EPSC Abstracts
Vol. 13, EPSC-DPS2019-551-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Validation tests of the calibration bench for the characterization of MAJIS/JUICE VIS-NIR detectors

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Abstract

The MAJIS (Moons And Jupiter Imaging Spectrometer) instrument is part of the science payload of the ESA L-Class mission JUICE (Jupiter ICy Moons Explorer) to be launched in 2022 with an arrival at Jupiter in 2030. The subsystems of the instrument, and in particular its detectors, need to be characterized in the laboratory before being tested at instrument level after the integration. During 2018 and early 2019, the design and development of the calibration bench to characterize the VIS-NIR detectors of MAJIS was completed. The next step is to validate the facility by using the Structural Model (STM) of the VIS-NIR Focal Plane Unit (FPU) and the Engineering Model (EM) of the VIS-NIR detectors. Here we present a description of the validation tests and the expected results. The characterization of the spare and flight models of the MAJIS VIS-NIR detectors is intended to be completed by the end of 2019.

1. Introduction

MAJIS (Moons And Jupiter Imaging Spectrometer) is an instrument part of the science payload of the ESA L-Class mission JUICE (Jupiter ICy Moons Explorer) to be launched in 2022 with an arrival at Jupiter in 2030 [1]. JUICE will perform detailed observations of the giant gaseous planet Jupiter and three of its largest moons: Ganymede, Callisto and Europa, for at least three years [1]. MAJIS will perform imaging spectroscopy through two channels: VIS-NIR (0.50 µm - 2.35 µm) and IR (2.25 µm - 5.54 µm), to characterize the Jovian atmosphere and magnetosphere, and to determine the global composition of surface materials of the icy moons [2]. The Royal Belgian Institute for Space Aeronomy (IASB-BIRA) and the Royal Observatory of Belgium (ROB) contribute to MAJIS with the characterization of the VIS-NIR detectors, including the design and development of the bench, which was developed in an ISO-5 laminar flux at IASB-BIRA facilities [3].

2. Description of the facility

The calibration bench guarantees the cleanliness and safety of its components and the necessary illumination, thermal (<140 K) and vacuum conditions (<10^{-5} mbar) to characterize the detectors in accordance with the requirements stablished by the MAJIS team. Figure 1 shows a schematic diagram of the setup. Since some parameters require different illumination conditions, beam uniformity, exposure time, and/or data acquisition procedure, three configurations were defined. The first one provides dark conditions thanks to the radiation shield (<190K) that surrounds the Focal Plane Unit (FPU) which rejects the thermal radiation coming from the vacuum chamber and the CaF_2 window. In configuration 2,

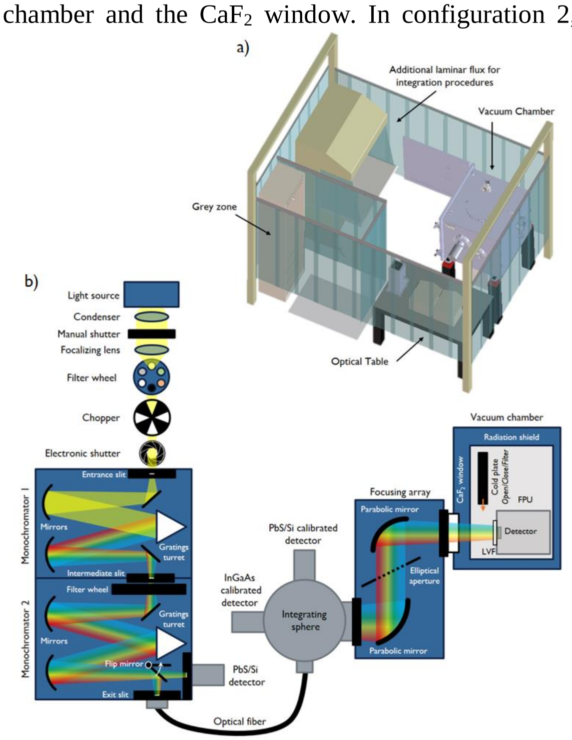

Figure 1: MAJIS VIS-NIR detectors characterization bench: a) schematic model inside the laminar flux, b) optical diagram of the facility at configuration 3.

