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BC-SIM-TR-005

SIMBIO-SYS NECP Test Report

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1. Introduction

1.1. Scope

This document will briefly report the results of the tests performed during the Near Earth Commissioning Phase (NECP) whose details are reported in [RD.1].

1.2. Reference document

[RD.1] BC-SIM-PL-001-NECP_Test_Planning_Summary,

<http://dx.doi.org/10.20371/INAF/TechRep/17>

[RD.2] BC-SIM-TN-003_-_Reports_and_Note_Layout_and_Flow,

<http://dx.doi.org/10.20371/INAF/TechRep/36>

[RD.3] BC-SIM-TN-001-SIMBIOSYS_FOPs_Decription,

<http://dx.doi.org/10.20371/INAF/TechRep/15>

[RD.4] BC-SIM-TR-002_-_HRIC_NECP_report,

<http://dx.doi.org/10.20371/INAF/TechRep/32>

[RD.5] BC-SIM-TR-003_STC_NECP_Report,

<http://dx.doi.org/10.20371/INAF/TechRep/26>

[RD.6] BC-SIM-TR_004_Issue1_VIHI_NECP_REPORT


[RD.7] BC-SIM-TR-001_-_EGSE_NECP_report,

<http://dx.doi.org/10.20371/INAF/TechRep/22>

[RD.8] BC-ESC-RP-10110, BepiColombo Mission Operations Report (MOR#8)

1.3. Acronyms


APID	Application Process Identifier
ASW	Application SoftWare
CSV	Comma Separated Values
FPA	Focal Plane Assembly
FOP	Flight Operation Procedure

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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.

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1.5. Document organization

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


- Section 2 – NECP objectives, with a brief description of the performance and inter-channel tests executed.
- Section 3 – NECP 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 reports ([RD.4], [RD.5] and [RD.6]).

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2. NECP Objective

The scope of the SIMBIO-SYS NECP was to verify the health status of the instrument at channel and system-level 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. TEC, Detector, 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;
3. **Inter-channel Tests**, to evaluate in space conditions the operability of the SIMBIO-SYS channels in parallel as expected during the nominal science phase around Mercury.

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3. Test Implementation

The SIMBIO-SYS NECP tests have been executed in three days, from 10th to 12th of December 2018. In this document, after a brief description their results are summarized evidencing eventual issues that are more deeply discussed in referenced Technical Notes ([RD.4], [RD.5] and [RD.6]).

Tests listed in Section 2 have been executed by means of proper FOPs, On-Board Control Procedures (OBCPs), and NECP PDORs whose description can be found in [RD.1]. All the tests represent the first inflight validation of the SIBIOSYS FOPs (detailed in [RD.3]).

3.1. SIMBIO-SYS Functional Tests


3.1.1. ME Functional Test

3.1.1.1. Scope

The scope of this test is to check the Main Electronics (ME) functionality on both MAIN and REDUNDANT channels after launch.

3.1.1.2. Results and discussion

The test was executed **with no errors** demonstrating the correct activation of the ME unit both on the MAIN and REDUNDANT channel.

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3.1.2. HRIC Functional Test on the MAIN ME channel

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 while operating on the MAIN ME channel.

3.1.2.2. Results and discussion

The HRIC Thermo-Electric Cooler (TEC) activation, **differently from what expected**, follows a hard start due to a wrong configuration of the its working parameters determining a peak in the current. Thanks to the interacting link with the S/C available during the test, the anomaly was resolved in real-time by uploading the correct parameters. After that, the test continued and terminated with no other issues demonstrating the correct activation of the channel unit. More details on the test results can be found in [RD.4].


3.1.3. STC Functional Test on the MAIN ME channel

3.1.3.1. Scope

The aim of this test is to check the functionality of the channel units and the capability to perform some science acquisitions while operating on the MAIN ME channel.

3.1.3.2. Results and discussion

Even with the correct parameters uploaded during the HRIC functional test, a peak in the current was observed during the STC TEC activation. Differently from the HRIC case, for STC the problem was related to the non-nominal (less than 10 K) difference between the actual FPA temperature and the TEC set-point. Apart from this anomaly, the test **continued and terminated with no other issues** demonstrating the

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correct activation of the channel unit. More details on the test results can be found in [RD.5].

