Aristotle Space & Aeronautics Team

A.S.A.T.

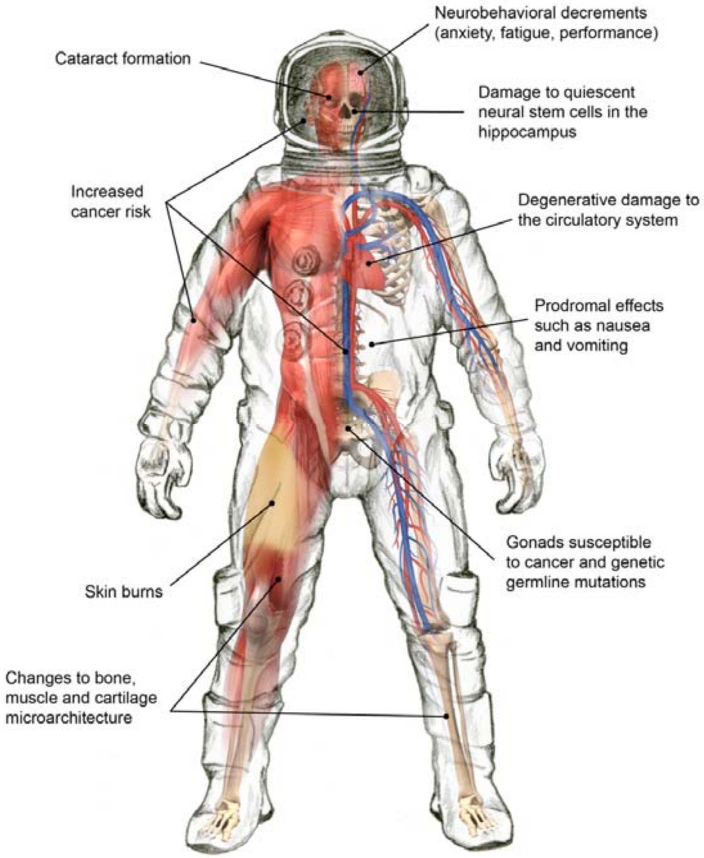
AcubeSAT: A lab-on-a-chip CubeSat mission from the Aristotle University of Thessaloniki

The “Dangers of Space”

