

Romanian CubeSat Project



GOLIAT – project overview



University of Bucharest



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Supervisor: Romanian Space Agency (ROSA)

Contents

- Mission concept
- Detailed Satellite description
- Ground Station
- Summary & Follow-up

Mission objectives

- Three original scientific payloads:
 - Meteorite detection
 - Remote sensing camera
 - Radiation dose measurement
- Customized components
 - EPS, Attitude stabilization, communications
 - Ground stations development

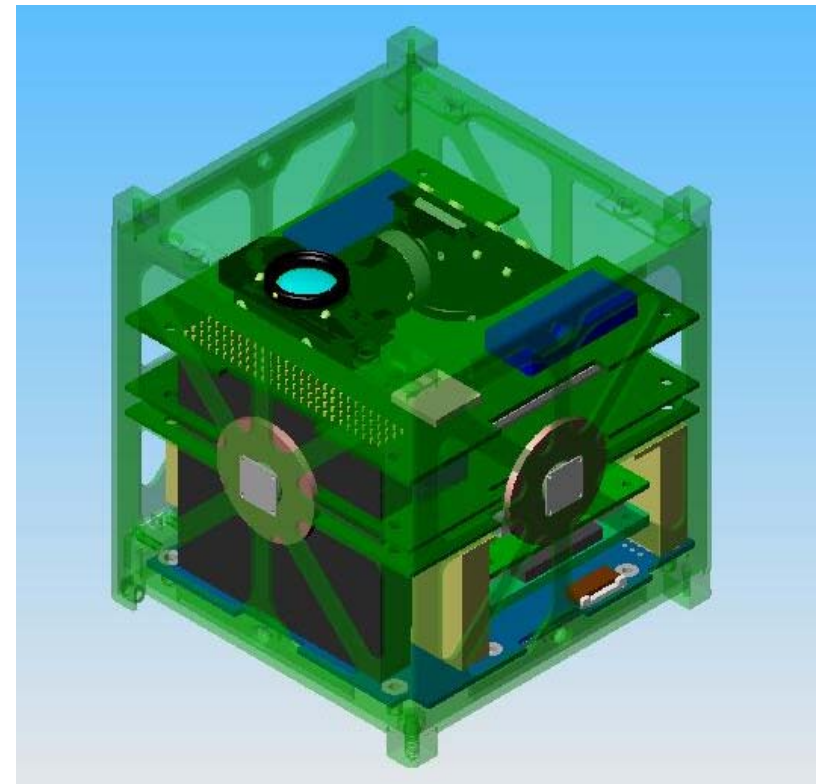
Satellite description

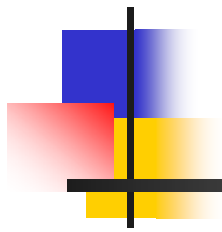
■ BUS

- Electronic Power Supply
- Attitude Determination & Control
- Radio COMM
- On board computer

■ Payload

- CICLOP – Earth observation Camera
- Dose-N – experiment for measuring the total radiation dose
- SAMIS – micrometeorites detection platform



