the effect.