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

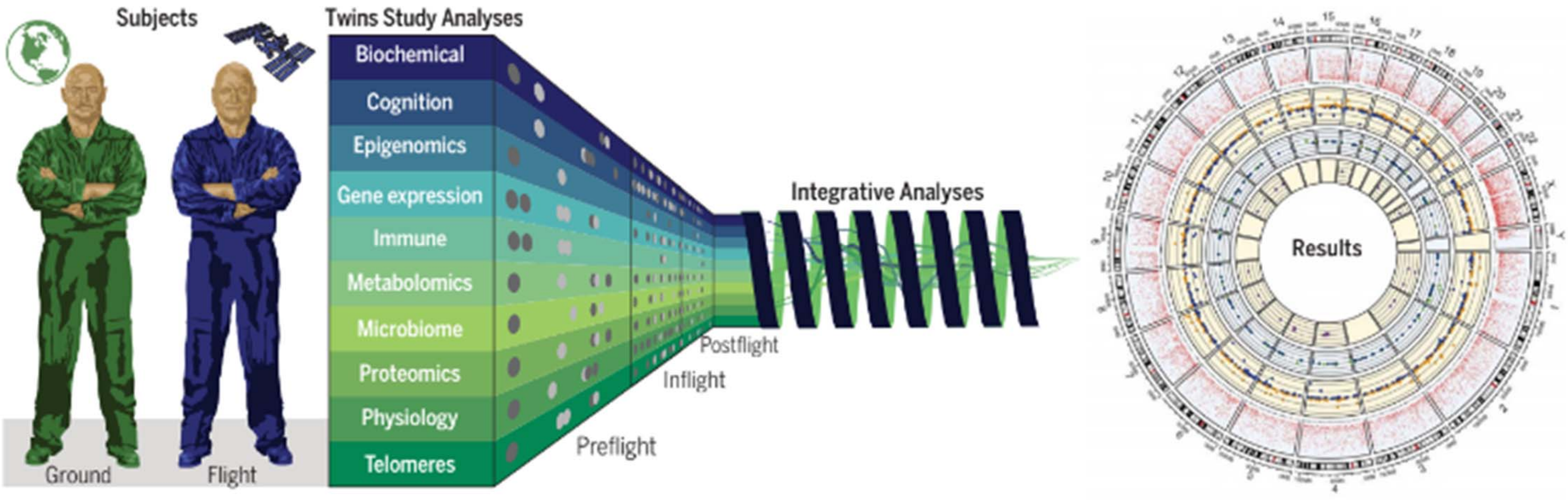
NASA, Human Research Program

Space Physiology



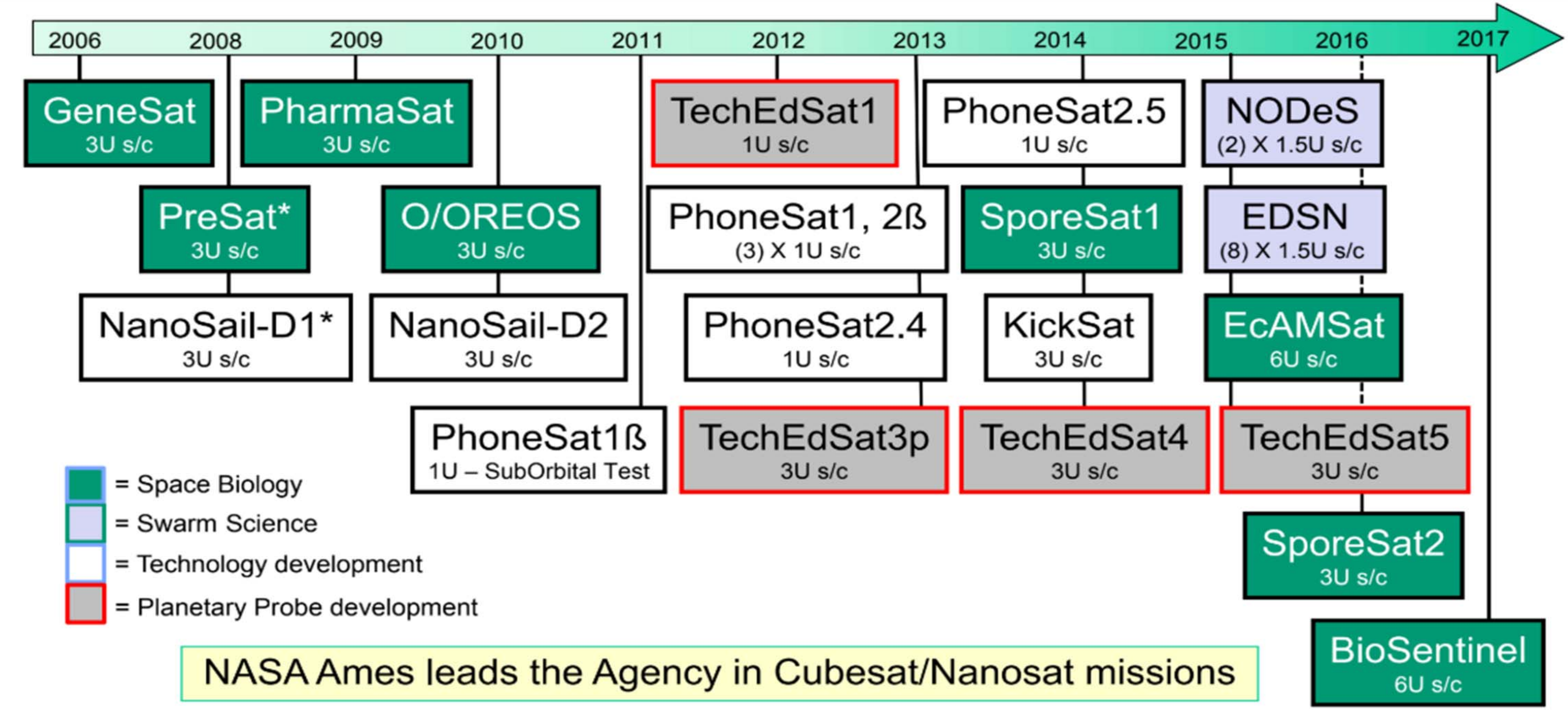
Demontis et al., *Front. Physiol* 2017
Williams et al., *CMAJ* 2009

