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BC-SIM-TR-012 HRIC ICO1 REPORT

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Approvation

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Document change record

Issue	Revision	Date	Affected Pages	Change description
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1 Introduction

1.1 Scope

The present document has been issued to describe the Instrument Check Out Phase (ICO#1) Tests of HRIC channel of the Spectrometers and Imagers for MPO BepiColombo Integrated Observatory SYStem (SIMBIO-SYS).

1.2 Reference Documents

[RD.1] BC-SIM-TN-003_-_Reports_and_Note_Layout_and_Flow, 10.20371/INAF/TechRep/36

[RD.2] BC-ALS-TN-00099 MPO PFM Monitoring Thermistors Location

[RD.3] BC-SIM-GAF-MA-002 rev.8_SIMBIO-SYS FM User Manual, 2017

[RD.4] BC-SIM-PL-002-Checkout_01_Test_Summary_Issue1_27Jun2019, 10.20371/INAF/TechRep/64

[RD.5] BC-SIM-IAPSUPA-TR-001 HRIC NECP report, 10.20371/INAF/TechRep/32

[RD.6] BC-SIM-GAF-TR-113 rev.0_TEC Control Parameters Revision for Commissioning_F1

[RD.7] Della Corte et al. 2018 "Performances of the SIMBIO-SYS High Resolution Imaging Channel on Board BepiColombo/ESA Spacecraft Channel Performance Parameters as Derived by on Ground Calibration Measurements". 5th IEEE International Workshop on Metrology for AeroSpace (MetroAeroSpace) Year: 2018

1.3 Acronyms

ACK	Acknowledgment
ADC	Analogical Digit Converter
APID	Application Process IDentifier
ASW	Application SoftWare
CM	Color Mode
CSV	Comma Separated Values
DSNU	Dark Signal Not Uniformity
FOP	Flight Operation Procedure
FPA	Focal Plane Assembly
HK	HouseKeeping
HRIC	High spatial Resolution Imaging Channel
ICO	Instrument CheckOut
IT	Integration Time

ME	Main Electronics
NECP	Near Earth Commissioning Phase
OBCP	On-Board Control Procedure
OB	Optical Bench
OBSW	On Board Software
PDOR	Payload Direct Operation Request
PDS	Planetary Data System
PE	Proximity Electronics
PNG	Portable Network Graphics
PSC	Packet Sequence Control
RT	Repetition Time
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	SpaceCraft
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.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 – sensors definition, with a brief description of the HRIC sensors used to monitor the environment in which the channel executes the tests
- Section 3 – ICO1-HRIC tests, with a brief description of the executed tests and a report on obtained HKs and data

2 Definitions and assumptions

In this section the main physical and technical terms are defined. The physical and instrumental assumptions are also included.

2.1 HRIC Sensors

Table 1 reports the main HRIC sensors covering the temperature measurement of the Focal Plane Assembly (FPA), the Proximity Electronics (PE), the backside of the detector and the HRIC Optical Bench (OB), the Current and the Voltage measurement of the Thermo-Electric Cooler (TEC) and the PE.