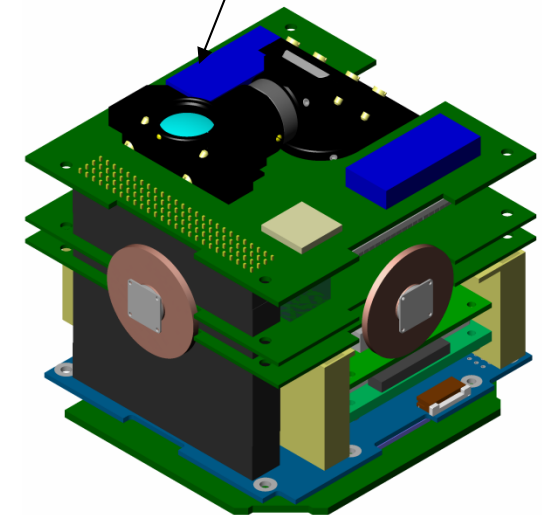
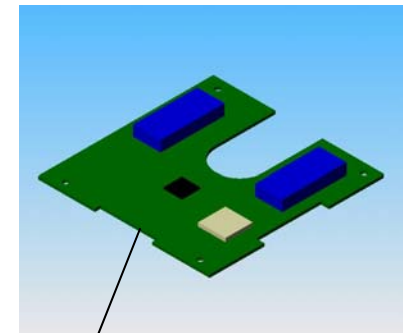
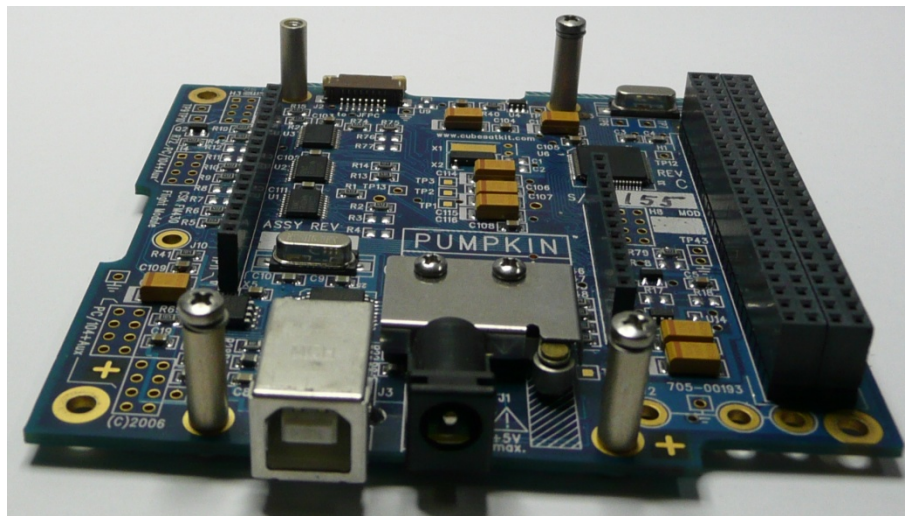


Satellite BUS

On board computer

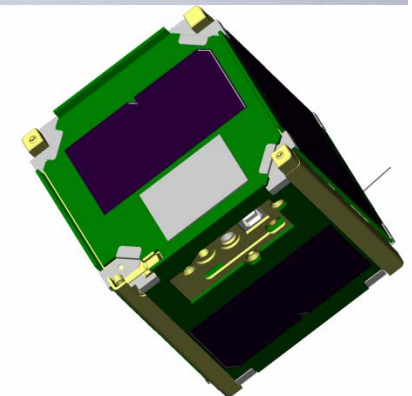
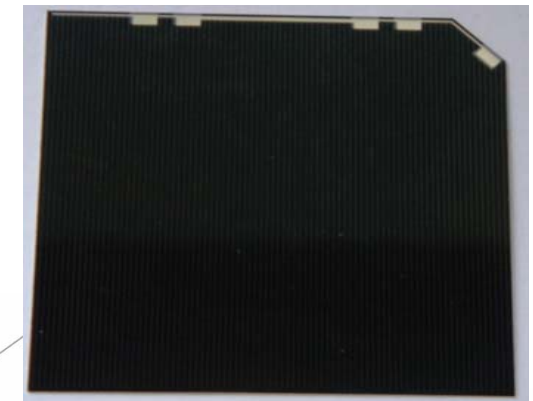
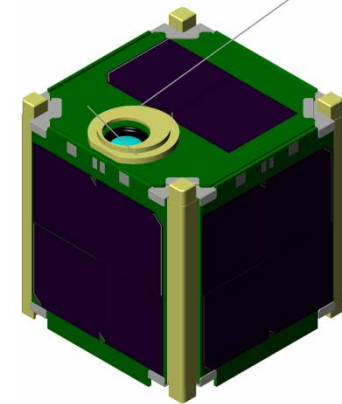
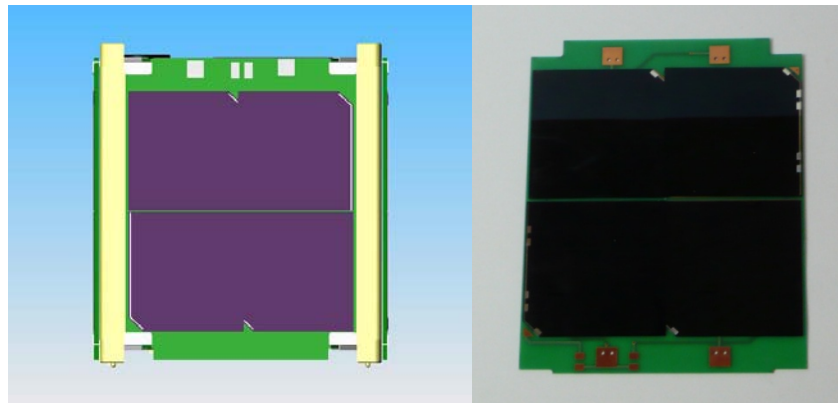
Two OBC boards