NASA's Twin Study



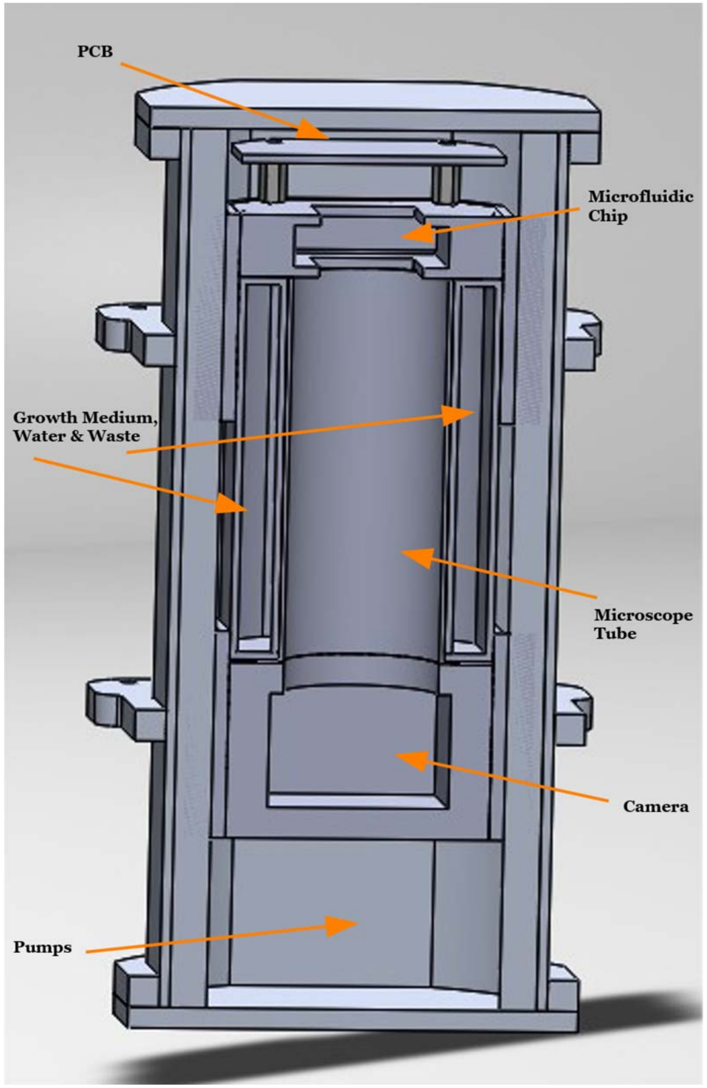
Garrett-Bakelman et al., *Science* 2019

Previous Nanosat Missions



Mission Goals

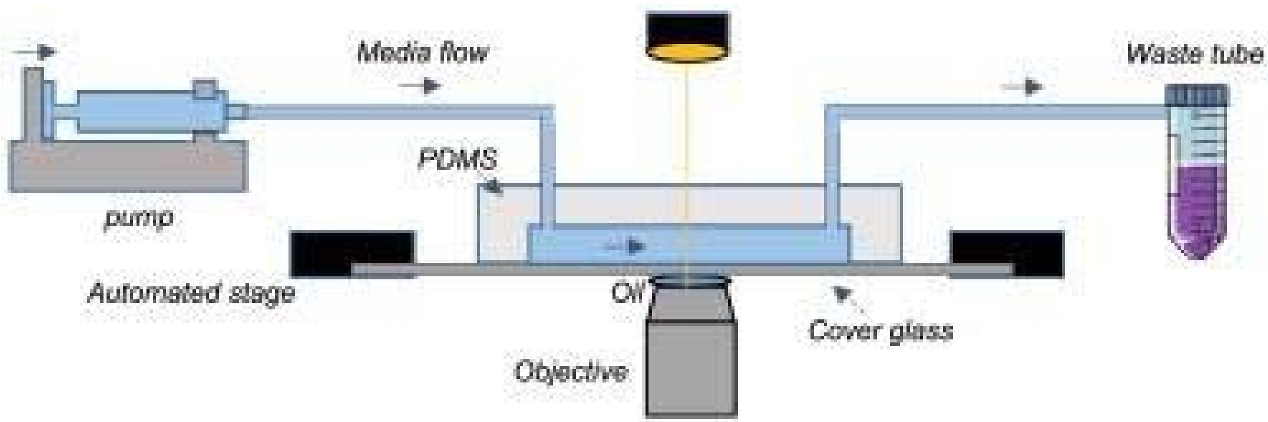
- Probing the regulation of gene expression in microgravity and radiation environment
- Acquisition of high-throughput data
- Long-term observation of studied cells
- Develop and demonstrate a modular platform for space biology research on CubeSats



The Mission

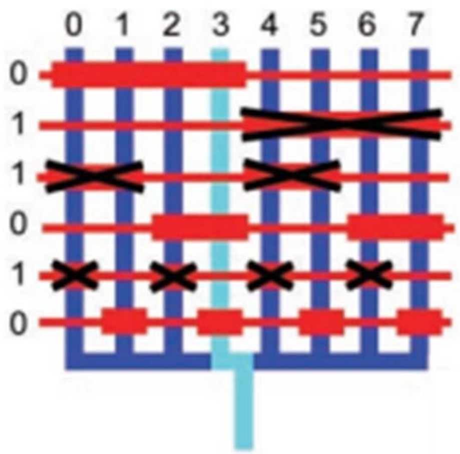
- Methods used:
  - Fluorescent microscopy.
  - Microfluidics device.
- Map in real-time and in an unprecedented high-throughput fashion the cellular responses of *S. cerevisiae.*

