INTEGRATION OF AN OPTICAL SETUP FOR THE CHARACTERIZATION OF NEAR-INFRARED DETECTORS USED IN SPACE AND GROUND BASED ASTRONOMY

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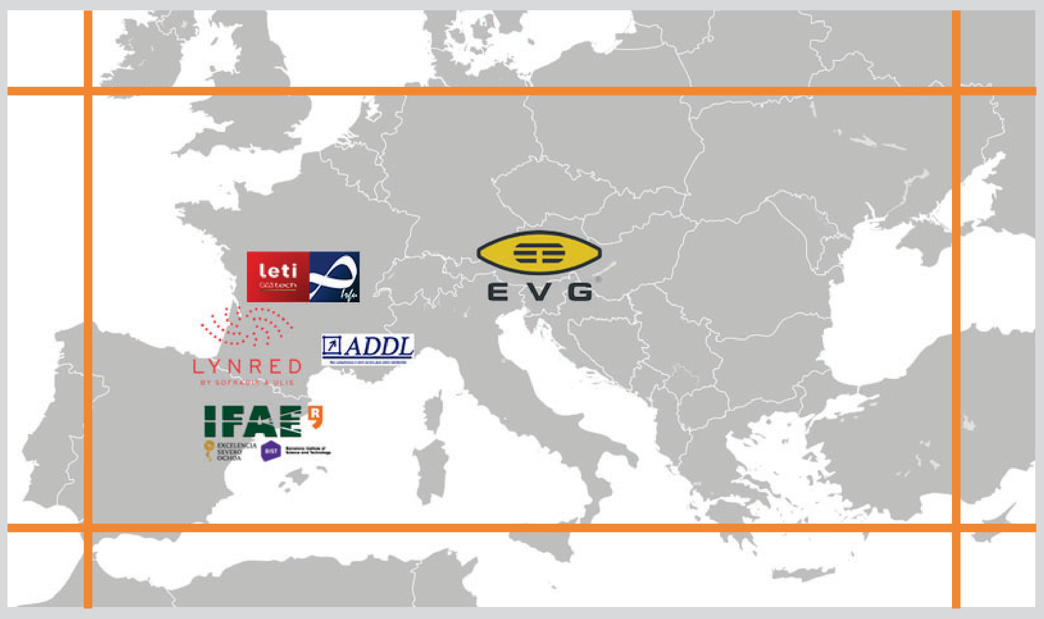
ASTRONOMY EUROPEAN INFRARED DETECTOR ASTEROID