the detector receives a uniform light beam coming from the monochromator through an integrating sphere. In this case, the radiation shield aperture changes to *open* position. The configuration 3 adds a collimating optical array that provides the necessary convergence beam to illuminate the detector through a Linear Variable Filter (LVF) installed in front of the detector, as it will be done in MAJIS instrument. The LVF is part of the FPU and is mainly used to reject the higher diffraction orders from the gratings.

Figure **2** shows the characterization measurements that will be performed. The persistence effect of the detectors will be measured by an additional configuration in which a cold Short-Wave Pass Filter (<190K) is combined to an electronic shutter to provide fast trigger (~42ms) from the high illumination to dark current level.

Additional features of the characterization facility include: calibrated detectors at different points of the optical path to monitor the intensity stability of the light beam, a N_2 flushing system to avoid the water vapor absorption at NIR wavelengths, several points for thermal control and temperature monitoring inside the vacuum chamber, a security system that avoids undesirable conditions that could damage the detector and its electronics, and the Optics Ground Support Equipment (OGSE) for the automatic operation of the calibration bench. The OGSE is synchronized with the Electric Ground Support Equipment (EGSE), which comprises the data acquisition software of the detectors. Figure **3** shows the described subsystems of the calibration bench.

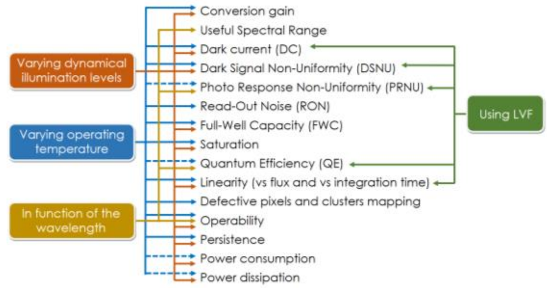

Figure 2: MAJIS VIS-NIR detectors characterization measurements.

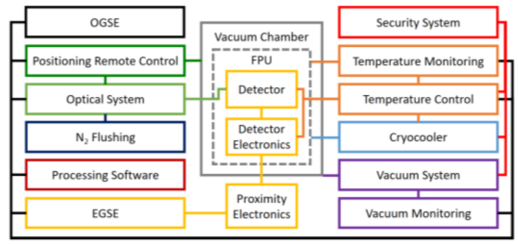

Figure 3: Subsystems of the MAJIS VIS-NIR detectors characterization bench.

3. Validation campaign

The Structural Model (STM) of the MAJIS VIS-NIR FPU was delivered by the Institute of Space Astrophysics (IAS, France) on March 2019. Subsequently, the thermal validation of the setup is performed. The copper straps that thermally connect the cold head of the cryocooler with the FPU baseplate and the radiation shield, will be adjusted in order to reach the stable target temperature in every component. The thermal control, monitoring and security systems will be tested. Later on, the Engineering Model (EM) detector will be delivered by IAS to optically validate the setup at the different configurations, as well as the data processing software, the Optics Ground Support Equipment (OGSE) system and the foreseen planning of measurements. It is expected to perform the characterization of the Flight Model (FM) and Spare Model (SM) VIS-NIR detectors during the second half of 2019.

4. Conclusions

This document describes the calibration bench developed at the IASB-BIRA facilities to characterize the MAJIS/JUICE VIS-NIR detectors and the foreseen objectives of the validation campaign.

Acknowledgements

This project acknowledges funding by the Belgian Science Policy Office (BELSPO) by PRODEX-11 Project Proposal: 'Characterization of JUICE/MAJIS VIS-NIR detectors', PEA 4000124255.

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