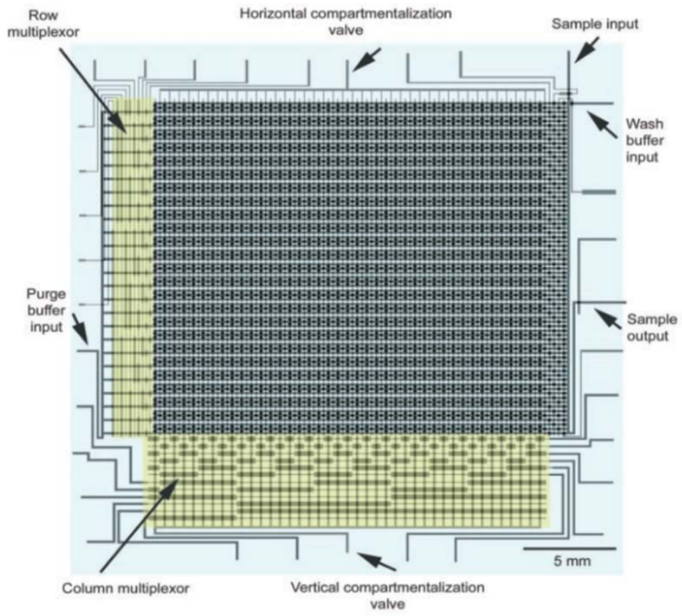
Experimental Setup



Microfluidic Chips

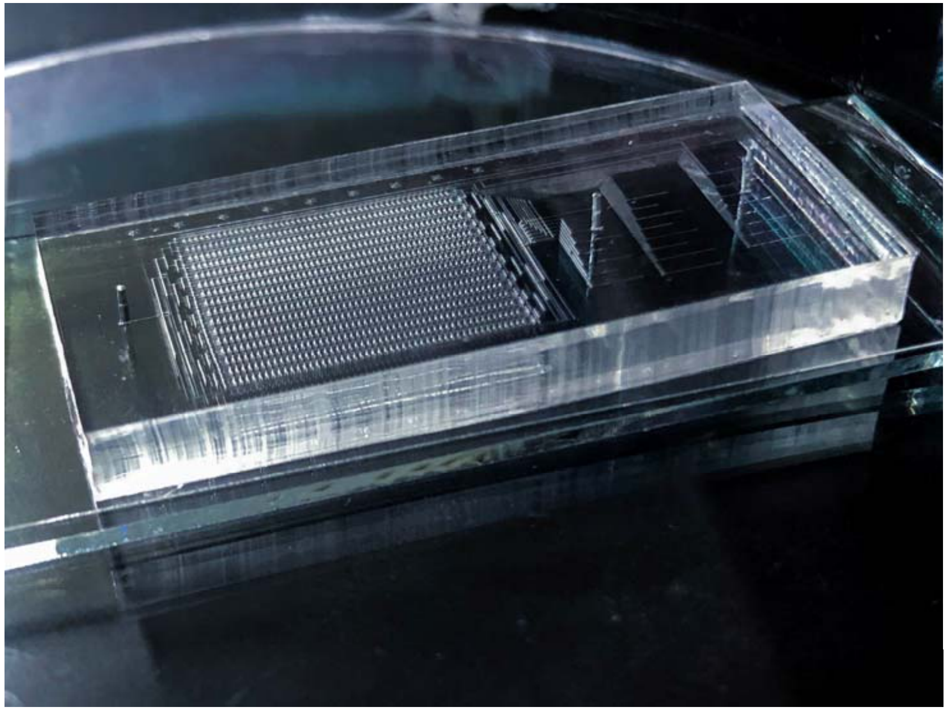
The multiplexor architecture

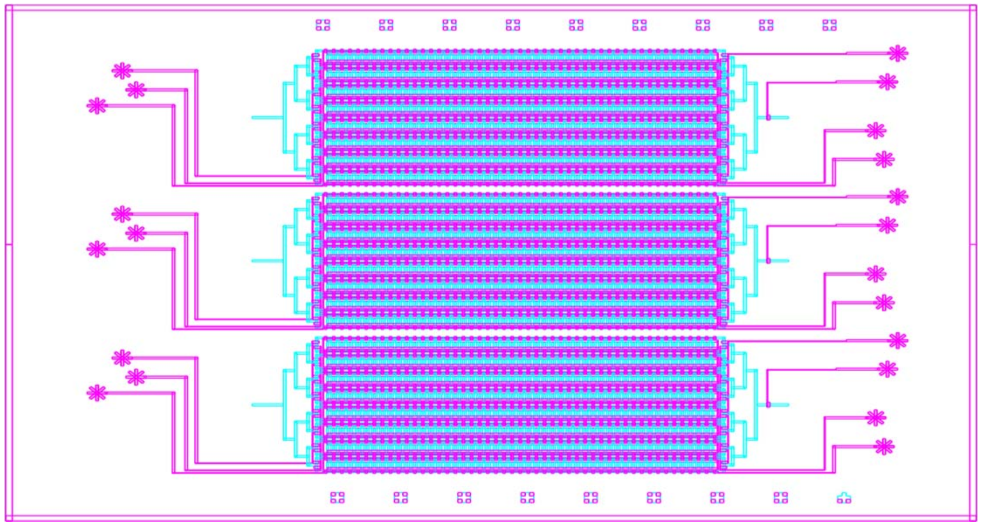




Thorsen et al, Science 2002,
Volpetti et al, ACS SynBio 2017

Microfluidic Chips

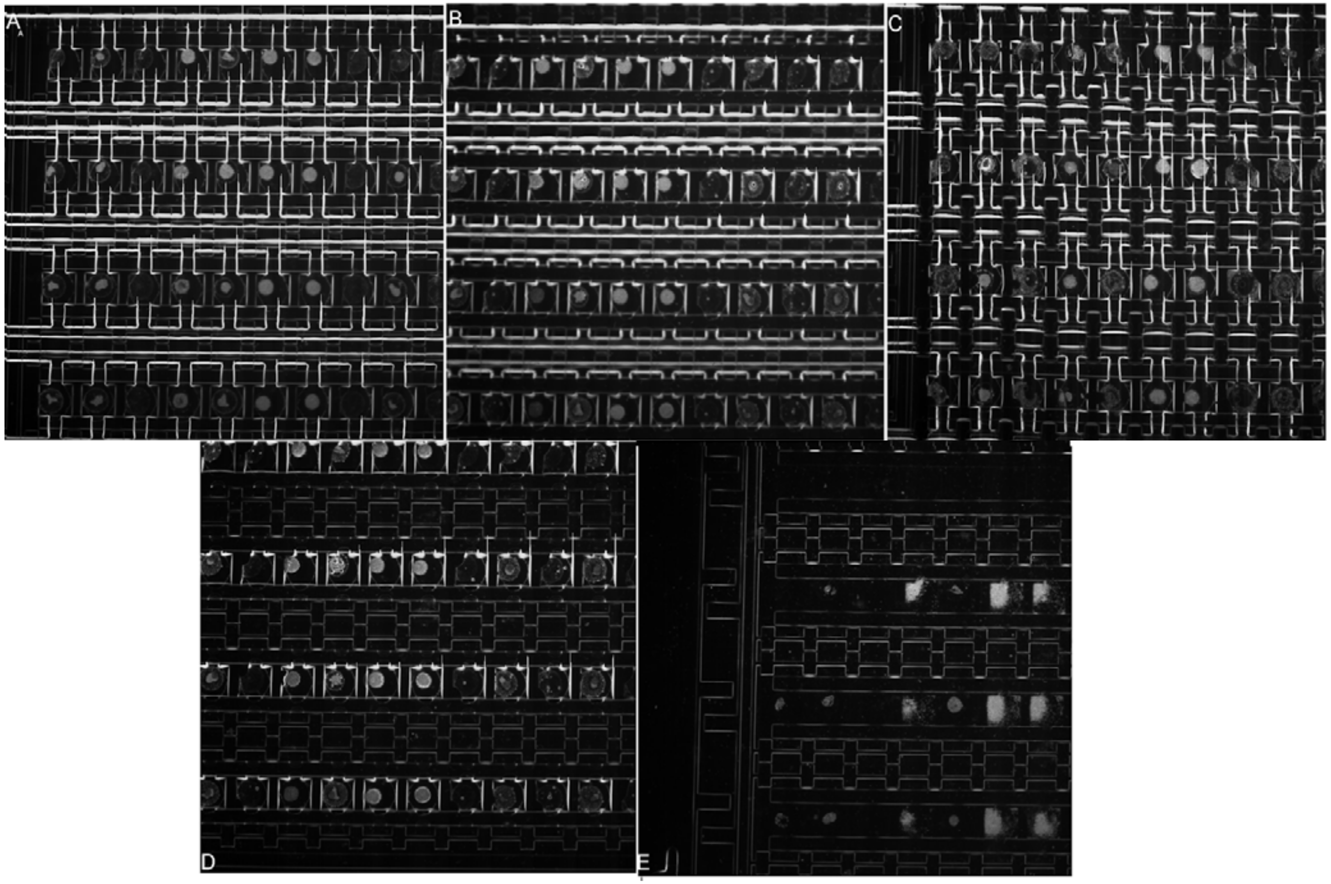




Space Biodisplay

Thorsen et al, Science 2002,