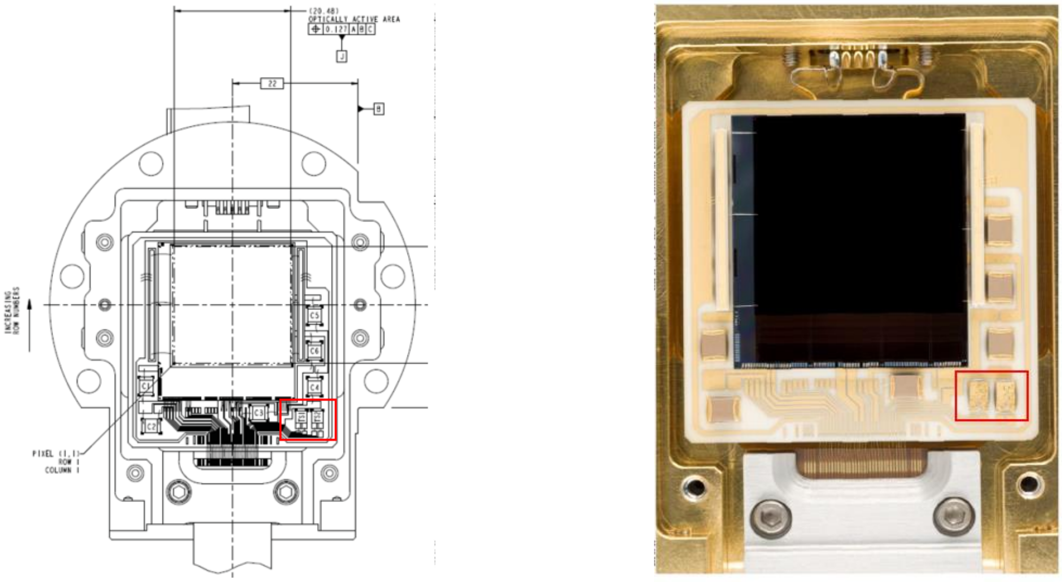
Param.ID	Param Name	Unit	Calibration
NSS11040	HRIC Temperature FPA1	K	CSSP0010TM
NSS11041	HRIC Temperature FPA2	K	CSSP0011TM
NSS11042	HRIC Temperature PE	K	CSSP0012TM
NSS11043	HRIC Temp Tele1	K	CSSP0013TM
NSS11044	HRIC Temp Tele2	K	CSSP0014TM
NSS11050	HRIC PE 3.3V Measured	V	CSSP0015TM
NSS11051	HRIC TEC Current	A	CSSP0016TM
NSS11051	HRIC TEC Current	A	CSSP0016TM

Table 1: Main HRIC temperature sensors of the FPA, PE, the backside of the detector and the HRIC OB as reported in [RD.2]. All HKs are part of the Packet YSS40001.

Table 2 and Figure 1 report the position of the above listed sensors.

Unit	Instrument Controlled Thermistors	Temp.	Location	Parameter
HRIC Optics 1	PT1000	-40/65	TIRD filter	HRIC_Temp_Tele_1
HRIC Optics 2	PT1000	-40/65	FPA package	HRIC_Temp_Tele_2
HRIC SCA 1	DT470	-40/65	FPA SCA	HRIC_Temp_FPA_1
HRIC SCA 2	DT470	-40/65	FPA SCA	HRIC_Temp_FPA_2
HRIC PE	PT1000	-40/65	PE hot spot	HRIC_Temp_PE

Table 2: HRIC temperature sensor position.



(a) (b)

Figure 1: HRIC-FPA temperature sensors [RD.3] next to the FPA, called SCA1 (on the left) and SCA2 (on the right) and associated respectively to the NSS11040 and NSS11041.

3 HRIC-ICO1 Tests

As reported in [RD.4], the ICO1 SIMBIO-SYS Phase had the scope to verify the health status of the instrument at channel and system level after 6 months after launch. To do this, few functional and performance tests are planned to monitor the evolution of some key instrument parameters.

To note that, during the Functional Tests, differently from NECP phase (see [RD.5]) the switch on of the channels was performed after the upload of the optimized parameters (see [RD.6]) for the gentle activation of the TEC (to avoid peak of the TEC current in the case of difference of temperature greater than 10K).

3.1 Test description and commanding

All the test details and command timelines are reported in [RD.4].

