FERSAT project

FER STUDENT
SATELLITE PROJECT

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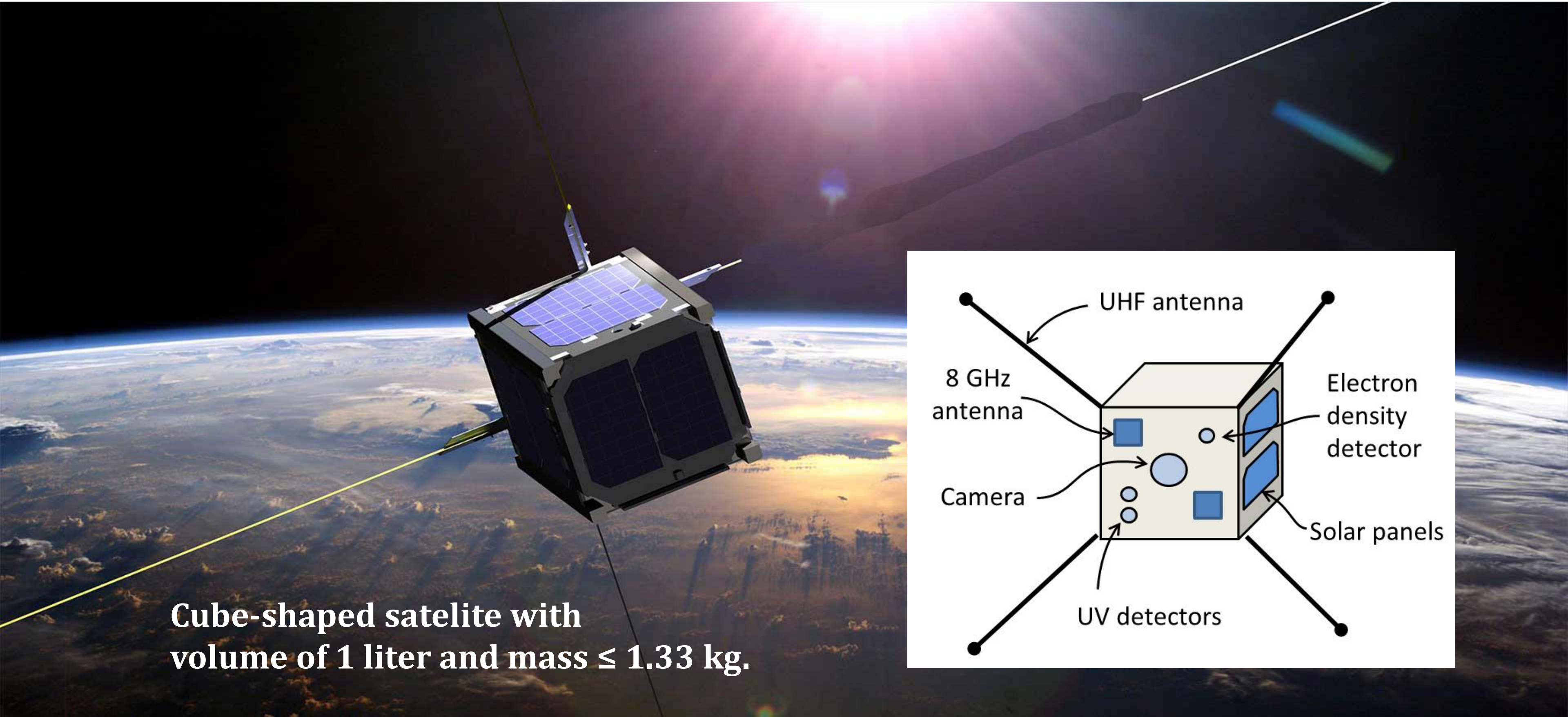
Objective: Launch 1U CubeSat with a selection of scientific payloads and engineering demonstrations

Funding and resources:

- Croatian Science Foundation (HRZZ IP-2018)
- Collaboration with other departments at FER, other Faculties at the University of Zagreb, and Croatian industry (Croatel d.o.o, Geolux d.o.o)
- Multiple donations from Croatian industry
- A dozen faculty and 70 students are involved