3.1.4. VIHI Functional Test on the MAIN ME channel

3.1.4.1. Scope

The aim of this test is to check the functionality of the channel units and the capability to perform some science acquisitions while operating on the MAIN ME channel.

3.1.4.2. Results and discussion

The test was executed **with no errors** demonstrating the correct activation of the channel unit. Differently from the cameras (i.e., HRIC and STC), no anomalies were reported regarding the TEC activation but it should be considered the low frequency of the HK rate that could hide the issue. More details on the test results can be found in [RD.6].


3.1.5. HRIC Functional Test on the REDUNDANT ME channel

3.1.5.1. Scope

The aim of this test is to check the functionality of the channel units and the capability to perform some science acquisitions while operating on the REDUNDANT ME channel.

3.1.5.2. Results and discussion

The test was executed **with no errors** demonstrating the correct activation of the channel unit. More details can be found in [RD.4].

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3.1.6. STC Functional Test on the REDUNDANT ME channel

3.1.6.1. Scope

The aim of this test is to check the functionality of the channel units and the capability to perform some science acquisitions while operating on the REDUNDANT ME channel.

3.1.6.2. Results and discussion

As per the analogue test on the MAIN ME channel, the TEC activation follows a hard start with a peak in the current due to a non nominal (less than 10 K) difference between the FPA temperature and the TEC set-point. Apart from this problem, the test **continued and terminated with no other issues** demonstrating the correct activation of the channel unit. More on the test results details can be found in [RD.5].


3.1.7. VIHI Functional Test on the REDUNDANT ME channel

3.1.7.1. Scope

The aim of this test is to check the functionality of the channel units and the capability to perform some science acquisitions while operating on the REDUNDANT ME channel.

3.1.7.2. Results and discussion

Differently from the test on the MAIN ME channel, also VIHI TEC experienced a peak in the current during its activation due to a non nominal (less than 10 K) difference between the FPA temperature and the TEC set-point. Apart from this problem, the test **continued and terminated with no other issues** demonstrating the correct activation of the channel unit. More details on the test results can be found in [RD.6].

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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), Spurious Charge (SC), compression and detector-reset performance just after launch.

3.2.1.2. Results and discussion

All the four tests listed above were executed **with no errors**. The obtained data, once reduced by the scientific team, demonstrate the channel performances are aligned with the one obtained during the on-ground calibration campaign and in line with what expected. More details on the test results can be found in [RD.4].

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, SC, and detector-reset performance just after launch.

3.2.2.2. Results and discussion

During the Performance Tests, 28 TCs were rejected by the ME Application SoftWare (ASW) due to a wrong configuration in the Science TC (inconsistency between the Compression Box Dimension and the vertical height of the image windows). The TC sequence has been corrected and repeated the day after (after the inter-channel test) **with no errors**.

All the other planned tests were executed correctly with no errors.

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The obtained data, once reduced by the scientific team, demonstrated the channel performances are aligned with the ones obtained during the on-ground calibration campaign and in line with what expected. More details on the test results can be found in [RD.5].

3.2.3. VIHI Performance Test 1

3.2.3.1. Scope

The scope of this test is to perform a set of measurements in dark conditions and with the calibration units (i.e., Lamp and LED) for monitoring the performance of the latter's after launch.

3.2.3.2. Results and discussion


During the test, a **TC related to the release of the shutter was not executed** due to an unexpected internal error occurred on the SpW. The effect was that more than half of the data were produced in a not correct configuration of the channel (i.e., the shutter remained closed and so the acquisitions with the LAMP and the LED were not performed).

The test was repeated the day after with no errors. The obtained data, once reduced by the scientific team, demonstrate the channel performances are aligned with the one obtained during the on-ground calibration campaign and in line with what expected. More details on the test results can be found in [RD.6].

3.2.4. VIHI Performance Test 2


3.2.4.1. Scope

The scope of this test is to perform a set of calibration measurements for monitoring the VIHI performance after launch.