3.2 HK interpretation

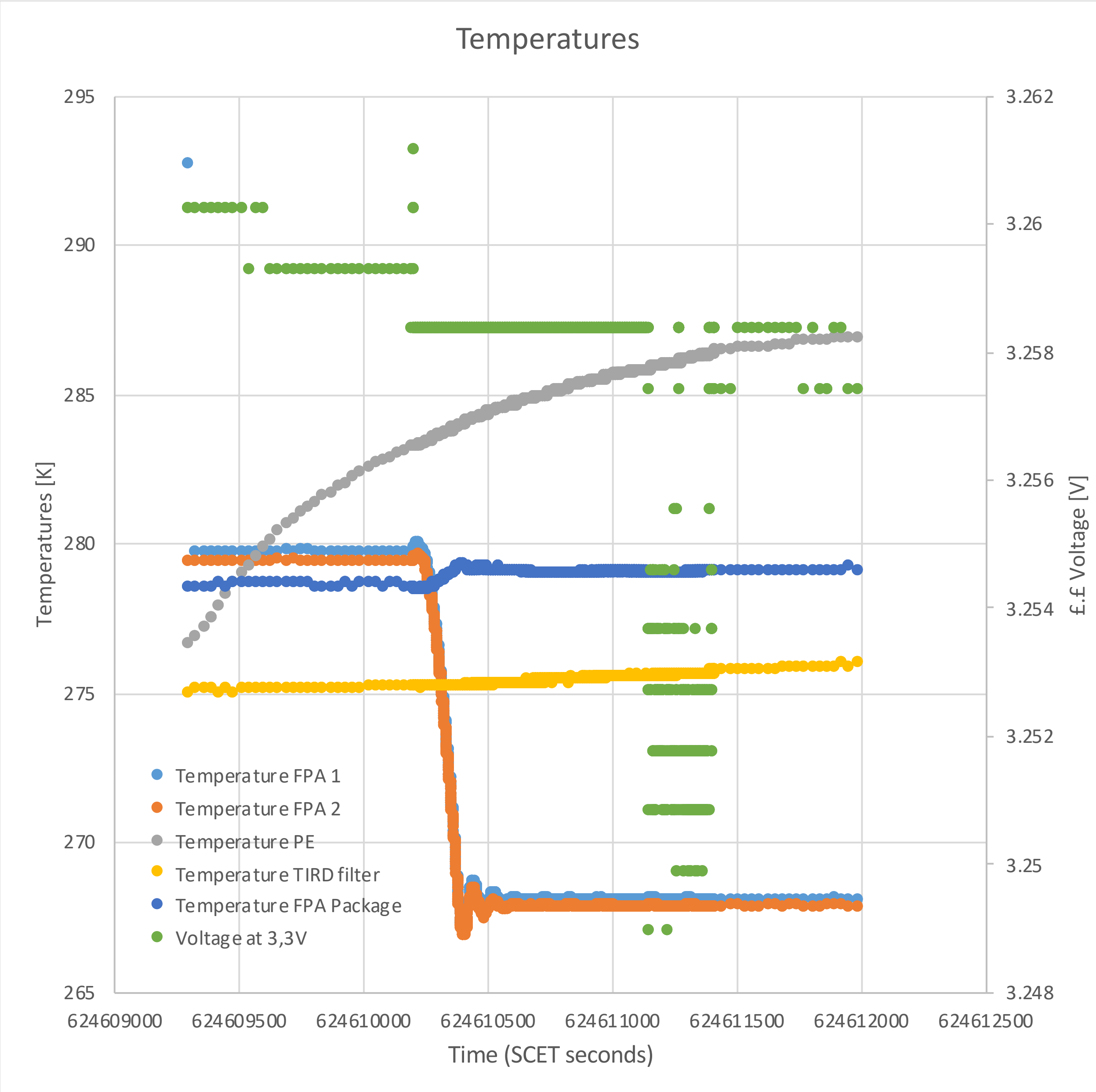


Figure 2: HRIC housekeeping for the entire ICO-01 tests. Left y axis reports the temperatures; right y axis reports the Voltage.

