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### Title

## The nanosatellite-class attitude control facility at ESA-ESTEC

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### Abstract

As the number of nanosatellites in orbit is rapidly growing, there is a strong interest in enhancing the reliability of such miniaturized platforms. The CubeSat standard, in particular, is becoming increasingly popular also at ESA, which currently provides technical and financial support for a wide range of technological and scientific missions. Some of these missions, however, suffer failures and/or need prolonged commissioning campaigns to resolve issues with the attitude determination and control system (ADCS) in orbit. A potential mitigation is to provide a verification and validation facility that can truly support a ‘test-as-you-fly’ philosophy [1].

In this work, we describe the joint effort undertaken by the University of Bologna and NautiluS - Navigation in Space, under ESA coordination and funding, towards developing one such facility to be installed at the AOCS Verification Laboratory in ESTEC. The envisaged facility intends to enable the verification of closed-loop attitude control with physical sensor stimulus and physical effects from the actuators driving the dynamics. By testing nanosatellites in such an environment, it is expected to catch issues not identified in other testing due to the compressed verification campaign typical of the so-called New-space approach.

The ongoing project relies on the experience gathered through a heritage facility developed in the past five years at the  $\mu$ 3S Laboratory at the University of Bologna. At the core of the heritage facility, which allows for testing ADCS of CubeSats in the range from 1U to 3U, is an articulated stand equipped with a table-top air-bearing platform whose function is to hold the mock-up under test and enable an almost frictionless rotational motion. Other subsystems include a Helmholtz cage for geomagnetic field simulation, a Sun simulator, and an in-house developed vision system for ground-truth attitude measurement [2].

The newly designed facility will improve upon its predecessor from several points of view, among which:

- a wider range of CubeSats is supported for testing, from 1U to 12U, allowing them to be placed on the rotating platform in any orientation and ensuring, at the same time, semi-automatic balancing capability;
- the Sun-lamp beam orientation can be adjusted from the overhead position to the horizontal position for testing orbital configurations with solar beta-angles from 0° to 90°.
- Adaptation of the Sun-lamp to enable stimulation of sensors and solar panels (and associated electrical currents / magnetic fields) at 1 solar constant as well as an additional lamp for Earth albedo emulation.
- a higher accuracy ground-truth system is foreseen, featuring star-tracker measurements emulation.

The project, which is currently in its design phase, is expected to end in December 2023 with the delivery and commissioning of the facility at ESTEC premises. An acceptance test campaign will also be performed, to ensure that the system meets its expected performance requirements. Eventually, the new facility will hopefully serve as a key tool to enhance the success rate of the next-generation ESA-led CubeSat missions.

The presentation will report on the project’s status and detail the main design choices adopted to fulfill its objectives.

**References**

- [1] European Space Agency, (2022). 3DOF Attitude Control Air Bearing Facility. Statement of Work ESA-TECSAA-SOW-2022-002591.
- [2] Modenini, D., Bahu, A., Curzi, G. and Togni, A. (2020). A Dynamic Testbed for Nanosatellites Attitude Verification. *Aerospace*. MDPI AG, 7(3), p. 31. doi: 10.3390/aerospace7030031.