



Marie-Laure Hellin
Yvan Stockman
Thierry Chantraine
www.csl.ulg.ac.be

Centre Spatial de Liège

Workshop EISC – 25/03/13

PROBA V Instruments Calibration and Tests

LIEGE Science Park
Av. Pré Aily
4031 Angleur - Liège



- CSL is an applied Research Center of the University of Liège created in 1959 and located in the Liège Science Park.
- Active in space instruments (observation) and space systems engineering since the 60's, CSL is recognized worldwide as an Optics Center of Excellence.
- CSL operates a comprehensive Space Environmental Test Center equipped to test instruments and structures up to 6 meters diameter in ultra clean conditions.
- CSL employs 90 highly skilled employees including 60% of Engineers, Master of Science and PhD's



- Earth Observation instruments on board of small satellites are more and more ambitious.

Typically, PROBA V payload has to ensure the continuity of Vegetation Instruments (on board of SPOT 4 & 5), with the same data precision but with an overall mass of about 30 kg, instead of the 130 kg of the actual ones.

Upsizing the performances while downsizing the payload lead to a real challenge :

The calibration campaign requires a high level of accuracy, with a reduced level of cash.

- The instruments (manufactured by OIP) is composed of three TMA telescopes, each of them containing 4 spectral bands (VNIR & SWIR). Those multispectral imagers are assembled in order to ensure a comprehensive 102° field of view.

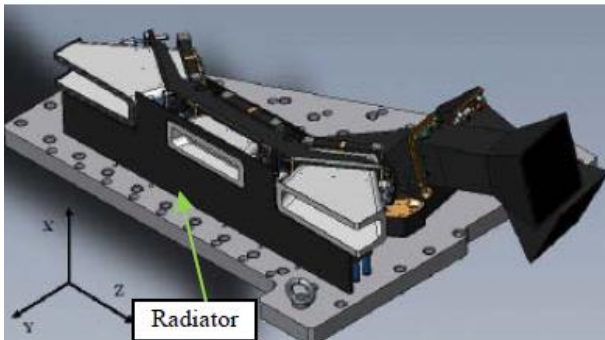
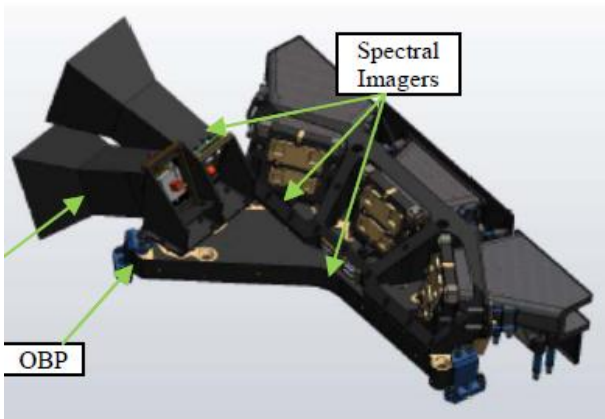