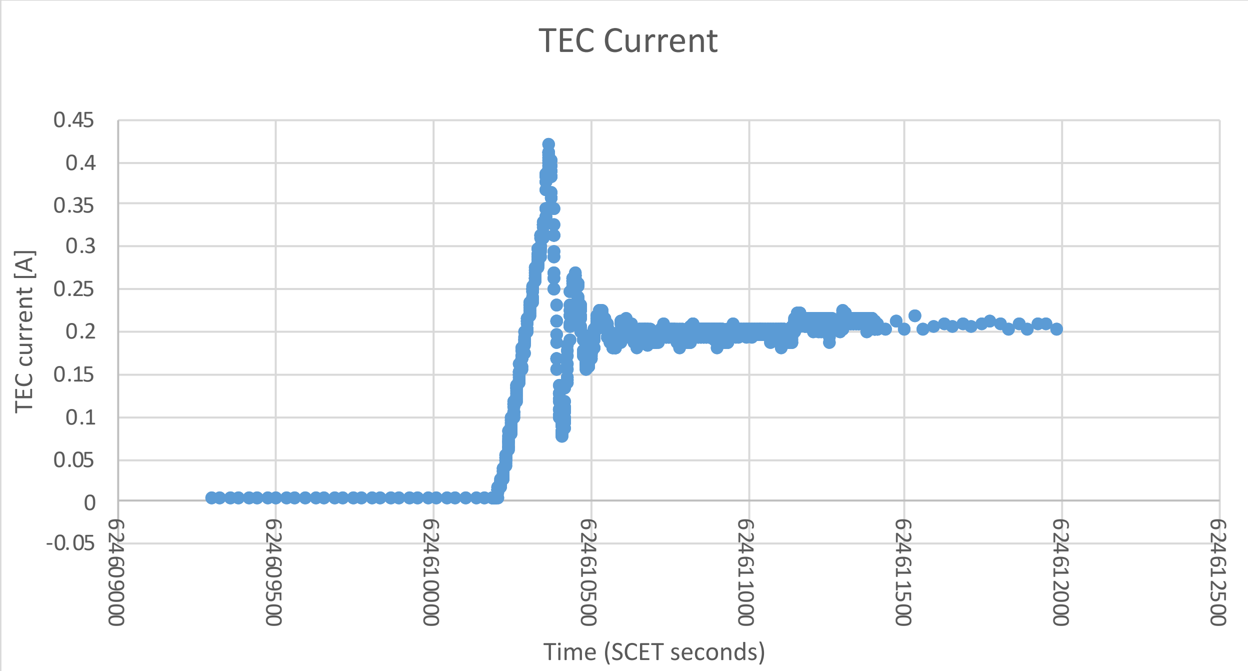


Figure 3: TEC Current for the entire ICO-01 tests.

Figure 2 and Figure 3 plots show the trends of the HK related to the temperatures and the TEC current during the all the HRIC test in ICO1. The temperatures trends are nominal: since the PE power on, PE temperature starts to grow up reaching at the end of the test a maximum value of about 287 K.

The temperature sensors linked to the detector show a trend connected to the operations: the temperatures after the switch on of the TEC drops down to the setting point.

The Temperature of FPA Package (i.e., Tele 2 of Table 1 and Table 2), that is connected to the external case of the FPA, shows a trend linked to the TEC and FPA activation with a small temperature increase.

The Temperature of the TIRD filter (i.e., Tele 1 of Table 1 and Table 2) shows a small increasing trend from the beginning of the test: the increase of the temperature during the test is less than 1 °C.

With the correct values for the TEC activation parameters, the TEC current trend shows the expected soft start. Nevertheless, the presence of several overshoot both in temperature and current before the temperature stabilization, requires revising again the values for the PID parameters.

3.3 Functional Test data analysis

The analysis of the frames acquired during the functional test show that the signals read from the detector are compatible with the values characterized during the on-ground calibrations. Average Signal Level and Standard deviation measured on the frames are compatible with the same parameters acquired in similar conditions during the calibration campaign and during NECP activities (see [RD.5]).
For both the measurements (at short and long) integration times the average values show small (in amplitude) trends. These do not show any simple correlation with the housekeeping parameters.

