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SIMBIO-SYS Instrument delta NECP Test Report

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Approvation

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1	0	02/04/2021	All	First issue

1. Introduction

1.1. Scope

In this document we briefly report the tests performed during the delta-Near Earth Commissioning Phase (NECP) for the Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem (SIMBIO-SYS) whose detailes are reprted in [RD.1] and discuss the obtained results.

1.2. Reference documents

[RD.1] BC-SIM-PL-003_-_SIMBIO-SYS_Delta_NECP_Test_Summary_Issue1_Revision0, 10.20371/INAF/TechRep/66

[RD.2] BC-SIM-TN-003_-_Reports_and_Note_Layout_and_Flow, 10.20371/INAF/TechRep/36

[RD.3] BC-SIM-TR-007_-_STC_dNECP_report, 10.20371/INAF/TechRep/71

[RD.4] BC-SIM-TR-008_-_VIHI_dNECP_report

[RD.5] BC-SIM-TR-009_-_SIMBIO-SYS_deltaNECP_Interchannel_Test_Report_Issue1_Revision0, 10.20371/INAF/TechRep/76

[RD.6] BC-SIM-TR-005_-_SIMBIO-SYS_NECP_Report, 10.20371/INAF/TechRep/42

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

[RD.8] BC-SIM-GAF-TN-113 rev.0_TEC Control Parameters Revision for Commissioning_F1

[RD.9] BC-SIM-TR-006_-_SIMBIO-SYS_EGSE_dNECP_report, 10.20371/INAF/TechRep/70

[RD.10]BC-ESC-RP-10110, BepiColombo Mission Operations Report (MOR#28)

1.3. Acronyms

APID	Application Process IDentifier
ASW	Application SoftWare
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 – delta NECP objectives, with a brief description of the performance and inter-channel tests executed.
- Section 3 – delta 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 STC and VIHI reports ([RD.3] and [RD.4] respectively) and in the System report ([RD.5]).

2. delta NECP Objective

The scope of the SIMBIO-SYS delta NECP was to complete and repeat the same performance and interchannel tests performed during the SIMBIO-SYS NECP campaign considering its results and issues (see [RD.6] for details). In particular, (see [RD.1] for details), it has been:

1. defined set of **Performance Tests**, to monitor the evolution of the performance of the STC and VIHI channels with respect to the results obtained during the on-ground calibration campaign and the tests performed during the NECP.
2. replanned an ORBIT_TEST as **Interchannel Test**, to monitor the Main Electronics (ME) Application SoftWare (ASW) capability to manage the operativity of all channels in parallel with a simulation of a generic orbit during the Global Coverage Phase (GCP) of SIMBIO around Mercury.

3. Test Implementation

The SIMBIO-SYS delta NECP tests have been executed June 6th 2019. In this document, after a brief description of the goal of each test, their results are summarized evidencing eventual issues that are more deeply discussed in referenced Technical Notes ([RD.3] and [RD.4]).

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 represent the first inflight validation of the new version of SIMBIO-SYS FOPs (detailed in [RD.7]) delivered after NECP phase.

3.1. SIMBIO-SYS Performance Tests

3.1.1. STC All-FPA Test

3.1.1.1. Scope

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

3.1.1.2. Results and discussion

During the channel switch on, the new TEC parameters (commanded to allow its "soft" activation – see [RD.8] for details) generated a **non-nominal oscillations in the current profile**.
Apart from the TEC issue, the test **operated correctly** apart from a set of TCs which was rejected by the ME ASW for a not correct parameter initialization: windows dimensions were not compatible with respect to the compression unit box size. More details on the test results can be found in [RD.3].

3.1.2. STC Mitigate-Reset Test

3.1.2.1. Scope

The aim of the test was the monitoring the offset behaviour by means of several acquisitions with different acquisitions strategies.

3.1.2.2. Results and discussion

The test was **not conclusive due to an error in the test sequence timing** that was not detected during the PDOR design. During the execution of the Test, 3 TCs were ignored without giving any acknowledgment since the ME ASW was waiting for the conclusion of the RT of the previous TC. More details on the test results can be found in [RD.3].

3.1.3. STC Hot-pixel Test

3.1.3.1. Scope

The aim of the test is the monitoring the spurious charge effect and popcorn effect on the hot pixel distribution.

3.1.3.2. Results and discussion

The test was **performed correctly**, and the performance of the instruments demonstrated no variation with respect to on ground calibration. Some images were corrupted due to a misalignment between Sequence Counter and Timing at ME level (see [RD.9] for more details). More details on the test results can be found in [RD.3].

3.1.4. VIHI Internal Calibration

3.1.4.1. Scope

The aim of this test was to verify the performance of the internal calibration by changing some of the parameters controlling the FPA and the lamp current.

3.1.4.2. Results and discussion

As per STC channel, during the VIHI switch on, the new TEC parameters (commanded to allow its "soft" activation – see [RD.8] for details) generated a **non-nominal oscillations in the current profile**.
Apart from the above issie, the test was **performed correctly** except for one TC which was rejected by the ASW for a not correct value setting (i.e., VIHI Write address: parameter out of range). This issue was not detected during the PDOR design phase. The **test's results were therefore not valid for a correct analysis of the detector performance.** More details on the test results can be found in [RD.4].

3.2. SIMBIO-SYS Interchannel Test

3.2.1. SIMBIO-SYS Orbit Test

3.2.1.1. Scope

The aim of this test was the repetition of the Orbit Test performed during the NECP to verify the anomalies of data loss identified during the NECP (see Issue 5 in [RD.5]).

3.2.1.2. Results and discussion

The test was **performed correctly** apart from two issues (see [RD.5] for details):

1. during the HRIC switch on, the new TEC parameters (commanded to allow its "soft" activation) generated a **non-nominal oscillations in the current profile** (as happened on STC during its performance tests – see [RD.3] for details)
2. three VIHI science acquisitions, out of eight, failed due to a wrong configuration of the numbers of the commanded rows when operating with spectral binning.

4. Conclusions

4.1. Summary

During the SIMBIO-SYS delta NECP, some tests have been executed to repeat and complete the instrument performance evaluation performed during NECP. The obtained results demonstrate that all SIMBIO-SYS units and subsystems work nominally, and the new FOP package provided is in line with the requirements.

Finally, during the delta NECP, it has been possible to validate some improvements in 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.9] for details).

4.2. Open issues

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

#	Name	Description	Occurrence	Connected ARs
1	TEC-INIT	Non-nominal built-in TEC activation parameters	STC during all-FPA Test, VIHI during its performance test and HRIC during the Orbit test	-
2	MISSING ACK	TC ignored without giving any acknowledgment	STC Mitigate-Reset Test	BC-AR-75
3	ME-GRANULARITY	Variation in the ME TC granularity	STC Mitigate-Reset Test	-
4	PACKET SORTING	Some science packets presented a wrong time tag	STC Hot-pixels Test	-

As indicated in the above table, some issues are associated to the Anomaly Reports [RD.10]. The status of the issues at the end of delta NECP phase is reported in following table:

#	Name	Status at the end of the NECP
1	TEC-INIT	**Open**: the used TEC parameters, derived from a new study of the Prime, seem to not be the right one to be used in the Cruise phase. A new study is necessary also considering the S/C thermal environment around the instrument.
2	ACK MISSING	**Open:** 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).
3	ME-GRANULARITY	**Open**: it has been found that the ME granularity managing TC execution could be modified by the RT parameter of a Science TC determining that some TC can be accepted but not executed.
4	PACKET SORTING	**Open**: some science packets presented a wrong time tag determining a bad frame reconstruction. The reason for this issue is still under study.