29th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Satellite Missions Global Technical Session (9-GTS.5)

Author: Dr. Paolo Marzioli
Sapienza University of Rome, Italy, paolo.marzioli@uniroma1.it

Mr. Sidhant Kumar
Sapienza University of Rome, Italy, sidhantkumar99@gmail.com
Ms. Michela Boscia
Sapienza University of Rome, Italy, michela.boscia@gmail.com
Mr. Alessandro Moretti
University of Rome "La Sapienza", Italy, moretti.ale1992@gmail.com
Mr. Diego Amadio
Sapienza - University of Rome, Italy, amadio.1200335@studenti.uniroma1.it
Mr. Lorenzo Frezza
Sapienza University of Rome, Italy, lorenzo.frezza@uniroma1.it
Mr. Federico Curianò
Sapienza University of Rome, Italy, fcuriano@gmail.com
Dr. Luca Gugliermetti
ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Italy, luca.gugliermetti@enea.it
Dr. Luca Nardi
ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Italy, luca.nardi@enea.it
Dr. Antonio Pannico
University of Naples "Federico II", Italy, antonio.pannico@unina.it
Prof. Stefania De Pascale
University of Naples "Federico II", Italy, robertorenis@hotmail.com
Dr. Marta Del Bianco
Italian Space Agency (ASI), Italy, marta.delbianco@asi.it
Ms. Silvia Mari
ASI - Italian Space Agency, Italy, silvia.mari@est.asi.it
Dr. Fabrizio Piergentili
Sapienza University of Rome, Italy, fabrizio.piergentili@uniroma1.it

MICROGREENS GROWTH TESTS AND SPACE QUALIFICATION FOR THE GREENCUBE CUBESAT CULTIVATION LABORATORY

Abstract

The need of developing and testing autonomous cultivation units for space use is increasing due to the future manned interplanetary missions which require life support and advanced nutrition systems. The GreenCube mission aims to demonstrate the possibility to cultivate edible plants in space conditions, using a technological and autonomous cultivation system allocated inside a 3U CubeSat. The payload is 2U CubeSat unit (20x10x10 cm) cultivation laboratory, and the remaining unit is allocated for the satellite

bus. The in-orbit experiment will be conducted with an on-ground replica to analyze and compare the data and the results. This mission has been designed and developed by a group of Italian researchers of the S5Lab (Sapienza Space Systems and Space Surveillance Laboratory) from Sapienza University of Rome, in collaboration with ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development), the University of Naples Federico II and coordinated by the Italian Space Agency (ASI). The GreenCube satellite has been selected, by the European Space Agency (ESA), for a free launch opportunity on the maiden flight of Vega-C which will take the experiment to a MEO circular orbit, at an altitude of 6000 km, in mid-2022. The cultivation system implements reduced cost, fast prototyping technologies, which are aiming at guaranteeing the growth of the microgreens through a constant monitoring of the plant status, achieved using different typologies of sensors controlling the environmental condition, and a series of actuators providing control over the environmental parameters and watering system. The reliability and validation of the system technology has been proven through more than ten functional tests conducted with different set-up, leading to a "ready to fly" system. The test campaign led to a better understanding of the criticalities that can occur during the assembling of the payload and testing for space qualification, requiring a high level of accuracy during the test operations and a deep knowledge of the involved facilities. If the GreenCube mission has a successful outcome, the developed technology will allow a direct access to cultivation system in space, thanks to the possibility of replication, guaranteed by the utilization of Commercial-Of-The-Shelf (COTS) components, and integration on future CubeSat missions. In this paper, the innovative technologies applied to the cultivation system and to this peculiar mission concept and design are analyzed, focusing on the operative methods of the functional tests and the lessons learned.