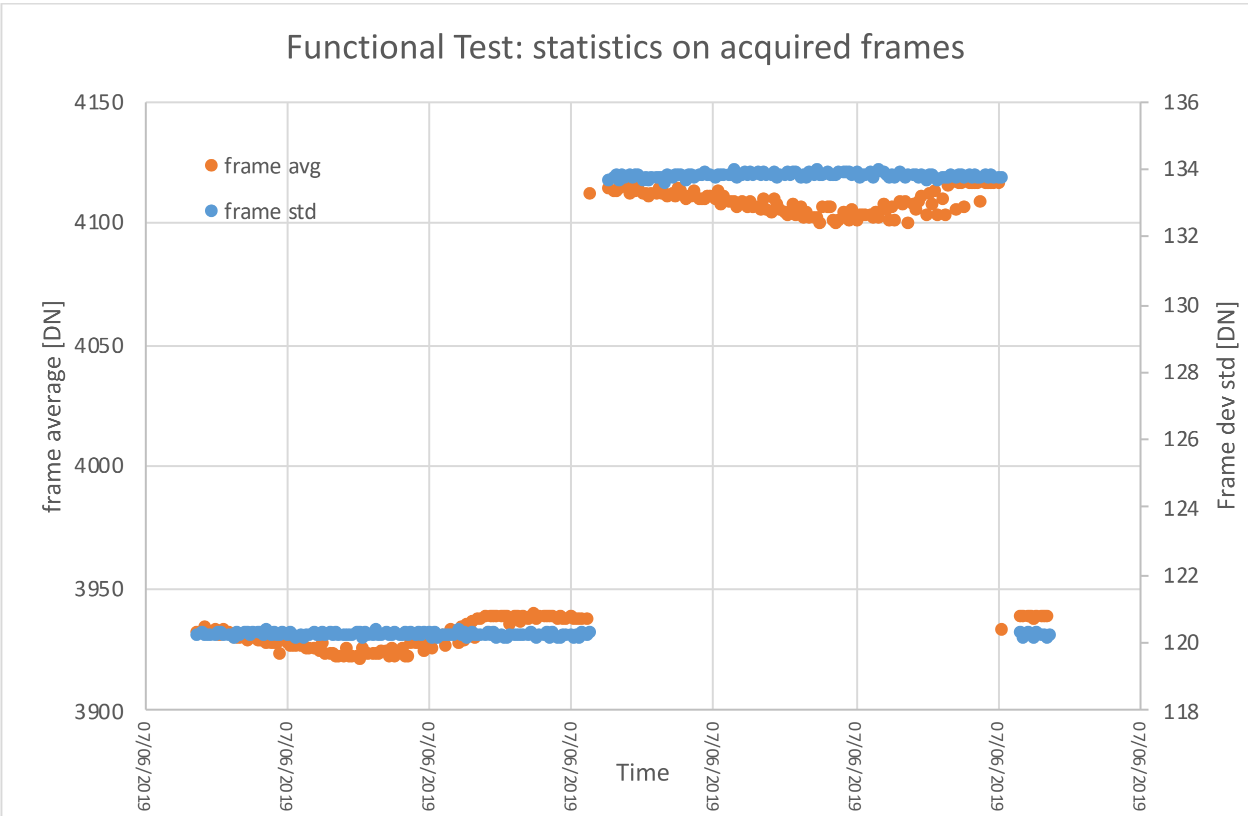


Figure 4: In the plot the frame average and the standard deviation are reported (orange plots refer to left y-axis while blu plots refer to right y-axis). The frames have been acquired in three steps changing the integration time: a) short integration time 38 μs; b) long integration time 0.3148 s; c) short integration time 38 μs.

The analysis of collected data shows different results with respect to NECP (Figure 5):

1. During the first switch on the average values of the acquired frames have different trend;
2. At longer integration time the average values are higher than in the NECP test.