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3.2.4.2. Results and discussion

The test was executed **with no errors**. The obtained data, once reduced by the scientific team, demonstrate the channel performances are aligned with the one obtained during the on-ground calibration campaign and in line with what expected. More details on the test results can be found in [RD.6].

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3.3. SIMBIO-SYS Inter-channel Tests

3.3.1. MAX stress Test

3.3.1.1. Scope

The scope of this test is to verify the capability of the SIMBIO-SYS ME to manage all the three channels operating in parallel in an operative mode that stress at maximum the on-board processing capabilities of the PE and ME.

3.3.1.2. Results and discussion

The test was executed **with no errors** demonstrating the capability of the instrument to operate nominally even with complex onboard processing and commanding are executed.

Part of the science data was completely lost due to a problem in the management of the packet store in the S/C SSMM.

More details on the test results can be found in [RD.4], [RD.5] and [RD.6].

3.3.2. MAX DataRate Test

3.3.2.1. Scope


The scope of this test is to verify the capability of the SIMBIO-SYS ME to manage all the three channels operating in parallel in producing their nominal max flux of data.

3.3.2.2. Results and discussion

The test was executed **with no errors** demonstrating the capability of the instrument to operate nominally even a great amount of data are produced.

Part of the science data was completely lost due to a problem in the management of the packet store in the S/C SSMM, as per the MAX Stress test.

More details on the test results can be found in [RD.4], [RD.5], [RD.6].

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3.3.3. OrbitTest


3.3.3.1. Scope

The scope of this test is to verify the capability of the SIMBIO-SYS ME to manage all the three channels operating in parallel in a typical configuration expect during the Global Coverage phase (i.e., STC and VIHI operating in continuous mode in different configurations simulating orbit segmentation; HRIC operating in target mode with three acquisitions).

3.3.3.2. Results and discussion

During the test, some **VIHI Science TC was not executed** due to the wrong initialization of some parameters. Part of the STC data was lost due to the packets management problem described previously. Anyway, the obtained data, once reduced by the scientific team, demonstrate the instrument capability to guide the three channels in a nominal Science orbital timeline.

More details on the test results can be found in [RD.4], [RD.5], [RD.6].

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4. Conclusions

4.1. Summary


During the SIMBIO-SYS NECP, several tests have been done to evaluate the instrument's health status and the evolution of its performance after the BepiColombo S/C launch occurred in October 2018. 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, and the FOP package provided is in line with the requirements.

Finally, during the NECP, it has been possible to validate the Ground Segment Equipment (GSE) and the data analysis tools developed by the team. Some issues raised on the telemetry downloaded from the ESA repository and related to the duplication of the diagnostic HK and the order of some Science packets (see [RD.7] for details).

4.2. Open issues

During the execution of the NECP tests, the following issues raised:

#	Name	Description	Occurrence	Connected ARs
1	TEC-INIT	Non-nominal built-in TEC activation parameters	HRIC Functional Test on the MAIN ME channel	BC_SC-41
2	TFPA SETPOINTS	Non-nominal temperature difference between the FPA temperature and the its nominal set-point	TEC activation of all channel	
3	WIND-CBD	Wrong setting of 28 Science TC	STC performance test	-
4	SHUTTER	Closed VIHI Shutter TC not executed	VIHI performance test 1	BC_SC-42
5	LOSS DATA	Loss of Science data	STC performance and inter-channel tests	-

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As indicated in the above table, some issues are associated to the Anomaly Reports [RD.8]. The status of the issues at the end of NECP phase is reported in following table:

#	Name	Status at the end of the NECP
1	TEC-INIT	Open: the TEC parameters have been defined to be used in Mercury-like thermal conditions. A study is required to find out new parameters to be used in Cruise conditions. The parameters must be uploaded before the TEC activation pending the update of the ME ASW where these parameters are fixed.
2	TFPA SETPOINTS	Closed: it has been found that the HRIC and STC TEC set-points were swapped. The parameters will be corrected in the next FOP release.
3	WIND-CBD	Closed: The TC wrong parameters were changed and the test were repeated correctly. FOPs will be updated consequentially.
4	SHUTTER	Open: 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.
5	LOSS DATA	Closed: the loss was due to an error in the management of the S/C SSMM packet store allocated for the SIMBIO-SYS data.