Figure 2. Concept of the PROBA V instrument

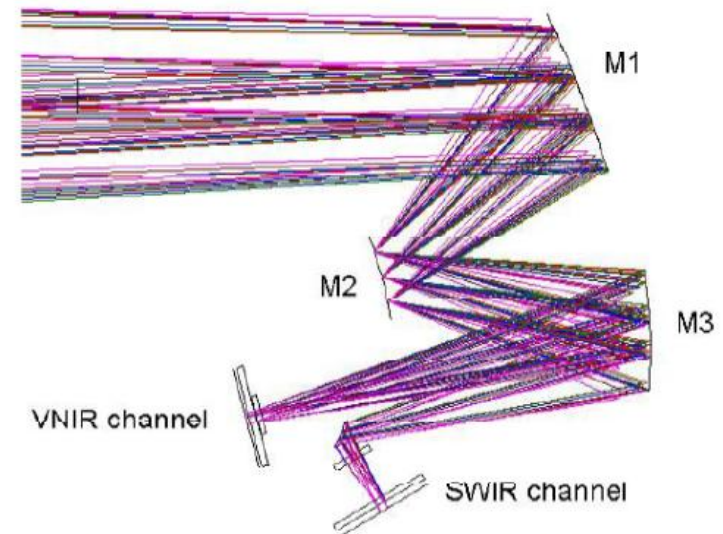
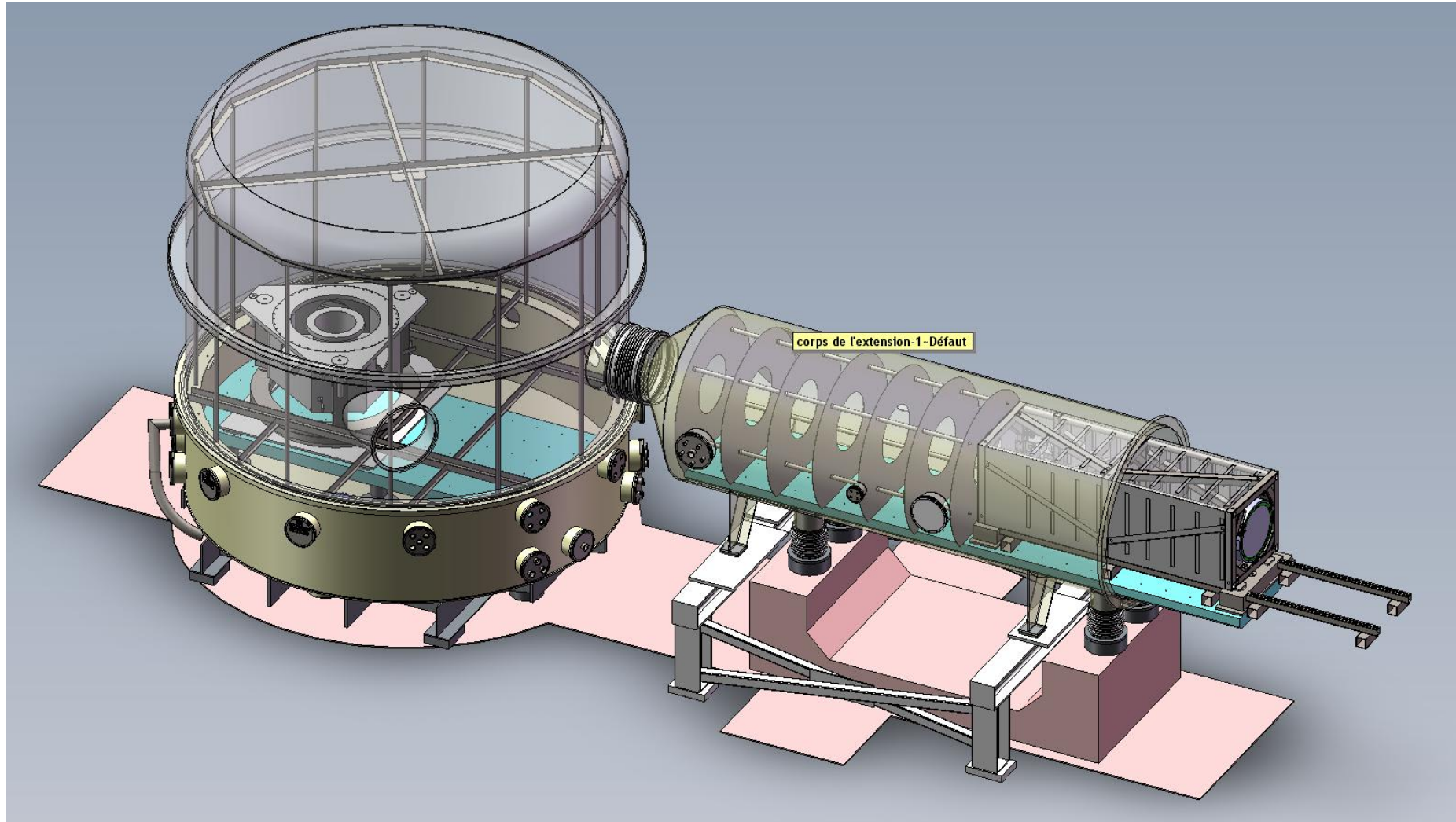


