Calibration facility to characterize the MAJIS/JUICE VIS-NIR detectors

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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. Here we present a description of the facility developed during 2018 and the early 2019. The next step is to validate the calibration bench by using the Structural Model (STM) of the VIS-NIR Focal Plane Unit (FPU) and the Engineering Model (EM) of the VIS-NIR detectors.

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 calibration bench [3].

Description of the facility

The calibration bench to characterize the MAJIS VIS-NIR detectors guarantees the cleanliness and safety of its components and the necessary illumination, thermal ($\leq$140 K) and vacuum conditions ($\leq 10^{-5}$ mbar) to characterize the detectors in accordance with the requirements stablished by the MAJIS team. Figure 1 shows the measurements that must be performed to characterize the MAJIS VIS-NIR detectors.

The Flight Model (FM) and Spare Model (SM) detectors consist of Teledyne H1RG HgCdTe arrays of 1024 x 1024 pixels. The detector and its electronics will be harbored inside a mechanical structure called the Focal Plane Unit (FPU), which additionally will contain temperature sensors and heaters to monitor and control the temperature stability of its components, and a Linear Variable Filter (LVF) to remove parasitic light and to reduce the background/thermal noise coming from the spectrometer. The FPU will be surrounded by a radiation shield (<190K) to reject the thermal radiation from the

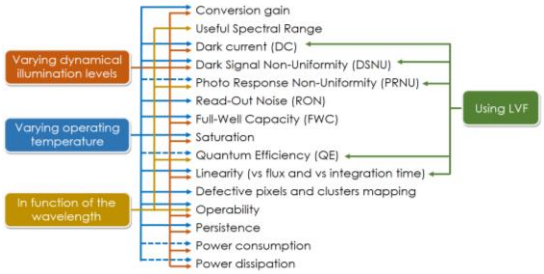

Figure 1. MAJIS VIS-NIR detectors characterization measurements.

internal walls of the vacuum chamber; it contains a translation stage to allow the entrance of light on the detector surface directly or through a cold Short Wave Pass Filter (<190K).

The stable tungsten light source of the calibration facility offers a continuum over the spectral range of MAJIS; it is mainly followed by a condenser and focalizing lenses, and a filter wheel to provide different optical densities of the uniform light beam. Then, the entrance light beam is directed to a dual output double monochromator, whose output is connected to an integrating sphere through an optical fiber. Since some of the parameters to be measured require different illumination conditions, three configurations were defined. Configuration 1 provides dark conditions to the detector and it is limited only to the radiation shield in close position. In configuration 2, the detector receives a uniform light beam coming from the monochromator through the integrating sphere. Configuration 3 adds a collimating optical array after the integrating sphere to provide the necessary convergence beam to illuminate the detector through the LVF, as it will be done in MAJIS instrument. Figure 2 shows a schematic diagram of the setup in Configuration 3.

Additional features of the 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.

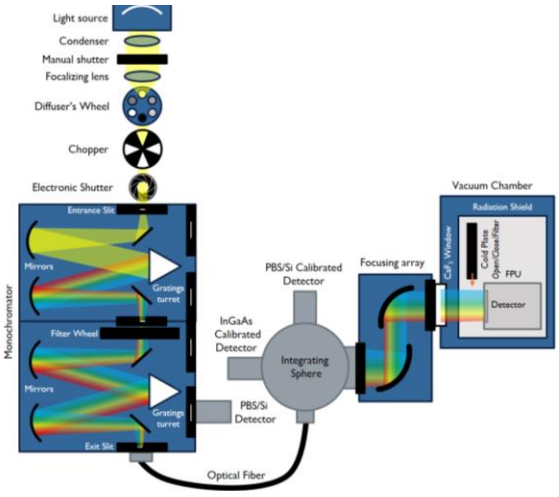

Figure 2. Optical diagram of MAJIS VIS-NIR detectors characterization facility.

Conclusions

A description of the calibration bench to characterize the MAJIS/JUICE VIS-NIR detectors is presented. We acknowledge funding from BELSPO by PEA 4000124255.

References

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