BC-SIM-PL-002
SIMBIO-SYS Checkout#01
Test Summary

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1 Introduction

1.1 Scope

In this document we describe all the tests to be performed during the Instrument CheckOut (ICO) # 01 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-TN-004_-_SIMBIO-SYS_FOP_update_after_NECP, 10.20371/INAF/TechRep/58

[RD.5] BC-ASD-SP-00176

[RD.6] BC-SIM-TR-002_-_HRIC_NECP_report, 10.20371/INAF/TechRep/32

[RD.7] BC-SIM-GAF-TN-113 rev.0_TEC Control Parameters Revision for Commissioning_F1

[RD.8] BC-SIM-TR-003_-_STC_NECP_report, 10.20371/INAF/TechRep/26

[RD.9] BC-SIM-TN-001_-_The_Flight_Operation_Procedures_of_the_SIMBIO-SYS_instrument_aboard_the_BepiColombo_ESA_mission, 10.20371/INAF/TechRep/15

[RD.10]BC-SIM-TN-002_-_STC_Strategy_Observation, 10.20371/INAF/TechRep/35

[RD.11]AIRBUS_MIB_Report-TC_Packet_Overview_PFMv10.2_13.09.2017

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
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
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 – ICO#01 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 – ICO#01 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 – ICO#01 timeline, with the list of activities to be performed logically ordered to optimize instrument activations and test duration.

3 Test objective

The scope of the SIMBIO ICO#01 is to verify the instrument functionality at channel and system level after 6 months from launch. Few performance tests are also planned to monitor the evolution of some key instrument parameters. Finally, with reference to the issues raised during the instrument Near Earth Commissioning Phase (NECP) reported in Section 4.2 of [RD.3], some updates in the commanding and on the FOPs (see [RD.4]) are verified.

3.1 Functional Test

During the ICO#01 the SIMBIO-SYS functionality shall be verified by means of dedicated Functional Test procedures on the following elements:

- HRIC, with the verification of:
  - PE, TEC and detector activation
  - memory/registers status
  - science acquisition capability
- STC, with the verification of:
  - PE, TEC and detector activation
  - memory/registers status
  - science acquisition capability

3.2 Performance Test

During the ICO#01 the SIMBIO-SYS performance shall be verified by means of minimal Performance Test procedures on the following elements:

- HRIC, with the verification of Dark Current (DC) behavior for the nominal Integration Time (IT);
- STC, with the verification of DC behavior for the nominal ITs and Repetition Times (RTs);
- VIHI, with the verification of:
  - PE, TEC and detector activation,
  - Shutter operativity,

- Sources (Lamp and LED) operativity,
- Science acquisition with sources;

4 Test implementation

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.4], [RD.5] and Annexed files.

4.1 SIMBIO-SYS Functional Tests

4.1.1 HRIC Functional Test

4.1.1.1 Scope

The aim of this test is:

- to check the status and the functionality of the following electric components of the channel:
  - Proximity Electronic (PE),
  - Detector and
  - Thermo-Electric Cooler (TEC);
- to modify some configuration parameters;
- to perform a science acquisition.

4.1.1.2 Preparation

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

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

Waiting for SIMBIO-SYS ME Application SoftWare (ASW) update which should affect also the parameters for the correct TEC activation, 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 5).
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 summarized in Section 4.2 of [RD.3] and detailed in Section 4.1 of [RD.6], new parameters have been computed for the Cruise phase considering the study described in [RD.7].

4.1.1.3 Description

The HRIC functionality channel will be tested by means of the following TCs sequence:

- Proximity Electronics (PE) switch-on,
- Detector switch-on,
- Thermo-Electric Cooler (TEC) switch-on,
- Test of the reading and writing of a specific memory address,
- The following science acquisitions:
  - 2 minutes of 640x2048 window size acquisitions with Repetition Time (RT) = 1s, Integration Time (IT) = 50 s and IBR = 32,
  - 2 minutes of 640x2048 window size acquisitions with RT = 1s, IT = 315 ms and IBR = 32,
  - 10 acquisitions of 640x2048 window with RT = 1s, IT = 50 s and IBR = 32,
- TEC switch-off,
- Detector switch-off,
- PE switch-off

Above listed checks have been included in the **SS-TST-010** whose details can be found in [RD.4].

To note that differently from the NECP, the execution of the test session will be automatic with no interaction from ground by the Science Team.

4.1.1.4 Validation

A PDOR that calls the FOP **SS-TST-010** has been produced and validated by means of a Simulation Software and produces the following results:

Sequence duration			**00:19:40**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	0.6554 [Gb]	0 [Mb]	0 [Mb]	0.6554 [Gb]
HK	0.0292 [Mb]	0.9947 [Mb]	0 [Mb]	0 [Mb]	1.0238 [Mb]
Total	0.0292 [Mb]	0.6564 [Gb]	0 [Mb]	0 [Mb]	0.6564 [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.