Figure 1. Optical design of the PROBA V TMA

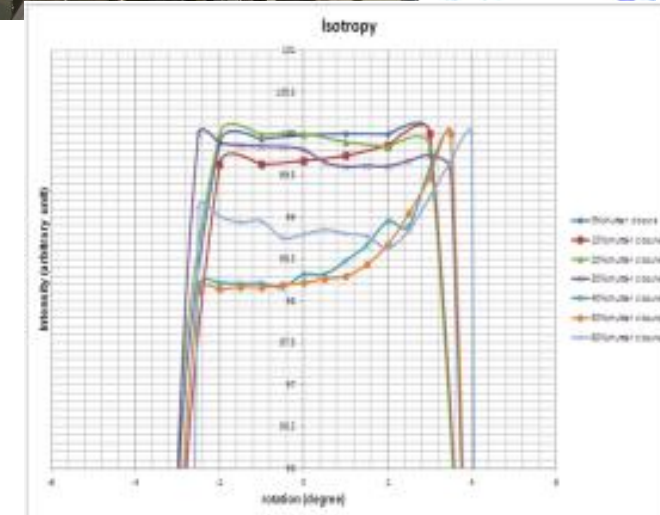
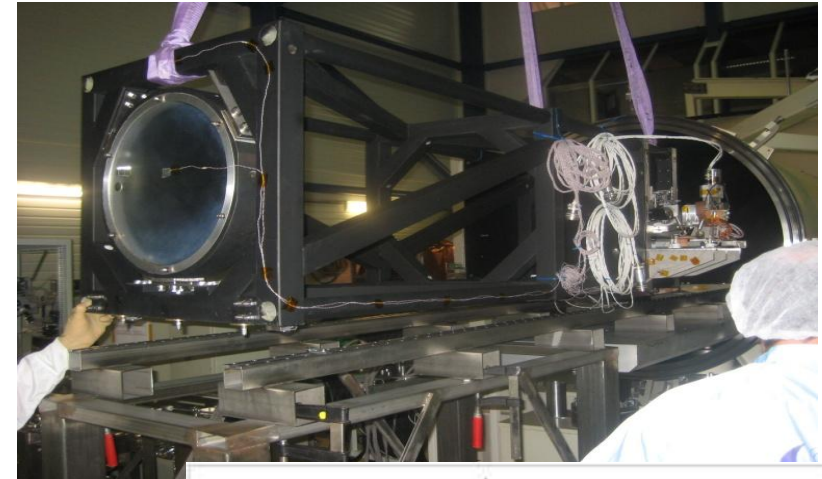
The optical design of the PROBA-V telescopes involves only reflective elements assembled in a TMA telescope which allows a significant reduction of mass and complexity for a multispectral imager with a wide field of view. However the mirrors are off-axis and aspherical bringing manufacturing and alignment difficulties.



- The facility needs to address the geometrical and radiometric calibration of the payload in ultra-clean environment (ISO 4).

To achieve this, a 400 mm clear aperture off axis collimator with a dedicated focal plane was developed for the geometrical calibration and a 300 mm integrating sphere calibrated was used for the radiometric calibration. To access all the Field Of View, the payload was placed on a rotating tip tilt table allowing rotation of $\pm 180^\circ$ for across track Field Of View scanning and $\pm 10^\circ$ for along track scanning. The payload was surrounded by thermal shroud to provide the required thermal environment **(-40° to 60°C)**.