CROSPERITY

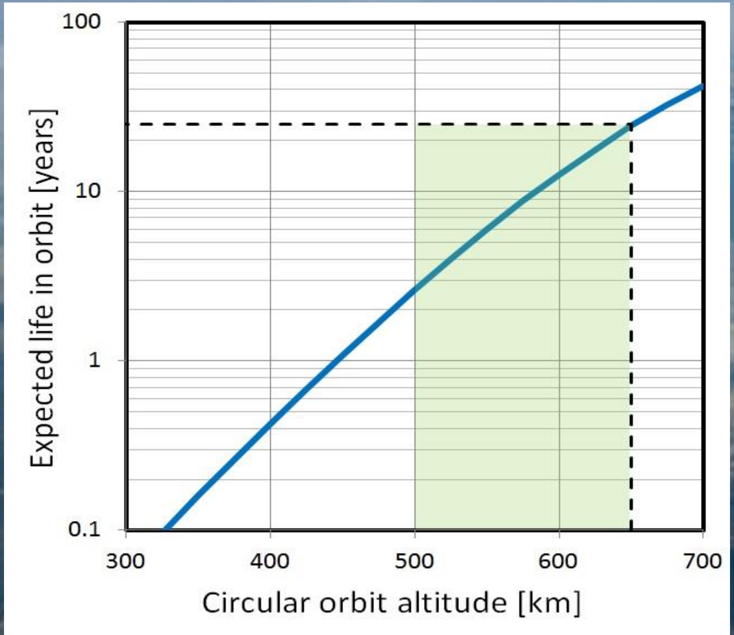
FERSAT nanosatellite



Cube-shaped satelite with volume of 1 liter and mass ≤ 1.33 kg.

Planned FERSAT orbit

- Sun-synchronous orbit at altitude 500 – 650 km



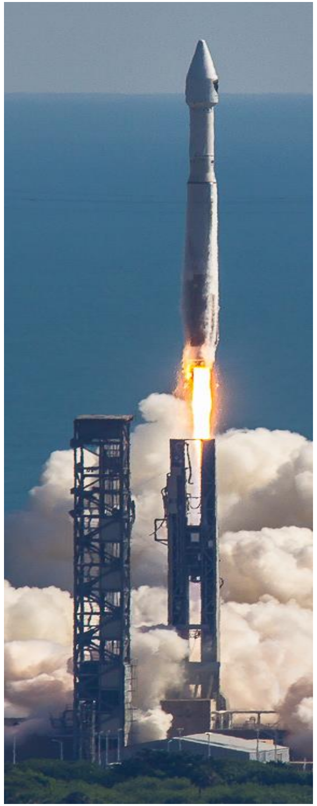
Satellite project components:

Building a satellite

Operation phase

Data download, analysis, adapting satelite functions

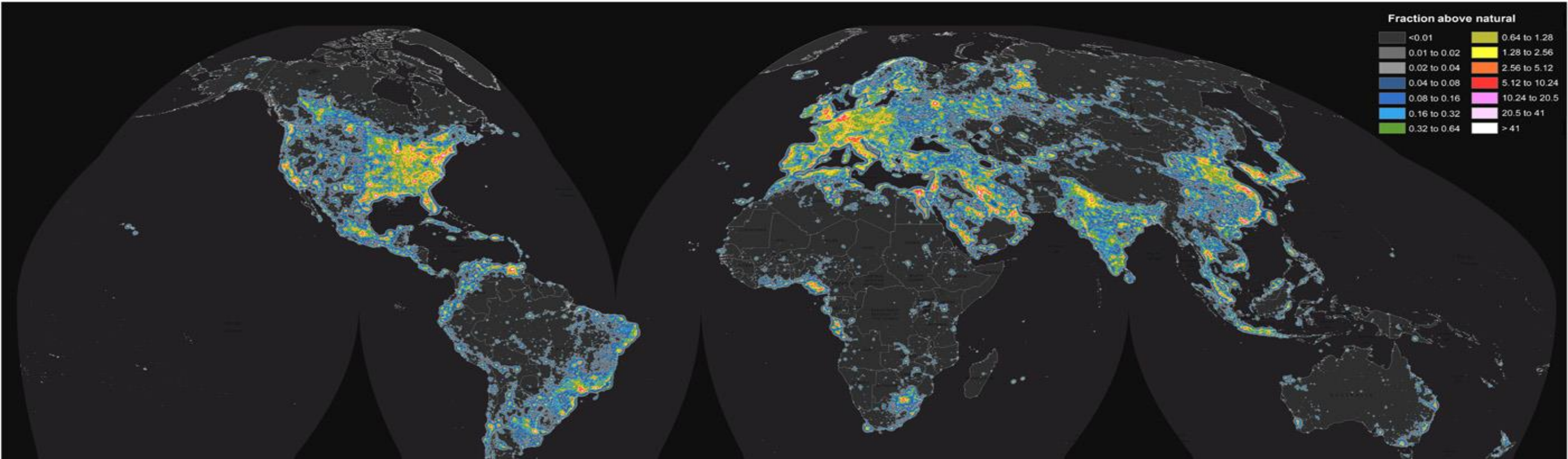
Satellite Launch



Building an Earth station

Primary payload: Light pollution measurement

- The type of illumination is changing in the world: from conventional sodium/Mercury lighting, people are moving to solid-state ligthing (LED).
- **Question:** Can we get an estimate of what fraction of global lighting has been converted to LEDs?