- MSP430 Flight Module – CubeSat kit (Rev C)
 - Antenna deployment
 - MHX-2400 communications
 - Image acquisition
- A second MSP430 handles:
 - ADC for the experiments & data storage
 - Attitude Determination and Control system
 - The beacon



Power supply

- Triple junction solar cells.
- 2 pairs per panel – sides,
- 1 pair- top, bottom and front
- Output – 2 V/cell => 3.4 V/pair (considering 0.6 V Diode)
- 23.5 % Efficiency
- 41 x 42.4 mm cell area
- 70 % coverage
- 1.8 – 2.1 W expected power

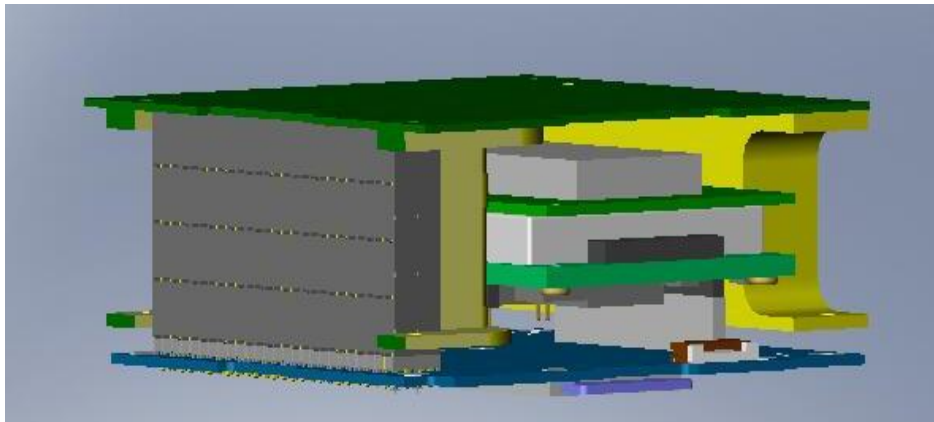
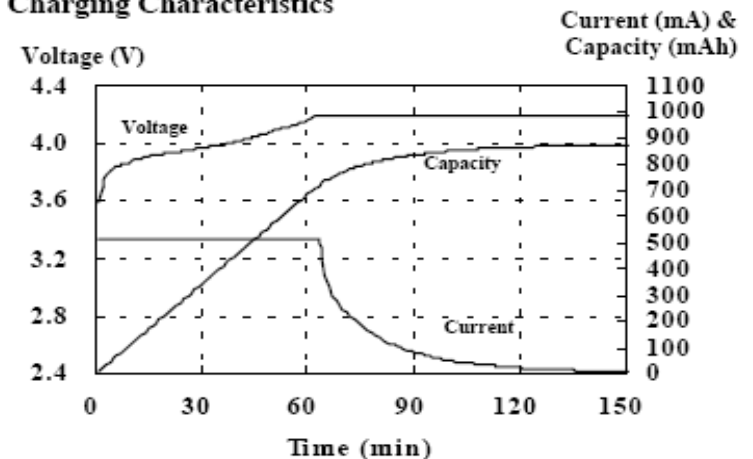


