Advanced CubeSat Attitude Determination and Control: Towards arc second range pointing

Commercial players in the CubeSat Earth observation market are emerging and Astronomy researchers are starting to recognize the advantages of these small platforms as well. As a result, there is a demand for ever more accurate CubeSat attitude determination and control systems.

At KU Leuven, we have developed a 0.5U ADCS (95x91x50 mm^3) that fits on the CubeSat stack and gives high accuracy attitude determination and pointing performance to CubeSats. This ADCS was developed within the ESA IOD mission SIMBA and has been thoroughly tested, both functionally as environmentally.

The ADCS contains a set of sensors, of which the star tracker is the most accurate. This star tracker uses in-house developed algorithms that are specifically aimed at low-cost platforms. They are highly robust to disturbances in the image and have a low computational cost. As the star tracker was built using commercial of the shelf components, certain design and calibration actions needed to be taken to ensure the reliability and accuracy of the system.

Three in-house developed reaction wheels are the main actuators within the ADCS. Reaction wheels have been known to end a satellite's operational lifetime. Accelerated lifetime tests in thermal vacuum were carried out to qualify our reaction wheels for a period of more than 6 years, longer than a typical CubeSat mission lifetime.

The ADCS alone can control the spacecraft up to an absolute pointing accuracy of around 0.1 degree (1 sigma). High resolution Earth observation missions and Astronomy missions require an accuracy that is an order of magnitude better. In order to achieve this, we are designing – and have built – a High Precision Pointing Platform (HPPP). This system uses a fast steering mirror in the optical train of the payload to compensate for (high frequency) disturbances. The payload measurement or a dedicated fast guidance sensor is used to measure the disturbances.

In the presentation, we will present the overall ADCS architecture and will highlight the in-house developed technology that leads to the high accuracy performance of our system. The test and calibration campaign will be briefly discussed. Next to that, we will present the High Precision Pointing Platform and show first results.

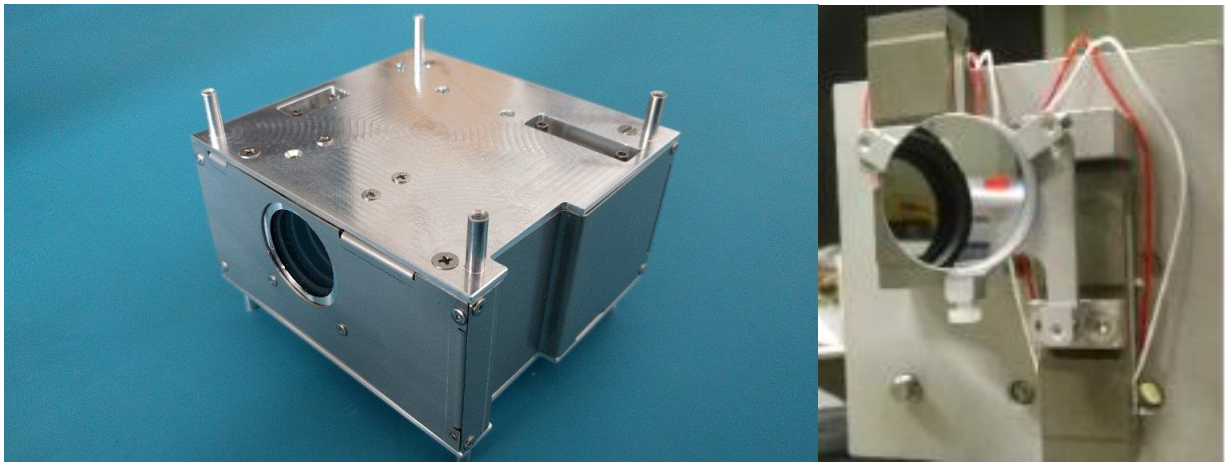

Figure 1 (left) The flight model ADCS for the SIMBA mission. (right) The fast steering mirror of the HPPP prototype.

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