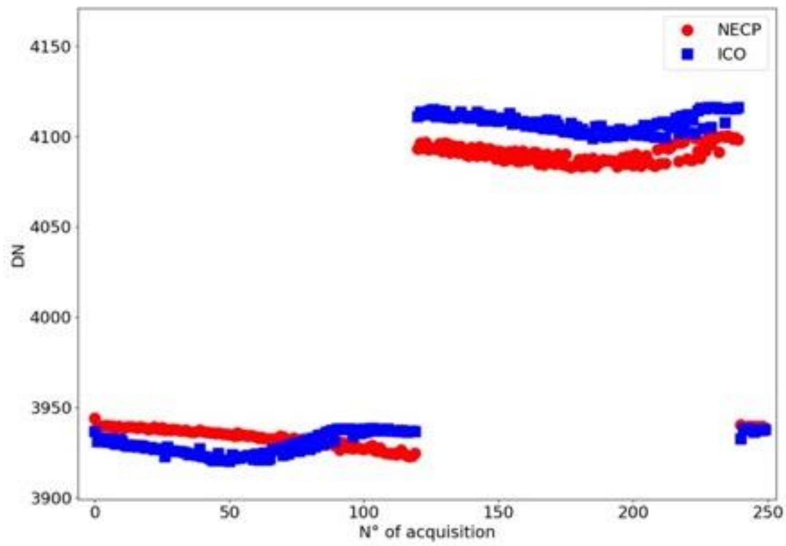


Figure 5: Comparison of the results of functional test between NECP and ICO_01.

The second effect is compatible with the different temperatures setting of the focal plane. In fact, during the ICO-01 the FPA temperature was about 1 °C higher than the temperature during the NECP, this results in an increased value for the dark current and thus the average value for the acquired frames is higher than in the NECP test.
The second effect will be investigated during the IC02 where a longer sequence of acquisitions will be commanded to check the presence of a low frequency oscillation on the detector background.

3.4 Dark Current Test data analysis

During the Dark test/measurement the areas of the detector corresponding to the Panchromatic, has been acquired with different integration times starting from the minimal (400 nano-seconds in the configuration used for the ROIC) up to about 6 seconds. The values of the average of the acquired frames are reported in Figure 6. The trend shown in the plot is compatible with the trends measured during the calibration campaign on ground and reported in [RD.6].

