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BC-SIM-PL-003
SIMBIO-SYS Delta NECP Test Summary

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1 Introduction

1.1 Scope

In this document we describe all the tests to be performed during the delta-Near Earth Commissioning Phase (dNECP) for the Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem (SIMBIO-SYS).

1.2 Reference Document

[RD.1] BC-SIM-TN-003_-_Reports_and_Note_Layout_and_Flow, 10.20371/INAF/TechRep/36
[RD.2] BC-SIM-GAF-MA-002 10 001 – SIMBIO-SYS User Manual
[RD.3] BC-SIM-TR-005_-_SIMBIO-SYS_NECP_Report, 10.20371/INAF/TechRep/42
[RD.4] BC-SIM-PL-001-NECP_Test_Planning_Summary_Issue1_v1_02Jan2020, 10.20371/INAF/TechRep/17
[RD.5] BC-SIM-TN-004_-_SIMBIO-SYS_FOP_update_after_NECP, 10.20371/INAF/TechRep/58
[RD.6] BC-ASD-SP-00176
[RD.7] BC-SIM-GAF-TN-113 rev.0_TEC Control Parameters Revision for Commissioning_F1

1.3 Acronyms

APID	Application Process IDentifier
ASW	Application SoftWare
CM	Color Mode
CSV	Comma Separated Values
DSNU	Dark Signal Non Uniformity
FPA	Focal Plane Assembly
FOP	Flight Operation Procedure

GM	Global Mapping
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
STC	STereo imaging Channel
RON	ReadOut Noise
TC	Telecommand
TEC	Thermo-Electric Cooler
TM	Telemetry
UM	User Manual
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 – dNECP objectives, with a brief description (see Section 8.2.2 of [RD.2] for details) of the functional tests we are going to execute;
- Section 3 – dNECP implementation and validation, with:
  - a brief description of which Flight Operation Procedures (FOPs) and Payload Direct Operation Requests (PDORs) we are going to use to perform the required test,
  - the results of the sequence validation using a Simulation Software developed within the team,
  - an estimation of the required resources in terms of Data Volume, duration and expected number of frames (i.e., sub-images, normally called windows, acquired; for instance, a single acquisition of STC-GM should generate 3 Frames: 2 Panchromatic window and a Filter-X) for each sequence;
- Section 4 – dNECP timeline, with the list of activities to be performed logically ordered to optimize instrument activations and test duration.

2 Test objective

The scope of the SIMBIO delta-NECP is to repeat and to complete the SIMBIO-SYS NECP performance tests also considering the results and issues reported in [RD.3].

2.1 Performance Test

During the dNECP the SIMBIO-SYS performance shall be verified by means of dedicated Performance Test procedures on the following elements:

- STC, with the monitoring of
  - dark and DSNU in all the detector (all_fpa test)
  - dark offset behaviour (mitigate_rest test)
  - hot pixels presence as function of spurious charge (hot_pixel test)
- VIHI, with the monitoring of the internal calibration lamp/LED performance and test of the detector bias parameters

2.2 Interchannel Test

During the NECP a problem occurred in the management of the on-board S/C SSMM determining a significant data loss for the verification of the SIMBIO-SYS Application SoftWare (ASW) capabilities (see issue 5 of [RD.3]). To recover this information, the ORBIT_TEST (see [RD.4] for more details) shall be repeated.

3 Test implementation

3.1 Resources

As per ESA-ESOC official communication, the SIMBIO-SYS dNECP test will take place on 07/06/2019 at 04:30:00 UTC and the available time and Data-Volume resources will be:

- test duration: 4 hours
- Data-Volume: 10 Gb

On the basis of the above reported information, the tests reported in the following sub-sessions shall be executed by means of proper FOPs, On-Board Control Procedures (OBCPs) and PDORs listed in the following subsections and described in [RD.5], [RD.6] and Annexed files.