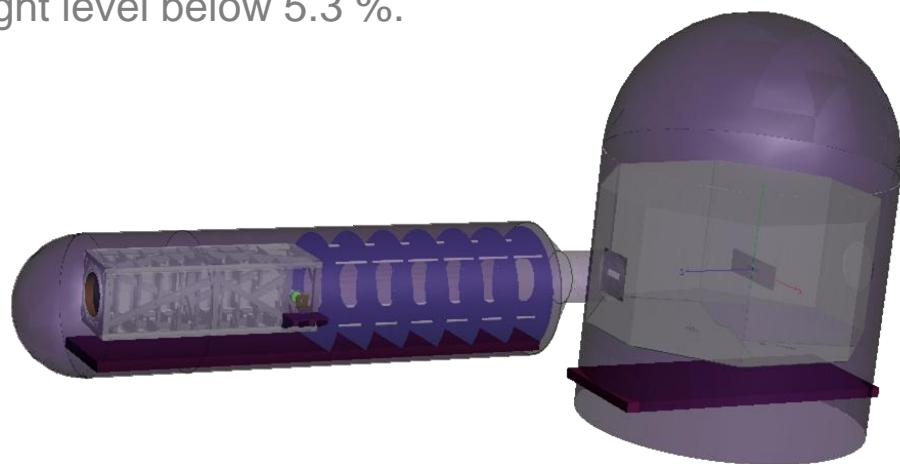
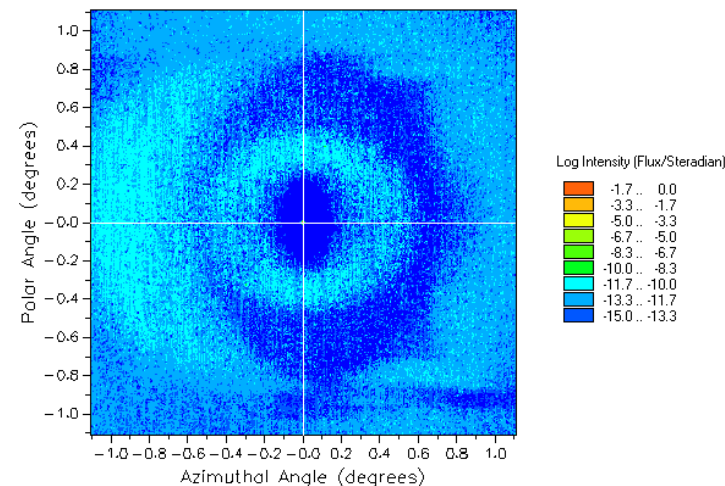
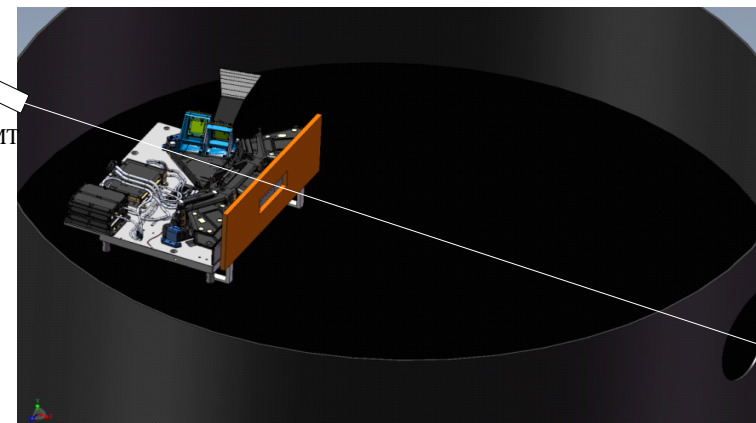
The calibration process requested almost two weeks under vacuum.



- In addition of the calibration campaign, CSL performed **the Stray Light analysis** of the Proba V instrument.

The purpose of this analysis is to avoid out-of-field stray light on the detectors coming directly or through reflections on the mirrors. The possible stray light by reflection, transmission or scattering on the SWIR folding mirror has also been studied.

Through this analysis, CSL was able to recommend specific adjustments allowing a reduction of the stray light level below 5.3 %.





- The increasing performances of compact satellites and instruments leads to new challenges.
- One of the most critical is the ability to perform a highly precise calibration with a reduce amount of time and money.
- Proba V experience highlighted the capability of Belgian industry to achieve this goal. It stands on a large range of competences and skills available in Belgium in the domain of small sats.
- CSL is part of this team and strongly support the Belgian strategy in this matter.

THANKS FOR YOUR ATTENTION