Volpetti et al, ACS SynBio 2017

Microfluidic Chips



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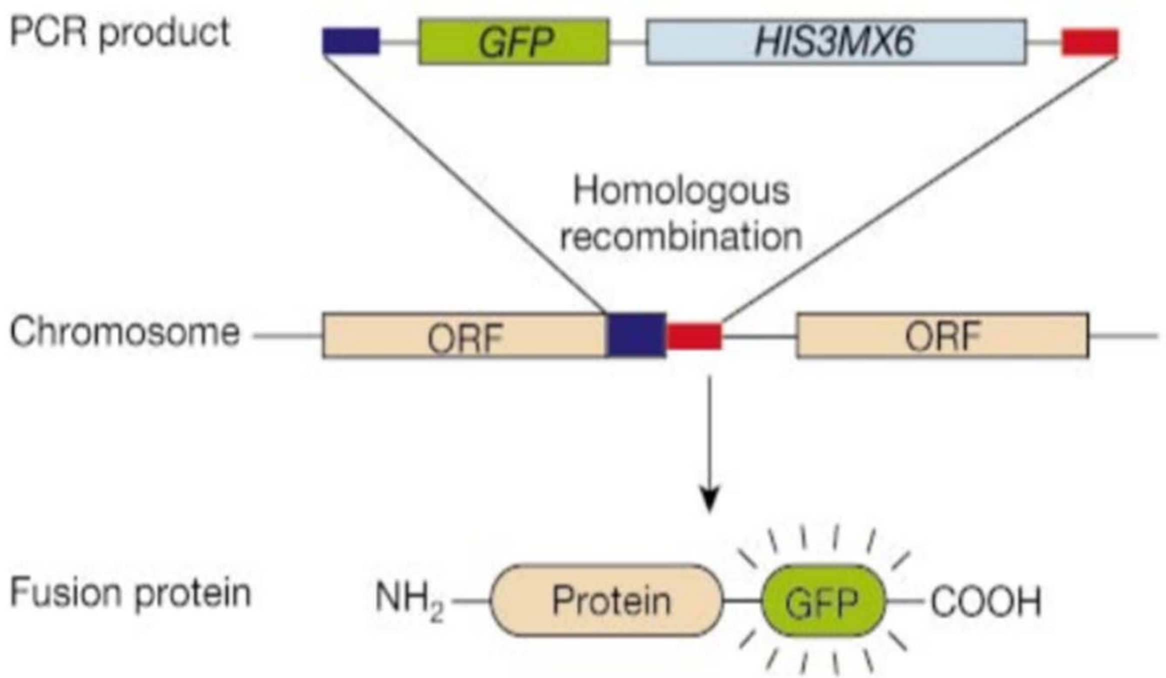
GFP Library



Wu et al, *Nature 2003*

Fluorescent Microscope

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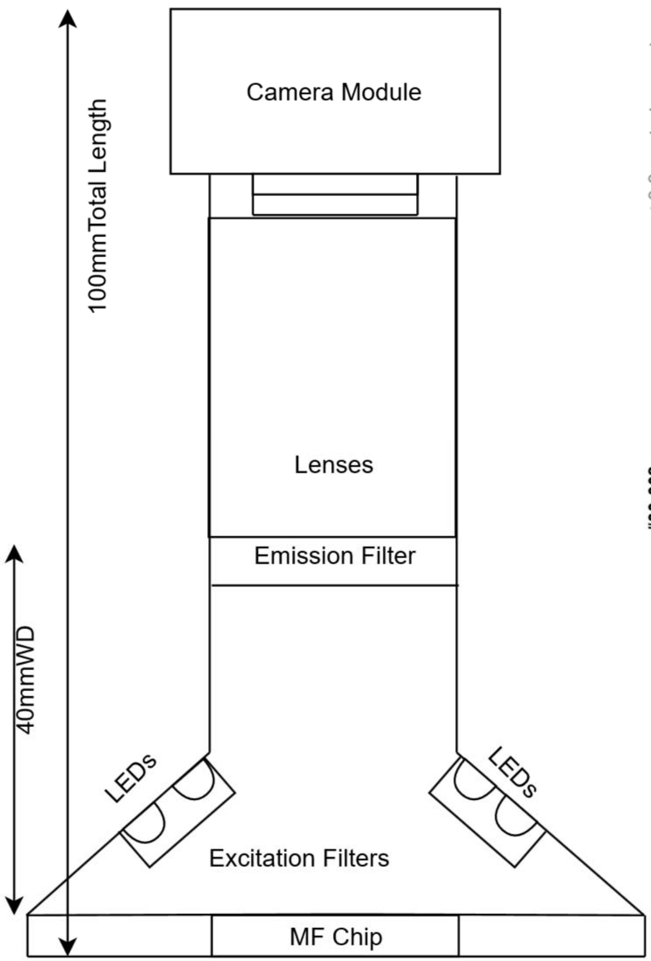
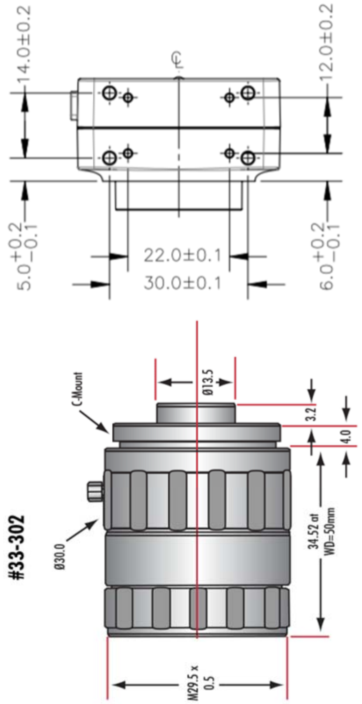
Fluorescence Imaging System