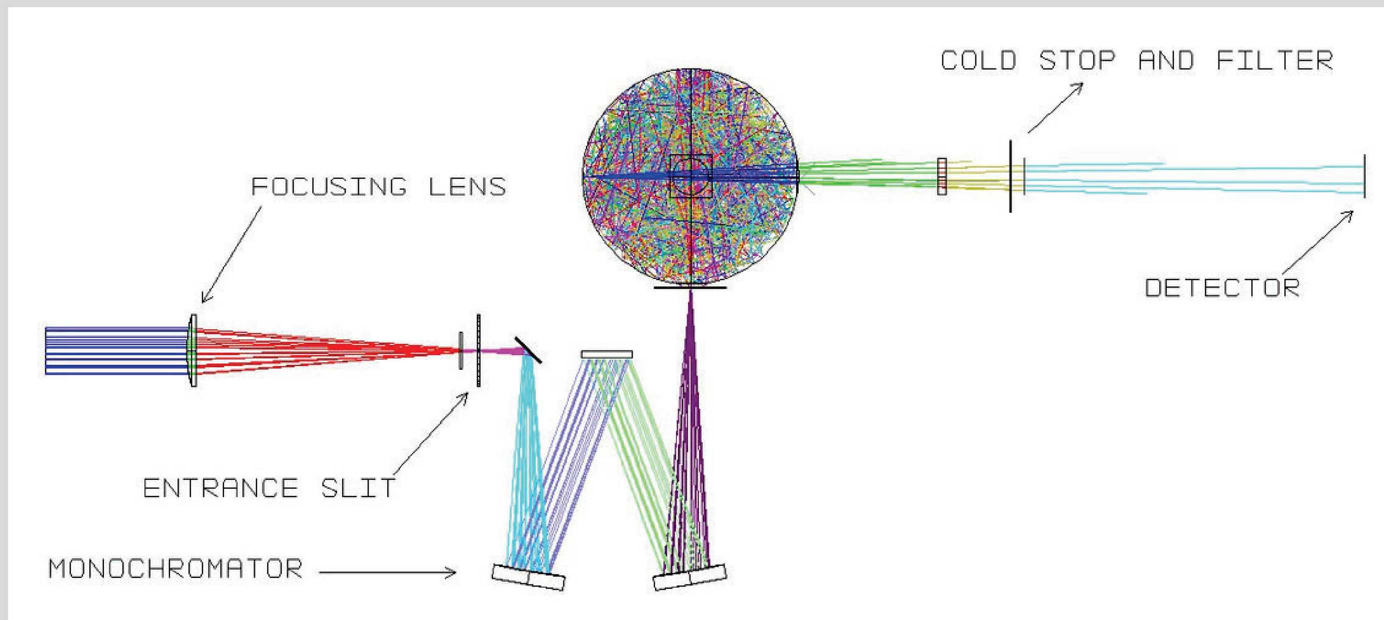
Introduction



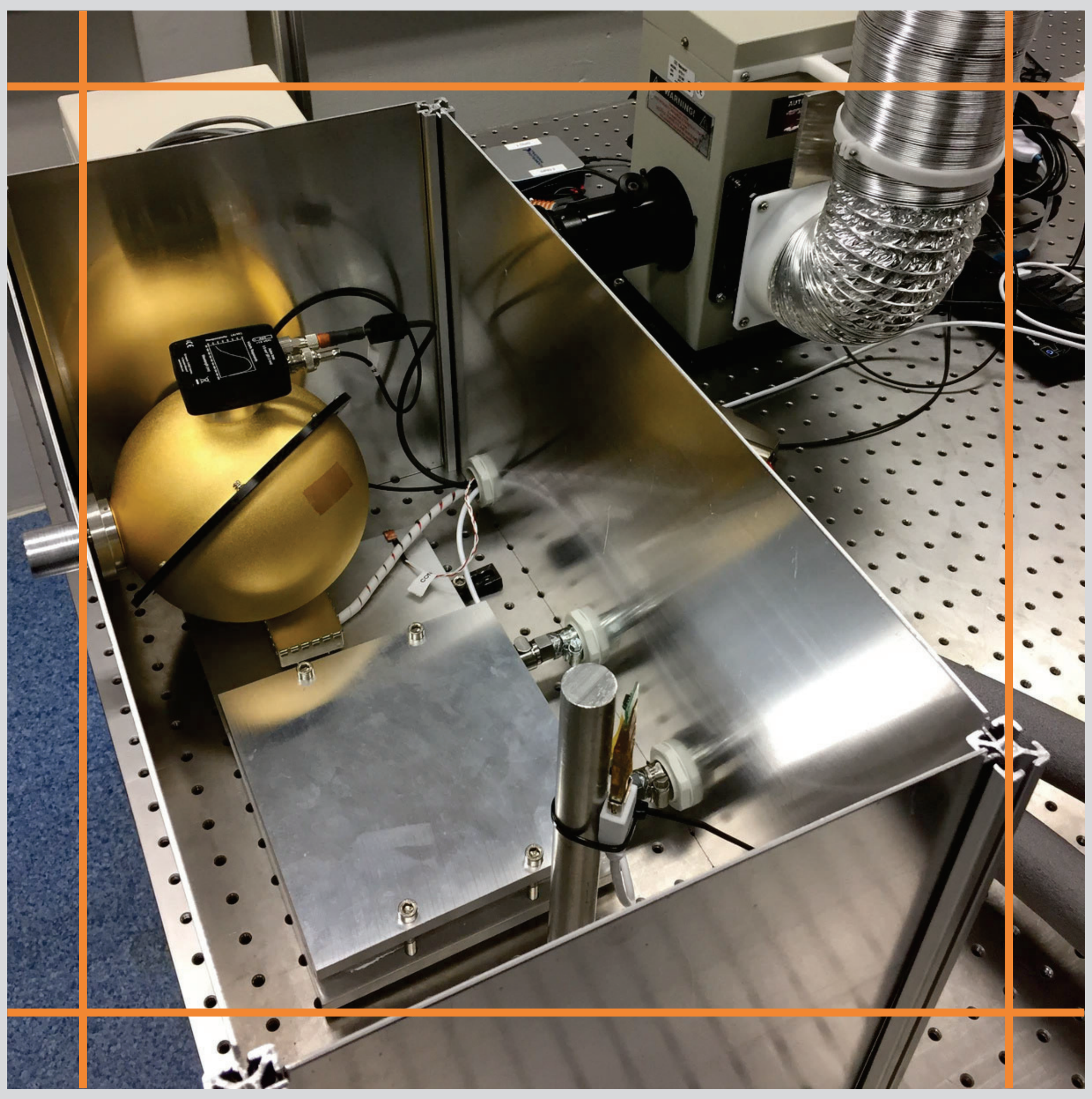
The *mercury-cadmium-tellurium* (MCT) alloy has been considered the best infrared detector material for space and ground-based applications, offering the highest performance with the current technology. Bearing this in mind, European Community has been funding several projects to get expertise in the development of large MCT focal plane arrays (FPAs). The Astronomy European Infrared Detector (ASTEROID) project is the current flagship to fully design and mass-produce a NIR (near-infrared) detector of 2k×2k pixels with 15 µm pitch. The project is funded by a H2020- COMPET grant and led by key research institutions (CEA-Leti, CEA-IRFU and IFAE) and industrial partners (Lynred, EVG and ADDL) with the common goal of providing Europe the know-how to be self sufficient on this technology.