3.2 SIMBIO-SYS Performance Tests

3.2.1 STC All-FPA Test

3.2.1.1 Scope

The aim of the test is the monitoring of dark, the Dark Signal Non Uniformity (DSNU) and the ReadOut Noise (RON) by means of several acquisitions of all the detector.

3.2.1.2 Preparation

To execute this test SIMBIO-SYS shall be in the following status:

Unit	Status
ME	ON (on the MAIN channel)
HRIC	OFF
STC	ON
VIHI	OFF

Waiting for SIMBIO-SYS ME ASW update which should affect also the parameters for the correct TEC activation, a PDOR with **SPOT ID BPSS00157** to upload the correct TEC parameters has been prepared (see **SIMBIOSYS_STC_TEC_init** in the Timeline table of Section 4).
To note that, differently from what indicated in the SIMBIO-SYS User Manual (UM) (see Section 8.3.1.16 of [RD.2]), with reference to the issues 1 and 2 raised on the TEC Activation during the NECP (See Section 4.2 of [RD.3]), new parameters have been computed for the Cruise phase considering the study described in [RD.7].

3.2.1.3 Description

A PDOR with **SPOT ID BPSS00142** has been prepared which performs the acquisition of the entire FPA sliced in contiguous areas (see **SIMBIOSYS_stc_all_fpa** in the Timeline table of Section 4).

The execution of the test session will be automatic with no interaction from ground by the Science Team.

3.2.1.4 Validation

The PDOR **SIMBIOSYS_stc_all_fpa** has been validated by means of a Simulation Software and produces the following results:

Sequence duration			**00:36:30**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	0 [Gb]	2.4222 [Gb]	0 [Gb]	2.4222 [Gb]
HK	0.0245 [Mb]	0 [Mb]	0.0292 [Mb]	0 [Mb]	0.0537 [Mb]
Total	0.0245 [Mb]	0 [Gb]	2.4222 [Gb]	0 [Gb]	2.4223 [Gb]

To note that above resource computation it has to be considered as upper limits since, for their computation, the Simulation Software needs to introduce some fake TCs (i.e., ME and channel switch-on) in order to reproduce the correct SIMBIO-SYS state for the analysis.

3.2.1.5 Expected Science data

In the following table it is reported the number of frames that are expected to be produced during the test:

HRIC		**STC**		**VIHI**	
TC	**# Frames**	**TC**	**# Frames**	**TC**	**# Frames**
-	-	1	5	-	-
		2	5		
		3	5		
		4	5		
		5	5		
		6	5		
		7	5		
		8	5		
		9	5		
		10	5		

		11	5		
		12	5		
		13	5		
		14	5		
		15	5		
		16	5		
		17	5		
		18	5		
		19	5		
		20	5		
		-	100		

3.2.2 STC Mitigate-Reset Test

3.2.2.1 Scope

The aim of the test is to monitor the offset behaviour by means of several acquisitions with different acquisitions strategies.

3.2.2.2 Preparation

To execute this test SIMBIO-SYS shall be in the following status:

Unit	Status
ME	ON (on the MAIN channel)
HRIC	OFF
STC	ON
VIHI	OFF

For the correct TEC parameters upload procedure see Section 3.2.1.2.

3.2.2.3 Description

A PDOR with **SPOT ID BPSS00140** has been prepared which performs nominal acquisitions in Color Mode (CM) interleaved by fake detector reading in order to try to remove detector reset anomaly (see **SIMBIO-SYS_STC_mitigate_test** in the Timeline table of Section 4).

The execution of the test session will be automatic with no interaction from ground by the Science Team.