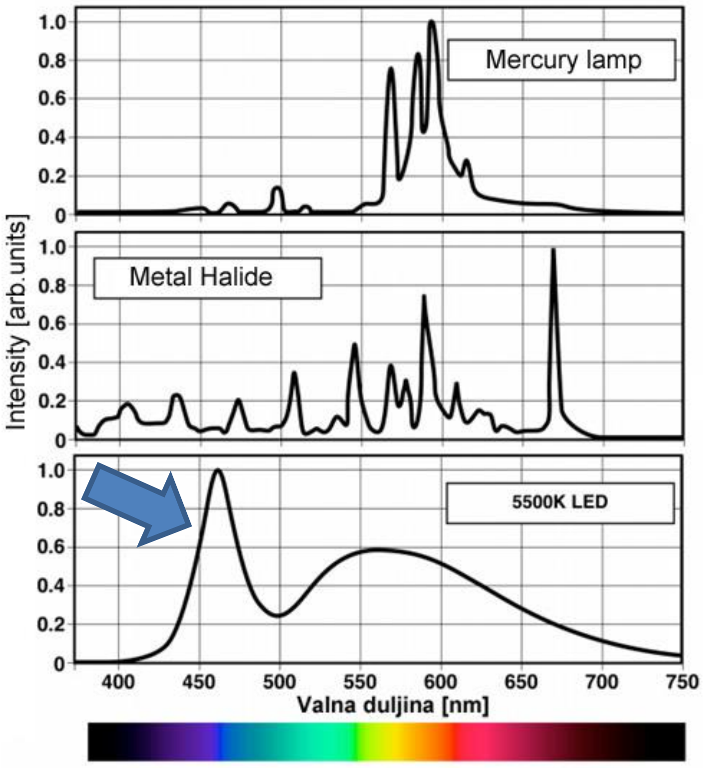


The problem

Solid-state lighting exhibits an unnaturally high intensity of blue light. Blue light in the night disturbs animal behavior and human circadian rhythm.

Our objectives:

- Develop an algorithm to provide the fractional contribution of solid-state lighting in the overall world illumination from spectrally resolved images from FERSAT and existing satellites.
- Demonstrate that this can be done efficiently and inexpensively using a CCD camera on a 1U CubeSat.



Secondary payload: Implement X-band downlink

- CubeSat downlinks are generally in the VHF/UHF amateur radio band and it typically takes 6 satellite passes to download 2MPixel image.
- **Question:** Can we speed this up to download tens or hundreds of images per satellite pass?

The objective:

- Demonstrate high data-rate X-band communication between 1U CubeSat and Earth station.

Secondary payload: the approach

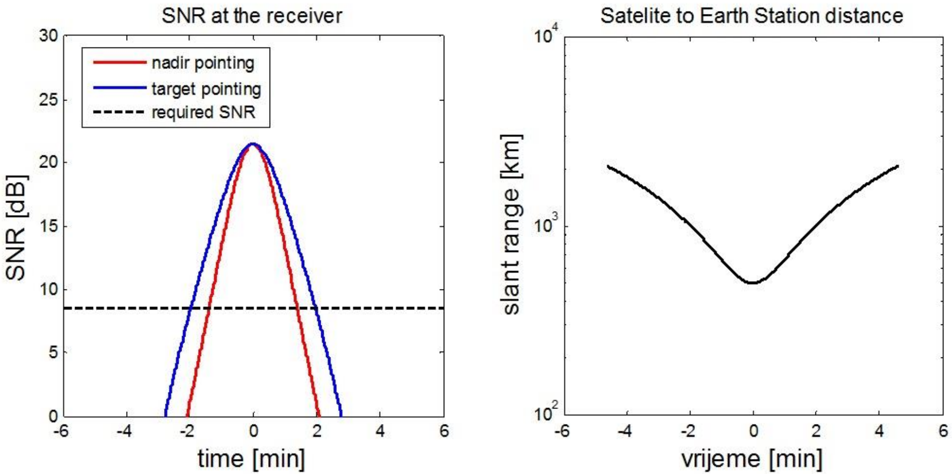
The challenge:

- CubeSat thermal budget is very limited, while X-band transmitters dissipate a lot of power (several Watts).

The approach

- Design and implement highly efficient X-band transmitter
- Optimize the link budget.
- Optimize satellite energy management for short-term emission.