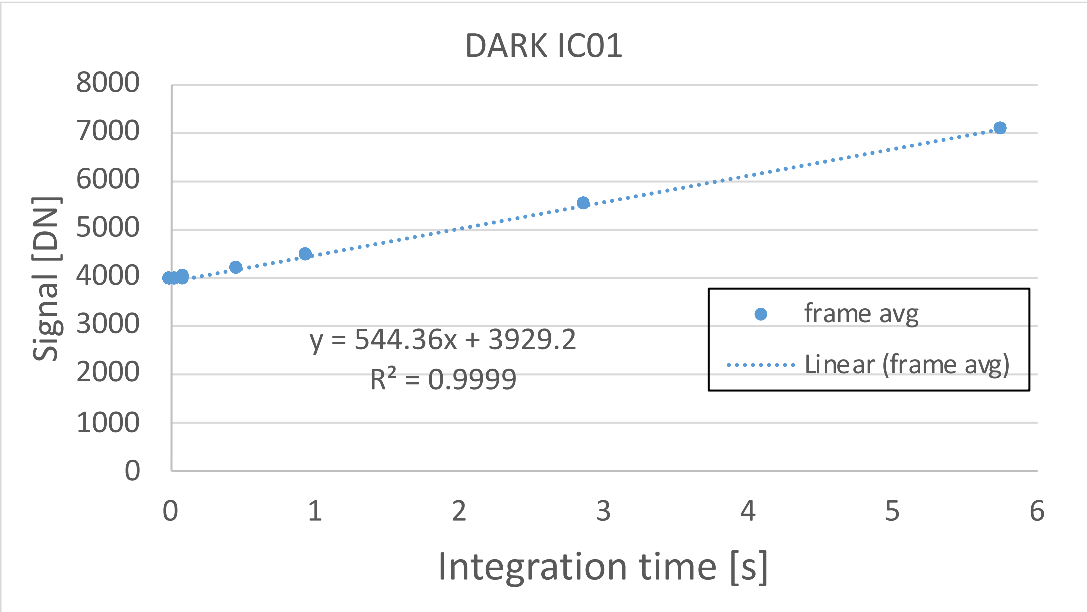


Figure 6: Average of the pixel values over the frames acquired during the DARK test. In the plot are reported the values of the average of the frame for the Panchromatic filter and the corresponding linear fit of the data.

In Figure 7 is reported the Dark acquisitions comparison among on-ground calibration (Blu), NECP data (Green) 4, ICO data (Red). The NECP dark rate seems better that the data acquired during the calibration, while the ICO-01 data show an increase of the Dark current. These fluctuation in the Dark rate are compatible with the small differences in temperature of the focal plane among the three tests. This behavior will be monitored in the next cruise checkout.

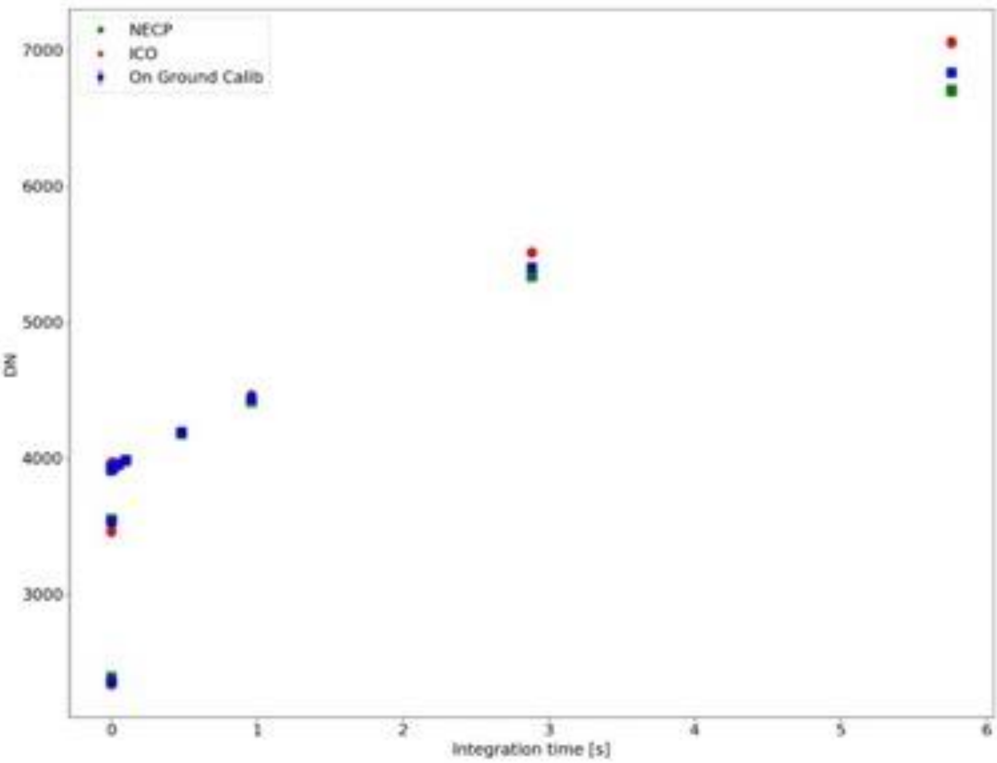


Figure 7: Comparison of the dark current trends acquired during the on-ground calibration, NECP and ICO-01.