Basic Components

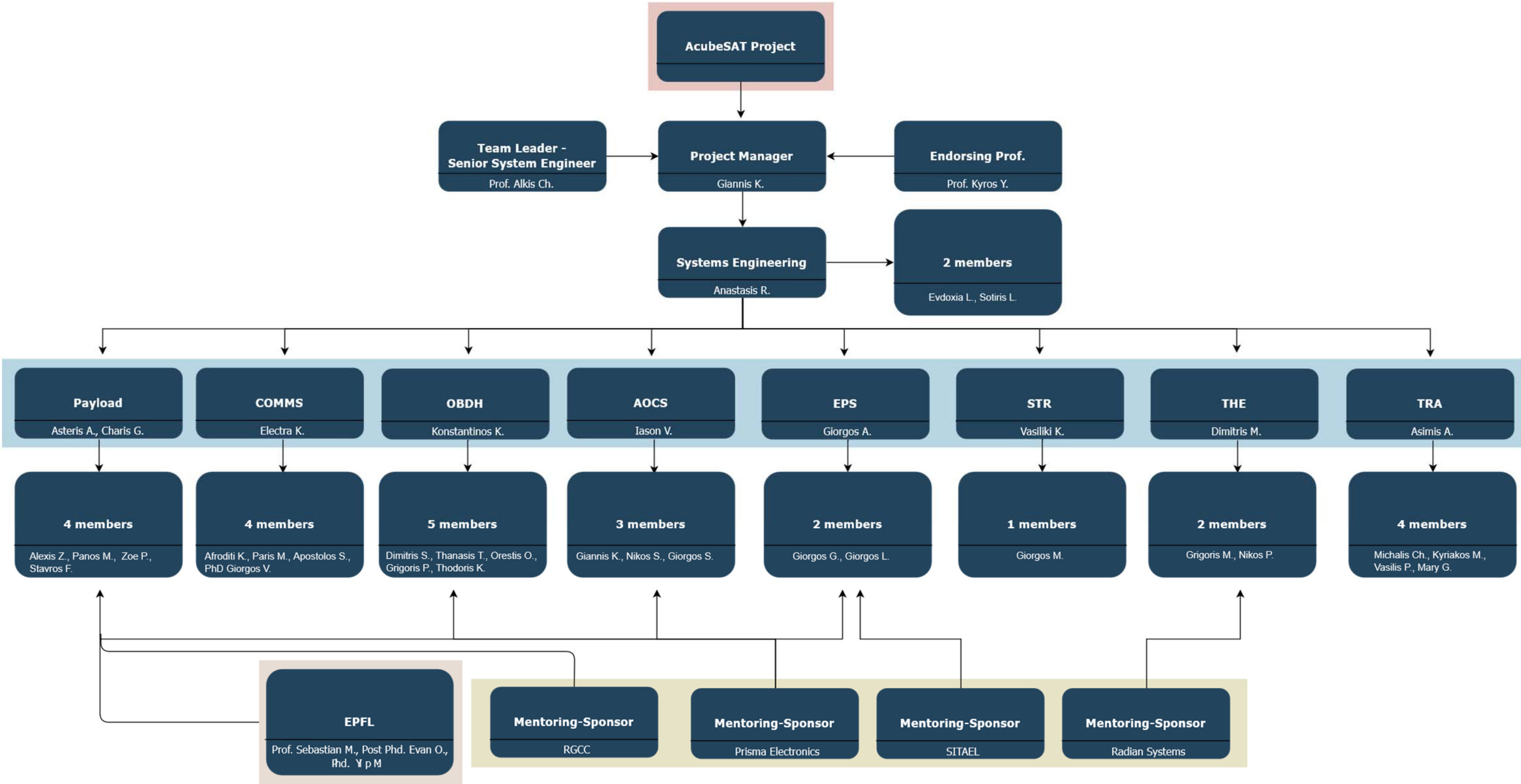


The Team

35 members

Fields of study:

- *Electrical Engineering*
- *Mechanical Engineering*
- *Electronic Engineering*
- *Medicine*
- *Physics*
- *Computer Science*
- *Biology*



AcubeSAT Project
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Prof. Kyros Y.
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Anastasis R.
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OBDH
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AOCS
Iason V.
EPS
Giorgos A.
STR
Vasiliki K.
THE
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2 members
Giorgos G., Giorgos L.
1 members
Giorgos M.
2 members
Grigoris M., Nikos P.
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Mentoring-Sponsor
RGCC
Mentoring-Sponsor
Prisma Electronics
Mentoring-Sponsor
SITAEL
Mentoring-Sponsor
Radian Systems

