AstroBio CubeSat: a mini laboratory payload for space environment astrobiology experiments

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Abstract

AstroBio CubeSat (ABCS) will be a 3U CubeSat to be launched with the Vega C launch system, operated from the Guiana Space Center in 2020. The CubeSat will host a mini laboratory payload based on an innovative lab-on chip technology suitable for research in the life sciences, biotechnology and pharmaceutical technologies sectors. The objective of the project is to test in space environments an automatic laboratory able to provide a highly integrated in-situ multiparameter platform that uses immunoassay tests exploiting chemiluminescence detection.
ABCS will be launched at an altitude of 5900 km and the in-orbit validation of the proposed technology would represent a significant breakthrough for autonomous execution of bio-analytical experiments in space with potential application in planetary exploration for biomarkers detection, astronauts' healthcare, space stations' environmental monitoring and more.

The perform the experiment, a paper-based later flow device will be used. The paper-based support will contain:

- biomolecules immobilized in specific test areas (i.e., enzyme in experiment 3, antibody in experiment 4, see the experiment list below);
- chemicals deposited in a non-permanent fashion and in a dry form in the initial part (starting area) of the microfluidic path (e.g., luminol and potassium ferricyanide): when the reagents-delivery-system provides a volume of a reagent or sample in the liquid form to the starting area, capillary forces will capture the liquid reagents and force them to

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flow along the paper-based microfluidic pathway. During the flow, liquid reagents will solubilize and transport along the path the deposited reagents, thus triggering specific reactions.

As photon emission signals are recorded as a result of correct experiment execution, a photosensor will always be present in correspondence of each test area to detect the chemiluminescence reaction.

The experiments will aim at evaluating:

- the functional tests of the device (delivery of reagents, mixing of chemicals, detection of emitted photons, electronics, data storage and transmission);
- the stability of chemicals and biomolecules employed in the experiment and necessary for performing bioassays (e.g., immunoassays exploiting chemiluminescence detection) in space conditions for astrobiological investigations.

One of the he most critical issue of the Vega-C maiden flight mission profile is the final orbit in which the secondary payloads will be released. The orbit will be at an altitude of about 5900km and will be approximately circular (e=0). ABCS will spend a significant part of the orbital period within the internal Van Allen belt, close to its maximum. In order to guarantee ABCS operation for the time required to perform the payload experiments, a shielding structure will be integrated in the satellite structure.
In this work an overview of the main aspects of the experiment and payload definition of ABCS is presented.