4.1.1.5 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	-	-	-	-
2	120				
3	10				
-	370				

4.1.2 STC Functional Test

4.1.2.1 Scope

The aim of this test is:

- to check the status and the functionality of the following electric components of the channel:
  - PE,
  - Detector and
  - TEC;
- to modify some configuration parameters;
- to perform some science acquisitions.

4.1.2.2 Preparation

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

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

As per the HRIC channel (Section 4.1.1.2), a PDOR with **SPOT ID BPSS000157** has been prepared (see **SIMBIOSYS_STC_TEC_init** in the Timeline table of Section 5) to upload the TEC parameters described in [RD.7] following the issues 1 and 2 summarized in Section 4.2 of [RD.3] and detailed in Section 4.3 of [RD.8].

4.1.2.3 Description

The STC functionality will be tested by means of the following TCs sequence:

- PE switch-on,
- Detector switch-on,
- TEC switch-on,
- Test of the reading and writing of a specific memory address,
- The following nominal science acquisitions:
  - 20 seconds of Global Mapping (GM) compressed acquisitions with RT = 2 s, IT = 0.096 ms and IBR = 32
  - 2 minutes and 10 seconds of GM compressed acquisitions with RT = 12.3 s, IT = 1.5 ms and IBR = 32
  - 10 seconds of Color Mode (CM) compressed acquisitions with RT = 400 ms, IT = 5.3 ms and IBR = 63
  - 24 Seconds of CM compressed acquisitions with RT = 2.05 s, IT = 37.8 ms and IBR = 63
- TEC switch-off
- Detector switch-off
- PE switch-off

Science TCs have been commanded all in continuous mode.
Above listed checks have been included in the **SS-TST-020** whose details can be found in [RD.4]. The TST was changed with respect to the NECP phase [RD.9] to command acquisitions more consistent with the Observation Strategy [RD.10].

As described in section 4.1.1.3, the execution of the test session will be automatic with no interaction from ground by the Science Team.

4.1.2.4 Validation

A PDOR that calls the FOP **SS-TST-020** has been validated by means of a Simulation Software and produces the following results:

Sequence duration			**00:18:59**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	0 [Mb]	0.0615 [Gb]	0 [Mb]	0.0615 [Gb]
HK	0.0283 [Mb]	0 [Mb]	0.9571 [Mb]	0 [Mb]	0.9853 [Mb]
Total	0.0283 [Mb]	0 [Mb]	0.0625 [Gb]	0 [Mb]	0.0625 [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.

4.1.2.5 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	30	-	-
		2	30		
		3	125		
		4	55		
		-	240		

4.3 SIMBIO-SYS Performance Tests

4.3.1 HRIC Performance Test

4.3.1.1 Scope

The aim of this test is to perform several acquisitions in dark condition and variable integration times to monitor the DC evolution after 6 months from launch.

4.3.1.2 Preparation

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

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

For the correct TEC parameters upload procedure see Section 4.1.1.2.

4.3.1.3 Description

A PDOR with **SPOT ID BPSS00078** has been prepared which performs a reduced dark current calibration campaign on the Panchromatic and the 3 Broad-Band filters with low priority (see **SIMBIOSYS_hric_dc_red_test_noOBCP** in the Timeline table of Section 5).

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.

4.3.1.4 Validation

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

Sequence duration			**00:11:10**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	4.5233 [Gb]	0 [Mb]	0 [Mb]	4.5233 [Gb]
HK	0.0230 [Mb]	0.7395 [Mb]	0 [Mb]	0 [Mb]	0.7625 [Mb]
Total	0.0230 [Mb]	4.5240 [Gb]	0 [Mb]	0 [Mb]	4.5241 [Gb]

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

4.3.1.5 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	10	-	-	-	-
2	10				
3	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	30				
19	30				
20	30				

21	30				
22	30				
23	30				
24	30				
25	30				
26	30				
27	30				
28	30				
29	30				
30	30				
31	30				
32	30				
33	30				
34	30				
-	680				

4.3.3 STC Performance Test

4.3.3.1 Scope

The aim of this test is to acquire the Dark Current in order to study its evolution after 6 months from launch.

4.3.3.2 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 4.1.2.2.

4.3.3.3 Description

A PDOR with **SPOT ID BPSS00151** has been prepared which performs a reduced dark current campaign for the CM and GM operation modes (see [RD.10] for details) with low and high priority (see **SIMBIOSYS_stc_nominal_test** in the Timeline table of Section 5). The test acquired the same RTs and ITs commanded during the NECP phase (as detailed in Section 7.2 of [RD.8]) In its preparation the issue 3 reported in Section 4.2 of [RD.3] has been considered.

As per HRIC Performance Tests, the execution of the test session will be automatic with no interaction from ground by the Science Team.