Optical Path

To perform the characterization of the ASTEROID detector, an optical setup has been developed at the IFAE optical laboratory, with the capability to measure the main performance parameters of a detector: the dark current, linearity, full well, readout noise, quantum efficiency, and pixels' operability. This custom setup, which optical path is represented in the figure on the right, composed of a quartz–tungsten–halogen (QTH) lamp source that feeds a F#4 Czerny–Turner monochromator with its slits adjusted to yield a bandwidth of 0.01 µm . The monochromatic light is generated through two grating elements with a blaze wavelength at 1.2 and 2.0 µm , both with a groove density of 300 g/mm, providing a total dispersion of 0.019 µm /mm.

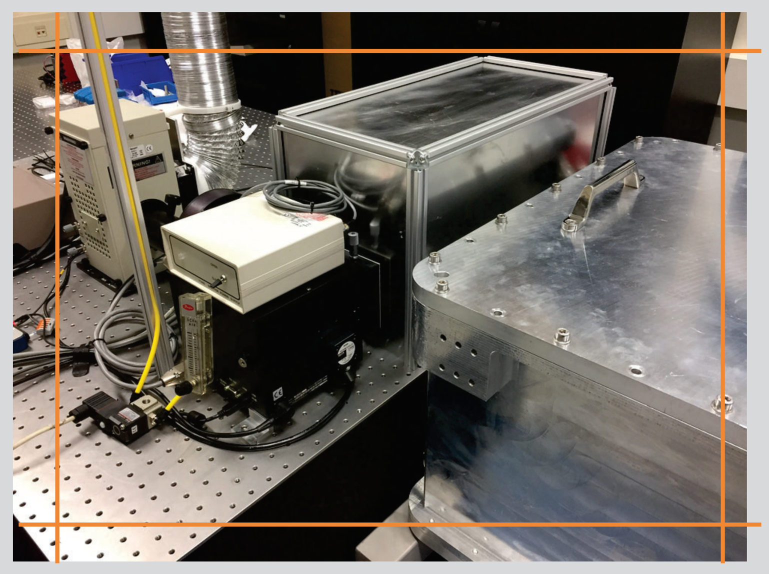


Optical Setup

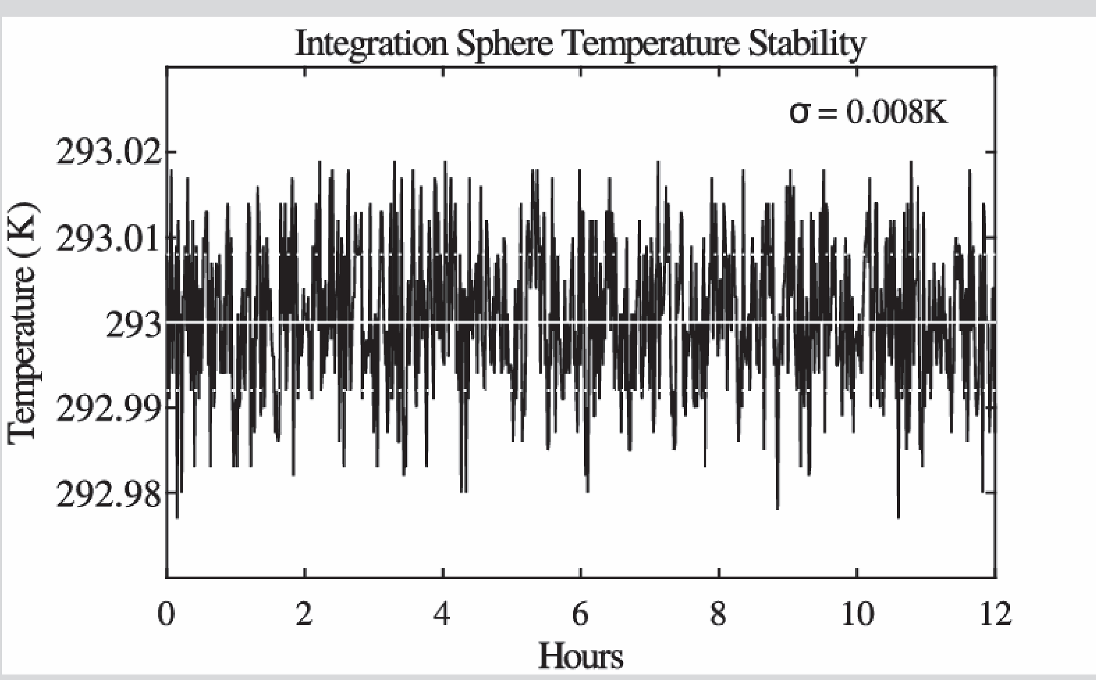


The integration sphere is equipped with three ports: 0°, 90°, and north–pole, where the last port holds an InGaAs photodiode used as a reference for the irradiance fluctuations. As shown in the figure on the left, the integration sphere resides inside an aluminum box used as a radiation shield. The box and the complete optical path are filled with nitrogen gas that is used to displace the atmospheric air to avoid water absorption in the NIR/SWIR region, which attenuates the J, H, and K astronomy bands.detector steady state regime.

Afterward, the integration sphere output is directly attached to the cryostat, which is containing the detector to be characterized.



Integration Sphere



The integration sphere temperature is controlled by a closed-loop proportional–integral–differential (PID) controller. As shown in the figure on the left, a relative error of σ≤0.008K is reached and statistically calculated by the standard deviation of the temperatures along 12 hours. Such temperature stability reduces the thermal radiation drift coming from its shell as a result of a "black body" behavior, despite the very low emissivity of the gold-coating. A temperature error of 0.008 K in the wavelength band from 0.8 to 2.5 µm corresponds to a total band radiance background of 8.2 nW/m2 and from 0.8 to 1.8 µm of 6.8 pW/m2 .

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