3.2.2.4 Validation

The PDOR **SIMBIO-SYS_STC_mitigate_test** has been validated by means of a Simulation Software and produces the following results:

Sequence duration			**00:33:24**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	0 [Gb]	0.1406 [Gb]	0 [Gb]	0.1406 [Gb]
HK	0.0224 [Mb]	0 [Mb]	0.0264 [Mb]	0 [Mb]	0.0487 [Mb]
Total	0.0224 [Mb]	0 [Gb]	0.1406 [Gb]	0 [Gb]	0.1407 [Gb]

To note that above resource computation it has to be considered as upper limits since, for their computation, the Simulation Software needs to introduce some fake TCs (i.e., ME and channel switch-on) in order to reproduce the correct SIMBIO-SYS state for the analysis.

3.2.2.5 Expected Science data

In the following table it is reported the number of frames that are expected to be produced during the test:

HRIC		**STC**		**VIHI**	
TC	**# Frames**	**TC**	**# Frames**	**TC**	**# Frames**
-	-	1	250	-	-
		2	50		
		3	3		
		4	15		
		5	6		
		6	50		
		7	1		
		8	50		
		9	2		
		10	50		
		11	2		
		12	50		
		13	2		
		14	50		
		15	2		
		16	50		
		17	3		
		18	50		
		19	1		
		20	50		
		21	20		

		22	5		
		23	5		
		24	5		
		25	5		
		26	5		
		27	5		
		-	787		

3.2.3 STC Hot-pixel Test

3.2.3.1 Scope

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

3.2.3.2 Preparation

To execute this test SIMBIO-SYS shall be in the following status:

Unit	Status
ME	ON (on the MAIN channel)
HRIC	OFF
STC	ON
VIHI	OFF

For the correct TEC parameters upload procedure see Section 3.2.1.2.

3.2.3.3 Description

A PDOR with **SPOT ID BPSS00143** has been prepared which performs acquisitions of the detector to monitor and evaluate the popcorn effect (see **SIMBIOSYS_STC_hot_pixels_test** in the Timeline table of Section 4).

The execution of the test session will be automatic with no interaction from ground by the Science Team.

3.2.3.4 Validation

The PDOR **SIMBIOSYS_STC_hot_pixels_test** has been validated by means of a Simulation Software and produces the following results:

Sequence duration			**00:34:36**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	0 [Gb]	3.2113 [Gb]	0 [Gb]	3.2113 [Gb]
HK	0.0232 [Mb]	0 [Mb]	0.0275 [Mb]	0 [Mb]	0.0507 [Mb]
Total	0.0232 [Mb]	0 [Gb]	3.2113 [Gb]	0 [Gb]	3.2113 [Gb]

To note that above resource computation it has to be considered as upper limits since, for their computation, the Simulation Software needs to introduce some fake TCs (i.e., ME and channel switch-on) in order to reproduce the correct SIMBIO-SYS state for the analysis.

3.2.3.5 Expected Science data

In the following table it is reported the number of frames that are expected to be produced during the test:

HRIC		**STC**		**VIHI**	
TC	**# Frames**	**TC**	**# Frames**	**TC**	**# Frames**
-	-	1	10	-	-
		2	10		
		3	10		
		4	10		
		5	10		
		6	10		
		7	10		
		8	10		
		9	10		
		10	10		
		11	10		
		12	10		
		13	10		
		14	10		
		15	10		
		16	10		
		17	10		
		18	10		
		19	60		
		20	60		
		21	60		

		-	360		

3.2.4 VIHI Internal Calibration and Detector BIAS test

3.2.4.1 Scope

The aim of this test is to verify the performance of the internal calibration by changing some of the parameters controlling the FPA and the lamp current.
In particular there are two objective for this internal calibration tests:

1. the FPA parameters VDet_Com and VDet_Adj have been programmed onboard with non-nominal values; the correct values are listed in chapter 8.3.1.10 of [RD.2]. The first run of the Internal Calibration will be performed with the onboard values of the parameters and the second run after substitution with the nominal values.
2. To verify the lamp performance with a different value of the current with respect to NECP.

