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JUICE/MAJIS on-ground calibration: challenges and setup design

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MAJIS is a hyperspectral imager onboard the ESA JUICE spacecraft bound to explore the Jupiter system, with a focus on its icy moons, due for launch in 2022. MAJIS will work with two optical channels, the VISNIR one ranging from 0.5 to 2.35 μm, and the IR one ranging from 2.25 to 5.54 μm. Such an extended spectral range will allow MAJIS to address many scientific goals which have been detailed by Y. Langevin et al in 2014 (LPSC abstract #2493).

Before launch, the fully integrated instrument will be fully calibrated at the Institut d'Astrophysique Spatiale (IAS, Orsay, France) test facilities. Previous missions have shown that geometric, spectral and absolute radiometric calibrations of the flight instrument are paramount for the future interpretation of its results. However, the expected pioneering performances of the instrument become a real challenge on ground calibration requirements. The main challenge is its high sensitivity to thermal radiation emission from the background at ambient temperatures, because of its LWIR cut-off at 5.54 μm. Other issues include the dearth of useful signal due to atmospheric absorptions and from the sharp drop of MAJIS optical efficiency in the channel overlapping region (2.25-2.35 μm).

To address these issues, we developed a calibration setup at IAS composed of a Thermal-Vacuum Chamber (TVC) which hosts the instrument, mounted on an hexapod for movements, and illuminated by an optical bench feeding it with the appropriate calibration light sources through a CaF2 window. The optical bench will feature traditional sources used for the calibration of this type of instrument such as a monochromator fed by two light sources to cover the entire spectral range, additional powerful light sources to assess straylight contributions, and mineral/gas samples as test science targets.

The setup will also include more specific solutions designed specifically for MAJIS. An additional flat-field blackbody IR source for radiometric calibration will be placed inside the TVC to overcome the thermal contributions from mirrors and lenses used at ambient temperature in the optical bench. For the same thermal emission reason, the whole instrument needs to be wrapped in a cold shield to cut down the emission from the 300 K TVC walls. The whole optical bench will be baffled, hermetically closed and flushed with gaseous N2 in order to diminish the contribution of atmospheric absorption bands below 1%. To cope with the overlapping region between both MAJIS spectral channels, we will use a custom Spectralon integrating sphere just in front of the TVC window. It will provide a stable and homogenous flux of very high intensity in VISNIR region up to 2.8 μm and in the IR range to ensure sufficient overlap in the knowledge of the instrument transfer function.

We will present at the conference the detailed justifications of the challenges raised by the calibration of MAJIS and the optical and thermal design we developed to overcome them.