Link budget at 8 GHz



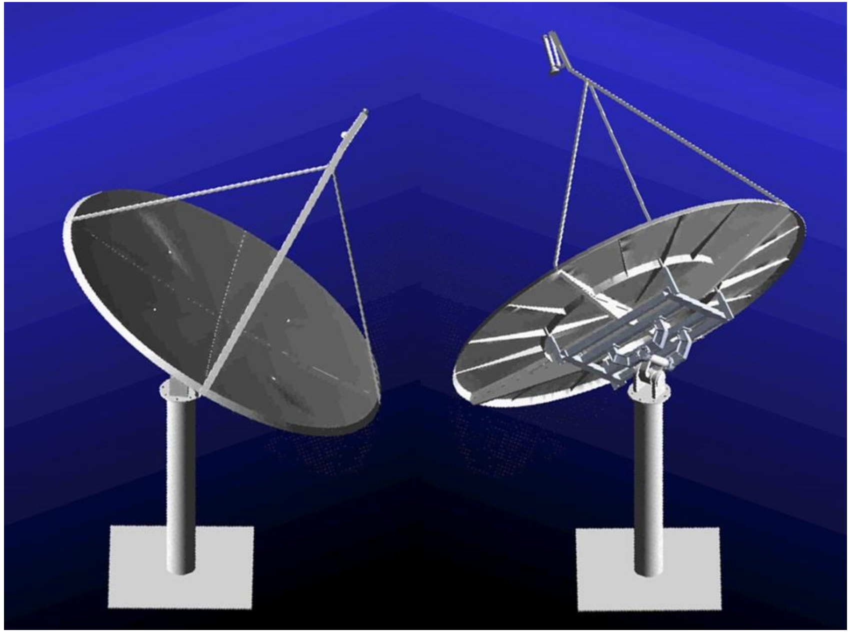
X-band Earth receiver

The challenge:

- Build a high-precision X/Y antenna with an X-band receiver

The approach

- Use 2.4-m elliptical dish with X-band receiving electronics
  - In collaboration with Croatel, d.o.o, and Geolux, d.o.o, Zagreb
- Innovative tracking system
  - in collaboration with Department of Aeronautical Engineering at the Faculty of Mechanical Engineering and Nautical Architectures in Zagreb



Tertiary payloads: Space-readiness of PureB detectors

- PureB detectors are detectors for electrons and ultra-violet light and are made using nanometer thin boron layer on silicon (nanotechnology)
- Technology has been developed at the University Twente/NL and in , detector developed in collaboration with FER/Zagreb.
  - Detectors are commercially used in scanning electron microscopes.

Question: Can we use PureB detectors to track the electron density in ionosphere and can we use them to track ozone holes?

The objective:

- Demonstrate a detection system for measuring electron density and ultra-violet light measurements in space.
- Use the data to add information to the study of sun’s activity

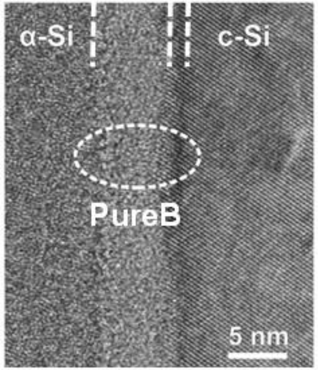
Ultra-violet light and electron-density detection

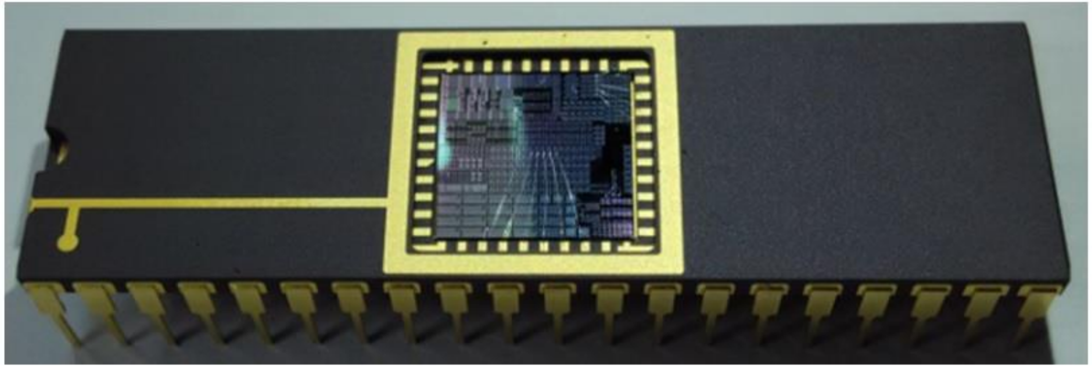
The challenge:

- PureB has not been used for electron-density measurements in space at low electron density range (Ionosphere at 500 km has T_E ~ 1400 K).

The approach

- Develop a practical detection system using PureB detectors





Satellite build is a STUDENT project

- energy harvesting
- attitude control
- control software
- communication electronics
- sensor data acquisiton electronics
- image and signal processing

CubeSat development team

plus 50 students