4.3.3.4 Validation

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

Sequence duration			**01:17:26**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	0 [Mb]	5.4913[Gb]	0 [Mb]	5.4913[Gb]
HK	0.0520[Mb]	0 [Mb]	0.0687[Mb]	0 [Mb]	0.1207[Mb]
Total	0.0520[Mb]	0 [Mb]	5.4913[Gb]	0 [Mb]	5.4914[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.

4.3.3.5 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	30	-	-
		2	30		
		3	30		
		4	30		
		5	30		
		6	30		
		7	30		
		8	30		
		9	30		
		10	30		
		11	30		
		12	30		
		13	30		
		14	30		
		15	30		
		16	30		
		17	30		
		18	30		
		19	30		
		20	30		
		21	30		

		22	30		
		23	30		
		24	30		
		25	30		
		26	30		
		27	30		
		28	30		
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		30	30		
		31	30		
		32	30		
		33	30		
		34	30		
		35	30		
		36	30		
		37	30		
		38	30		
		39	30		
		40	30		
		41	30		
		42	30		
		43	50		
		44	50		
		45	50		
		46	50		
		47	50		
		48	50		
		49	50		
		50	50		
		51	50		
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		56	50		
		57	50		
		58	50		
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		61	50		
		62	50		
		63	50		

		64	50		
		65	50		
		66	50		
		67	50		
		68	50		
		69	50		
		70	50		
		71	50		
		72	50		
		73	50		
		74	50		
		75	50		
		76	50		
		77	50		
		78	50		
		79	50		
		80	50		
		81	50		
		82	50		
		83	50		
		84	50		
		-	3360		

4.3.5 VIHI Internal Calibration

4.3.5.1 Scope

The aim of this test is to perform a VIHI internal calibration using the internal light sources. It is used also to verify the shutter operability. This specific test covers also the functional verification of the channel.
For this ICO#1 the lamp will not be powered (use PSS01639 = default value) while the LED shall be used at its nominal current (i.e., Science TC parameter PSS01640 = 2000). For more details see [RD.11].

4.3.5.2 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

4.3.5.3 Description

A PDOR with **SPOT ID BPSS00148** has been prepared which calls of several elementary FOPs for the channel activation, the TEC parameters update and the SS-TST-031 FOP [RD.4] (see **SIMBIO_VIHI_ICO_01** in the Timeline table of Section 5).

4.3.5.4 Validation

The POR **SIMBIO_VIHI_ICO_01** has been validated by means of a Simulation Software and produces the following results:

Sequence duration			**00:52:00**		
Sequence Data Volume					
-	**ME**	**HRIC**	**STC**	**VIHI**	**Overall**
Science	-	0 [Mb]	0 [Mb]	0.8320 [Gb]	0.8320 [Gb]
HK	0.0450 [Mb]	0 [Mb]	0 [Mb]	1.2315 [Mb]	1.2765 [Mb]
Total	0.0450 [Mb]	0 [Mb]	0 [Mb]	0.8333 [Gb]	0.8333 [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.

4.3.5.5 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
				-	724

5 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 POR package
1. SS-FCP-001	ME OBCP Power On via OBCP	00:03:05	0.0020 [Mb]	see FOP in [RD.4]
2. SIMBIOSYS_HRIC_TEC_init	HRIC Channel TEC init	00:03:50	0.0064 [Mb]	¤ BPSS00077_00001.BC
3. SS-TST-010	HRIC Functional Test	00:19:40[1]	0.6564 [Gb][1]	see FOP in [RD.4]
4. SIMBIOSYS_hric_dc_red_test_noOBCP	HRIC DC behaviour monitoring test	00:11:10[1]	4.5241 [Gb][1]	¤ BPSS00078_00001.BC
5. SS-FCP-004	HRIC Channel Off via OBCP	00:03:00	-	see FOP in [RD.4]

ID	Description	Estimated duration	Estimated Data Volume	Attached XML file of POR package
6. SIMBIOSYS_STC_TEC_init	STC Channel TEC init	00:03:50	0.0064 [Mb]	¤ BPSS00157_00001.BC
7. SS-TST-020	STC Functional Test	00:18:59[2]	0.0625 [Gb][2]	see FOP in [RD.4]
8. SIMBIOSYS_stc_nominal_test	STC DC behaviour monitoring test	01:17:26	5.4914 [Gb]	¤ stc_nominal_test_00151.BC
9. SS-FCP-007	STC Channel Off via OBCP	00:03:00	-	see FOP in [RD.4]
10. SIMBIO_VIHI_ICO_01	VIHI internal calibration	00:52:00[3]	0.8333 [Gb][3]	¤ BPSS00148_00006.BC
11. SS-FCP-002	ME OBCP Power Off via OBCP	00:03:00	-	see FOP in [RD.4]

[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