AcubeSAT: A lab-on-a-chip CubeSat mission from the Aristotle University of Thessaloniki
The “Dangers of Space”

1. Radiation (Mutations) 4. Hostile Environment
2. Distance from Earth 5. Isolation
3. Gravity

NASA, Human Research Program

16/10/2019
Space Physiology

Demontis et al., *Front. Physiol* 2017
Williams et al., *CMAJ* 2009
NASA’s Twin Study

Garrett-Bakelman et al., Science 2019
Previous Nanosat Missions

NASA Ames leads the Agency in Cubesat/Nanosat missions
Mission Goals

• Probing the regulation of gene expression in microgravity and radiation environment
• Acquisition of high-throughput data
• Long-term observation of studied cells
• Develop and demonstrate a modular platform for space biology research on CubeSats
The Mission

- Methods used:
  - Fluorescent microscopy.
  - Microfluidics device.
- Map in real-time and in an unprecedented high-throughput fashion the cellular responses of *S. cerevisiae*.
Experimental Setup
Microfluidic Chips

The multiplexor architecture

Microfluidic Chips


Space Biodisplay
Microfluidic Chips
Fluorescent Microscope
The Team

35 members
Fields of study:
• Electrical Engineering
• Mechanical Engineering
• Electronic Engineering
• Medicine
• Physics
• Computer Science
• Biology
Physical Architecture

16/10/2019
Attitude Determination and Control

• Actuators:
  - Three Magnetorquers
  - One Reaction Wheel for antenna pointing

• Sensors:
  - Magnetometer
  - Gyroscope
  - Fine Sun sensor
  - GNSS Receiver

• The software will be implemented by the team.

Source: ISIS
Communications

- TT&C frequency: 435-438 MHz
- Science data frequency: 2.4-2.45 GHz
- Data rate: ≈250 kbps, capable of image transmission from SU.
- Deployable turnstile antenna for TT&C on the +Z face.
- Patch antenna to be used to retrieve the images of the scientific mission.
- GS to be constructed within AUTH campus.
- SatNOGS Comms Board

https://gitlab.com/acubesat/comms
Electrical Power Supply

- Analog circuits to increase redundancy, minimal software
- Solar panels on all available areas of the 3U CubeSat (Each face ≈ max. 7W)
- High power demands by many subsystems
- GOMspace Battery Pack

16/10/2019
On-board Data Handling

- STM32L4 microcontrollers, for all basic operations and calculations
- 32-bit ARM Cortex-M architecture
- Software: C++ on the FreeRTOS operating system.
- Protection from radiation: internal and external watchdogs, parity-checked RAM and current limiters.
- MRAM (Radiation tolerant RAM)

https://gitlab.com/acubesat/obc
• Ongoing dynamic and static analyses of the 3U EnduroSat frame and pressurized vessel.

• A full scale thermal analysis is underway. Need for insulation because of:
  - Sensitive components with narrow temperature operational range.
  - The scientific payload, which must not exceed a certain temperature.
Trajectory

- Completed mission analysis for a deployment from the ISS (duration range 4-18 months).
- Compliant with all space debris regulation.
Mentoring - Sponsors
Contact information

Prof. Kyros Yakinthos kyak@auth.gr

Prof. Alkis Chatzopoulos alkis@ece.auth.gr

Project Leader
Giannis Kotsakiachidis ioankots@ece.auth.gr