Physical Architecture

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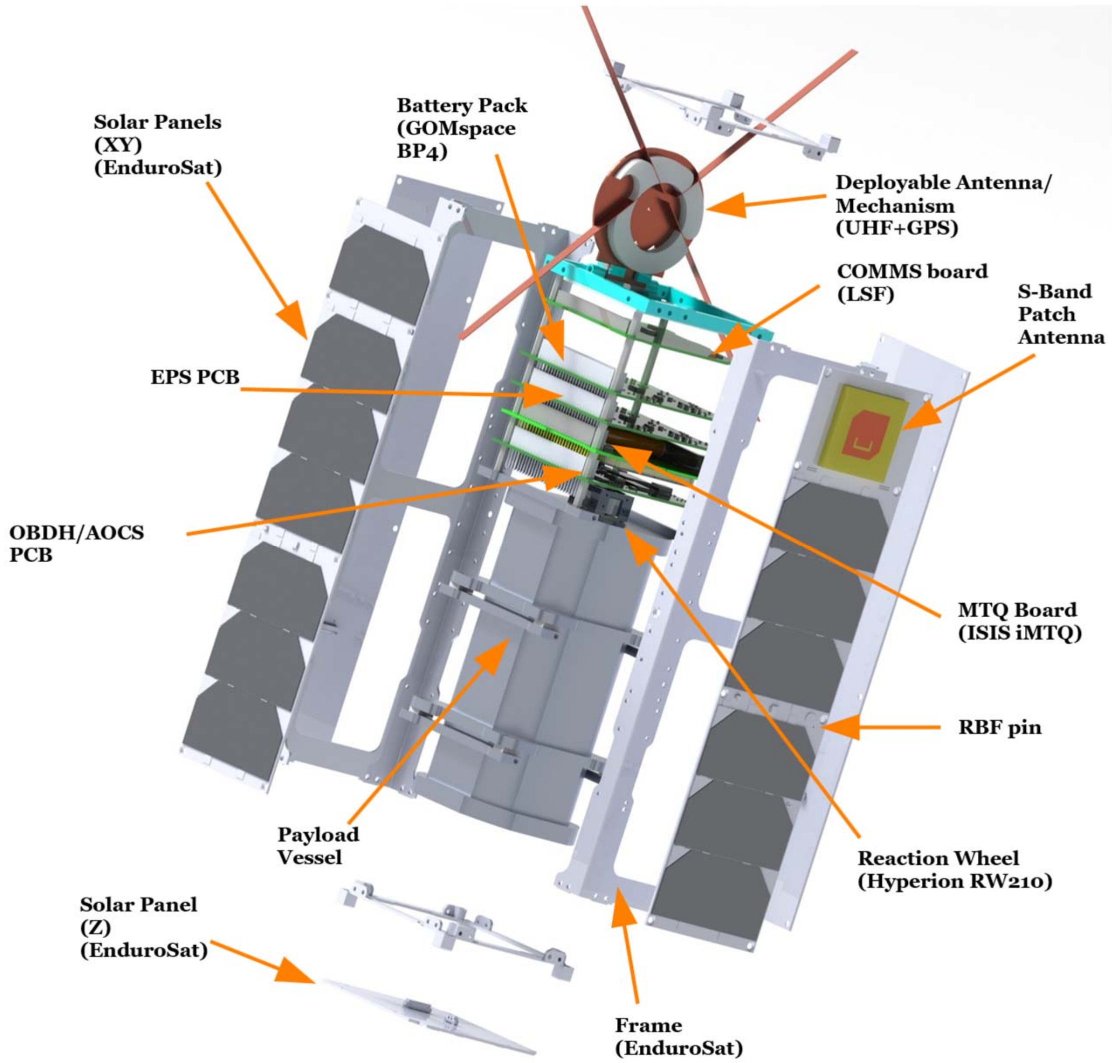


Attitude Determination and Control

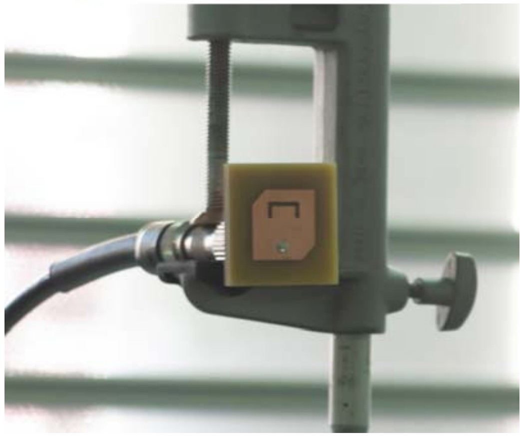
- Actuators:
  - Three Magnetorquers
  - One Reaction Wheel for antenna pointing
- Sensors:
  - Magnetometer
  - Gyroscope
  - Fine Sun sensor
  - GNSS Receiver
- The software will be implemented by the team.

Source: ISIS

Communications

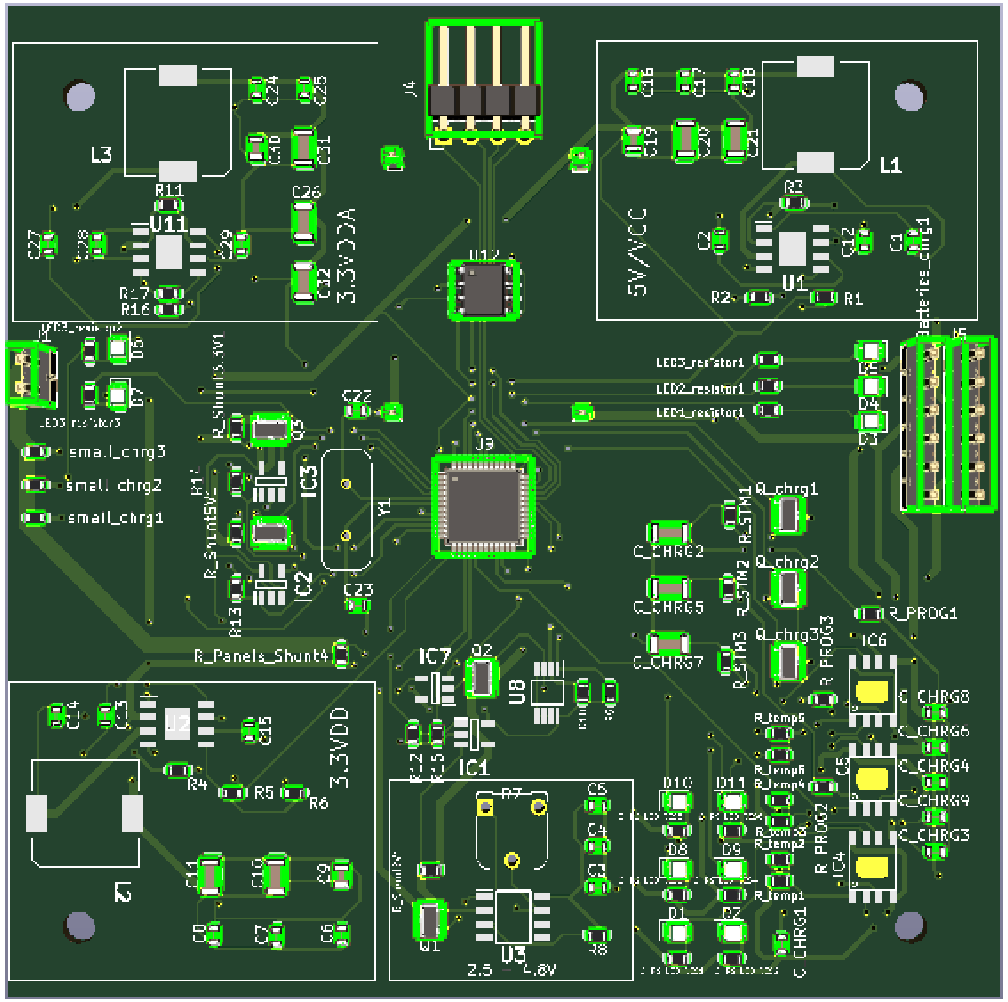
- TT&C frequency: 435-438 MHz
- Science data frequency: 2.4-2.45 GHz
- Data rate: ≈250 kbps, capable of image transmission from SU.
- Deployable turnstile antenna for TT&C on the +Z face.
- Patch antenna to be used to retrieve the images of the scientific mission.
- GS to be constructed within AUTh campus.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