3.2.4.2 Preparation

To execute this test SIMBIO-SYS shall be in the following status:

Unit	Status
ME	ON (on the MAIN channel)
HRIC	OFF
STC	OFF
VIHI	ON

3.2.4.3 Description

A PDOR with **SPOT ID BPSS00152** has been prepared which performs the following operations (see **SIMBIO_VIHI_DELTA_NECP_01** in the Timeline table of Section 4):

- PE switch-on
- Upload TEC parameters using data coming from [RD.7]
- Detector and TEC switch-on
- VIHI Read Address: VDet_Com and VDet_Adj
- Run Internal Calibration (i.e., execute the FOP SS-TST-031 - see [RD.5] for details) with:
    - LED current 2000DN

  - Lamp current 0 DN (Lamp will not be used)
- VIHI Write Address: update VDet_Com and VDet_Adj
- Run Internal Calibration (i.e., execute the FOP SS-TST-031) with:
  - LED current 2000DN
  - Lamp current 2500DN
- TEC, detector and PE switch-off

3.2.4.4 Validation

The POR **SIMBIO_VIHI_DELTA_NECP_01** has been validated by means of a Simulation Software and produces the following results:

Sequence duration			**01:41:05**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	0 [Gb]	0 [Gb]	1.6641 [Gb]	1.6641 [Gb]
HK	0.0679 [Mb]	0 [Mb]	0 [Mb]	2.4360 [Mb]	2.5038 [Mb]
Total	0.0679 [Mb]	0 [Gb]	0 [Gb]	1.6665 [Gb]	1.6666 [Gb]

To note that above resource computation has to be considered as upper limits since, for their computation, the Simulation Software needs to introduce some fake TCs (i.e., ME and channel switch-on) in order to reproduce the correct SIMBIO-SYS state for the analysis.

3.2.4.5 Expected Science data

In the following table it is reported the number of frames that are expected to be produced during the test:

HRIC		**STC**		**VIHI**	
TC	**# Frames**	**TC**	**# Frames**	**TC**	**# Frames**
-	-	-	-	1	14
				2	14
				3	14
				4	14
				5	59
				6	59
				7	59
				8	59
				9	59
				10	59
				11	59

				12	59
				13	59
				14	59
				15	59
				16	59
				17	59
				18	14
				19	14
				20	14
				21	14
				22	59
				23	59
				24	59
				25	59
				26	59
				27	59
				28	59
				29	59
				30	59
				31	59
				32	59
				33	59
				34	59
				-	1646

3.3 SIMBIO-SYS Interchannel Tests

3.3.1 Orbit Test

3.3.1.1 Scope

The aim of this test is the repetition of the Orbit Test performed during the NECP to verify the anomalies of data loss identified during the NECP.

3.3.1.2 Preparation

To execute this test SIMBIO-SYS shall be in the following status:

Unit	Status
ME	ON (on the MAIN channel)
HRIC	ON
STC	ON
VIHI	ON

For the correct STC TEC parameters upload procedure see Section 3.2.1.2. Similarly, for the HRIC channel a PDOR with **SPOT ID BPSS00077** to upload the correct TEC parameters has been prepared (see **SIMBIOSYS_HRIC_TEC_init** in the Timeline table of Section 4) to upload the TEC parameters described in [RD.7] following the issues 1 and 2 summarized in Section 4.2 of [RD.3].

3.3.1.3 Description

A PDOR with **SPOT ID BPSS00073** has been prepared which operates for 1 hour and performing (see **SIMBIOSYS_ORBIT_test_noME** in the Timeline table of Section 4):

- HRIC: 3 FPAN acquisitions with IBR=32 and RT=1.115s, 2s and 2.5s
- STC: continuous acquisition changing the IT, the RT and the cross-track dimension of the filters for 9 different sections of orbit. The channel operates in Global Mapping mode with IBR = 32 changing its cross-track window size from 128 px to 640 px.
- VIHI: continuous acquisition changing the IT and the RT for 8 different sections of orbit

As per the Functional Tests described in previous sections, the execution of the test session will be automatic with no interaction from ground by the Science Team

