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Calibration activities on the BepiColombo High-Resolution Channel (HRIC) of SIMBIO-SYS instrument

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Abstract

HRIC (High Resolution Imaging Channel) is the high resolution channel of the SIMBIO-SYS instrument onboard the ESA BepiColombo Mission. Calibration activities were performed at SelexES premises in spring-summer 2014 in order to check for Channel performances (radiometric performances, quality image and geometrical performances) and to obtain data necessary to setup a calibration pipeline necessary to process the raw images acquired by the channel when in operative scenario.

1. Introduction

Main measured parameters include electrical parameters of the channel (readout noise, fixed pattern noise, dark current); radiometric performances (response vs. integration time and flux spectral response). All parameters have been measured at pixel level due to the relatively high variability of CMOS detectors with respect to CCDs. The final target is to obtain parameters for the calibration pipeline correcting pixel-by-pixel HRIC data.

2. Calibration Setup Performed Measurements

The test has been performed in cleanroom class 100,000 where the HRIC OGSE and TVC have been placed for the entire HRIC PFM test campaign. The test set-up employed for the performed Performance Tests is shown in Figure 1 and mainly is composed of the TVC where the flight hardware is mounted, the TVC control system, the UT to control HRIC during the operative phases of the test and the OGSE to provide the optical stimulus through the optical window of the TVC (Fig.1). By means of the the collected data we characterized :

- The Dark Current (DC) behaviour
- The Read Out Noise (RON) of the detector
- The Fixed Pattern Noise (FPN)
- The Photo Response and the Photo Response Non Uniformity (PRNU)
- the Radiometric performances

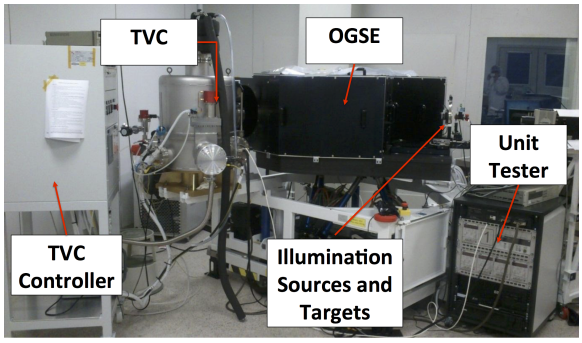

Figure 1: Experimental Setup used during the HRIC calibration campaign.

3. Results

3.1 Dark Current

The DC shows a double trend, in fact while for very short integration times (t_{exp} < 0,05 ms) the DC shows a high rate that can be fitted as a quadratic function of the exposure time, for t_{exp}> 0.05 ms the DC shows a smooth and relatively small linear rate well within the requirements. The DC behavior has an impact on data calibration only for very short integration times, for exposure greater than 0.05 ms.

3.2 Read Out Noise and Fixed Pattern Noise

Due to the behaviour shown by the dark current, we evaluated the RON and the FPN at two different value

of integration time: for $t_{exp} << 0.05$ ms and for $t_{exp} > 0.05$ms (Fig. 2). This approach simplifies the evaluation of the right parameters that have to be applied to the raw images in order to have calibrated data.

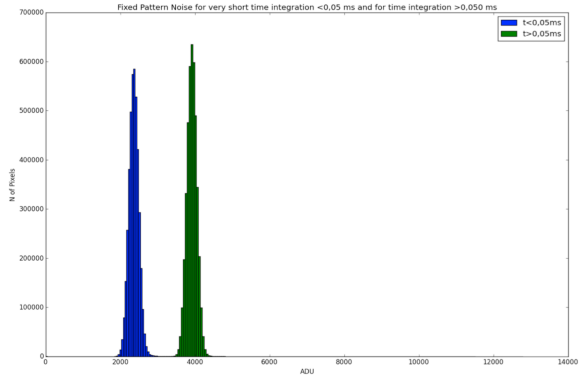

Figure 2: Different distribution for FPN considering the different behavior for very small integration time

3.3 Linearity

The response of each pixel of the channel vs. integration time and vs. light flux intensity has been characterized. The high resolution channel has a response with respect to the flux very close to linearity considering about 80% of the available signal range. Moreover the characterization of the response of each pixel allows us to remove the PRNU from the images (Fig. 3).

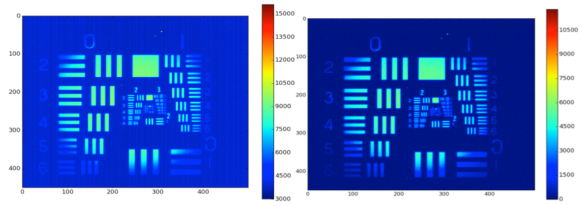

Figure 3: Left Panel raw acquired image; Right Panel Image after DC, FPN and PRNU removal.

4. Summary and Conclusions

Thanks to the characterization of the HRIC Channel obtained during the calibration campaign a first test of low level image processing has been performed. The on-going analysis activity on the acquired data is devoted to fully characterize the radiometric and geometrical performances of SIMBIO-SYS high resolution channel.

Acknowledgements

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