https://gitlab.com/acubesat/comms



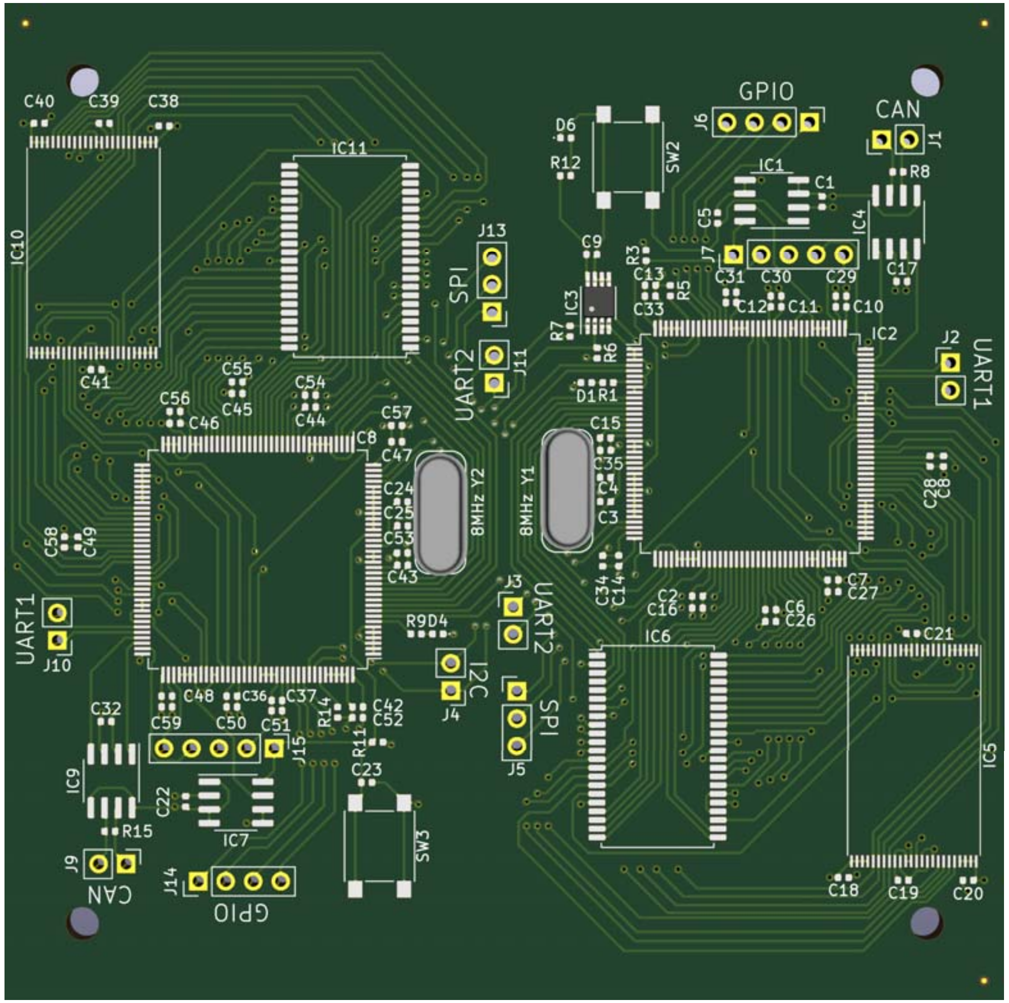
Electrical Power Supply

- 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



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)



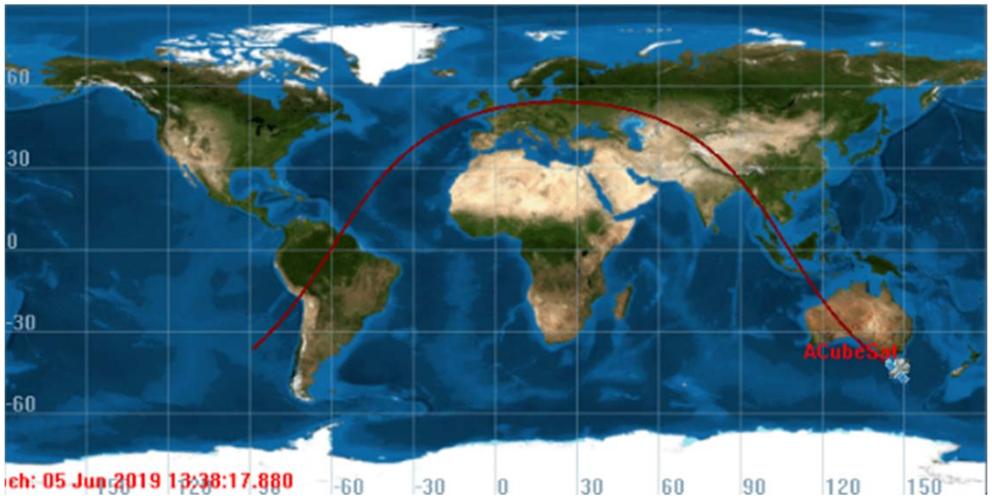
https://gitlab.com/acubesat/obc

Structure and Thermal

- 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

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