3.3.1.4 Validation

The PDOR **SIMBIOSYS_ORBIT_test_noME** has been validated by means of a Simulation Software and produces the following results:

Sequence duration			**00:59:50**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	0.5426 [Gb]	0.2208 [Gb]	0.5912 [Gb]	1.3546 [Gb]
HK	0.0652 [Mb]	0.0854 [Mb]	0.0872 [Mb]	0.1036 [Mb]	0.3414 [Mb]
Total	0.0652 [Mb]	0.5427 [Gb]	0.2208 [Gb]	0.5913 [Gb]	1.3549 [Gb]

To note that above resource computation it has to be considered as upper limits since, for their computation, the Simulation Software needs to introduce some fake TCs (i.e., ME and channel switch-on) in order to reproduce the correct SIMBIO-SYS state for the analysis.

3.3.1.5 Expected Science data

In the following table it is reported the number of frames that are expected to be produced during the test:

HRIC		**STC**		**VIHI**	
TC	**# Frames**	**TC**	**# Frames**	**TC**	**# Frames**
1	120	1	131	1	1846
2	80	2	77	2	2400
3	1	3	52	3	1874
		4	103	4	1750
		5	305	5	5624
		6	90	6	6600
		7	62	7	2571
		8	74	8	4500
		9	48		
-	201	-	942	-	27165

4 Timeline

With reference to the tests described in the previous sections, the following timeline applies:

ID	Description	Estimated duration	Estimated Data Volume	Attached XML file of PDOR package
1. SS-FCP-001	ME OBCP Power On via OBCP	00:03:05	-	See FOP in [RD.5]
2. SIMBIOSYS_STC_TEC_init	STC Channel TEC init	00:03:50	0.0064 [Mb]	¤ BPSS00157_00001.BC
3. SIMBIOSYS_stc_all_fpa	STC DC, DSNU and RON behaviour monitoring test	00:36:30	2.4223 [Gb]	¤ BPSS00142_00004.BC

ID	Description	Estimated duration	Estimated Data Volume	Attached XML file of PDOR package
4. SIMBIO-SYS_STC_mitigate_test	STC detector-reset behaviour monitoring test	00:33:24	0.1407 [Gb]	¤ BPSS00140_00004.BC
5. SIMBIOSYS_STC_hot_pixels_test	STC salt-and-pepper behaviour monitoring test	00:34:36	3.2113 [Gb]	¤ BPSS00143_00004.BC
6. SS-FCP-007	STC Channel Off	00:03:00	-	See FOP in [RD.5]
7. SIMBIO_VIHI_DELTA_NECP_01	VIHI internal calibration with on-board and nominal values for VDet_Com and VDet_Adj	01:41:05	1.6666 [Gb]	¤ BPSS00152_00004.BC

ID	Description	Estimated duration	Estimated Data Volume	Attached XML file of POR package
8. SS-FCP-008	STC Channel On	00:03:00	-	See FOP in [RD.5]
9. SIMBIOSYS_HRIC_TEC_init	HRIC Channel TEC init	00:03:50	0.0064 [Mb]	¤ BPSS00077_00001.BC
10. SIMBIOSYS_ORBIT_test_noME	SIMBIO-SYS Orbit Test	00:59:50	1.3549 [Gb]	¤ BPSS00073_00001.BC
11. SS-FPC-004	HRIC Channel Off	00:03:00	-	See FOP in [RD.5]
12. SS-FPC-007	STC Channel Off	00:03:00	-	See FOP in [RD.5]
13. SS-FCP-010	VIHI Channel Off	00:03:00	-	See FOP in [RD.5]
14. SS-FCP-002	ME OBCP Power Off via OBCP	00:03:00	-	See FOP in [RD.5]

[1] Data include ME and HRIC TEC parameters upload sequence duration and data volume
[2] Data include ME and STC TEC parameters upload sequence duration and data volume
[3] Data include ME sequence duration and data volume