Batteries

Two 7.4 V battery packs resulting from two 3.7 V Li-Ion

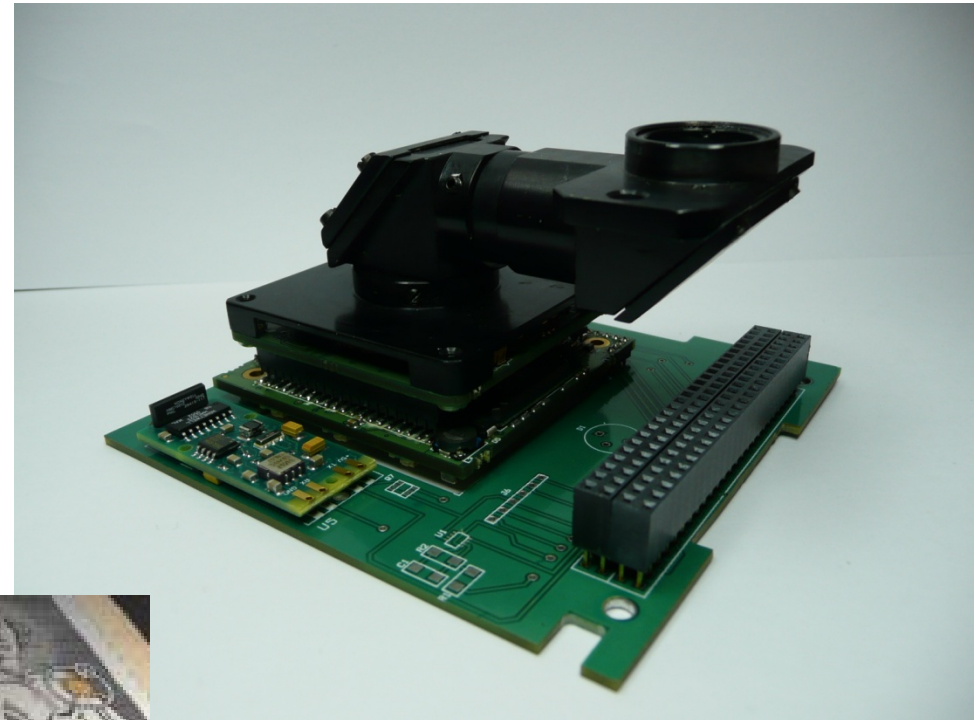
- Capacity : Typical: 860mAh (at 20 C)
 - Nominal Voltage : 3.7 V
 - Weight : Approx. 21 g
 - Dimensions:
 - Width = max. 34.0 mm
 - Height = max. 50.4 mm
 - Thickness (shipment) = 5.5 mm
 - Standard Discharge :
 - 172 to 860 mA to 2.8V
- Max discharge current 1800 mA

Charging Characteristics



Attitude determination

- 3-axis magnetometer – Honeywell HMR 3400
dimensions 15.24 x 38.1 x 7 mm
weight 3.75 g
Measurement Spectrum -2 to 2 Gauss
Sampling 8 Hz
- GPS receiver - TRIMBLE
dimensions 19 x 19 x 2.54
weight 1.7 g
12 channels
hot start 9 s
warm start 35 s
Cold start 39 s



Attitude determination Software

- GPS back-up algorithm
 - TLE decoding at the satellite
 - Position data is cross-referenced with the magnetometer for complete attitude determination

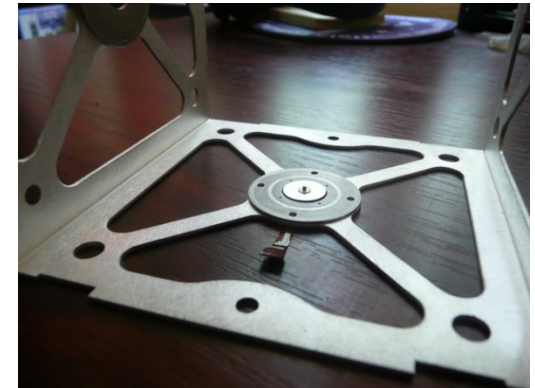
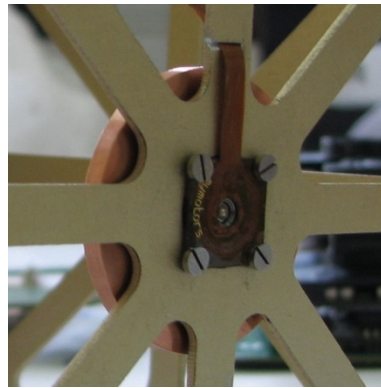
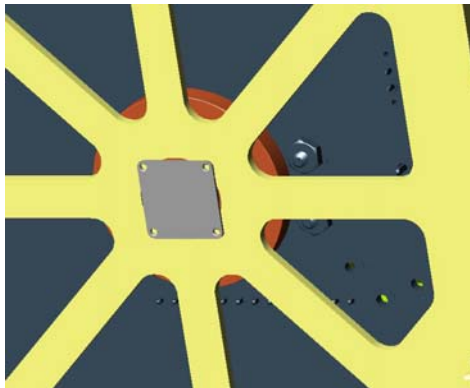
The screenshot shows a software window titled 'line_elem_tool'. It contains several input and output fields for satellite data. At the top, there is a 'TEST' button. Below it are two lines of input data: '1 27842U 03031C 07017.98525332 -.00000255 00000-0 -97918-4 0 9332' and '2 27842 98.7172 29.2099 0009762 143.1388 217.0395 14.20856870184205'. Below these are various parameter fields:

Satellite Number	Classification	Inclination		
27842	U	98.7172		
Year of launch	Launch number	Launch piece	Ascending Node	
03	031	C	29.2099	
Year	Month	Day	Time	Eccentricity
07	1	17	23:38:45	0.0009762
				Perigee
				143.1388
				Mean Anomaly
				217.0395
				Mean Motion
				14.20856870
				Revolution number
				18420

At the bottom of the window is a 'RUN' button.

Attitude control

- Two axes momentum wheels system
- Each micro-motor is fixed in the structure's hole, from the center of a face
- The momentum wheels are spinning in the inner space of the CubeSat
- The servo amplifiers controls the torque and the speed between the limits
- M (0 – 0.12 mNm)
- n (0 – 20000 s^{-1})
- Estimated 360° rotation 40 s



Radio communication

Functions:

- ❑ Satellite early tracking using the beacon
- ❑ Download Data and Telemetry from the Satellite
- ❑ Upload commands for reprogramming the flight computer

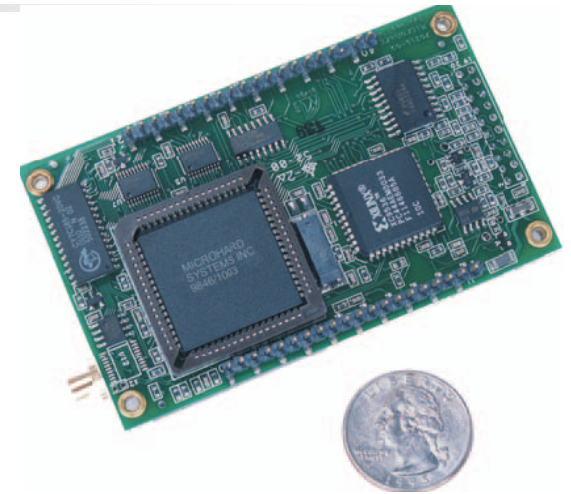
Two independent transceivers architecture commanded by two different processors for **redundancy**

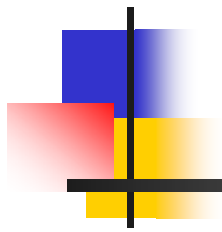
Beacon

- Ham Frequency - 437.485 MHz (IARU coordinated)
- 1200 bps AFSK packets
- Repeated transmissions (<60 s) including:
 - Identification of the satellite
 - Telemetry data and diagnosis of the subsystems
- 100mW – 300 mW output power
- Only transmit mode used initially
- Can act as a **back-up** for the main data link (Rx mode operations)

Main data link

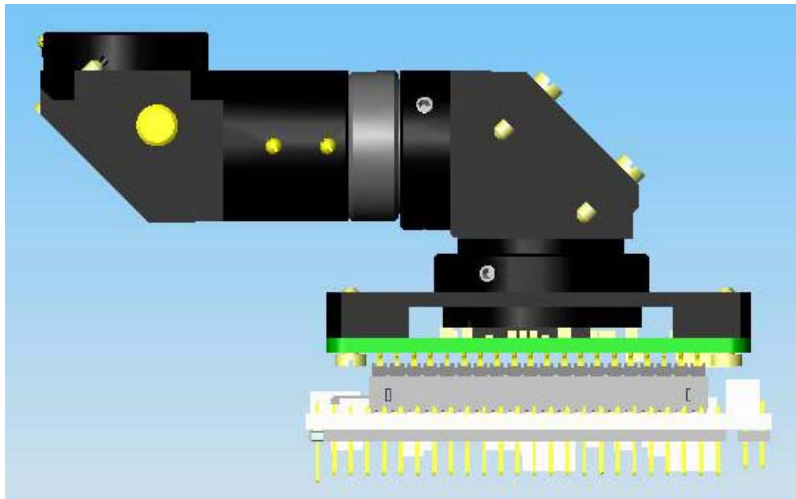
- 2.4 GHz transceiver
- Downlink for experimental data & detailed housekeeping
- Uplink for new commands
- Operates only when enters the range of the ground station
- Up to 1W output power
- Programmable bit rate (9600 bps average)





Satellite PAYLOAD

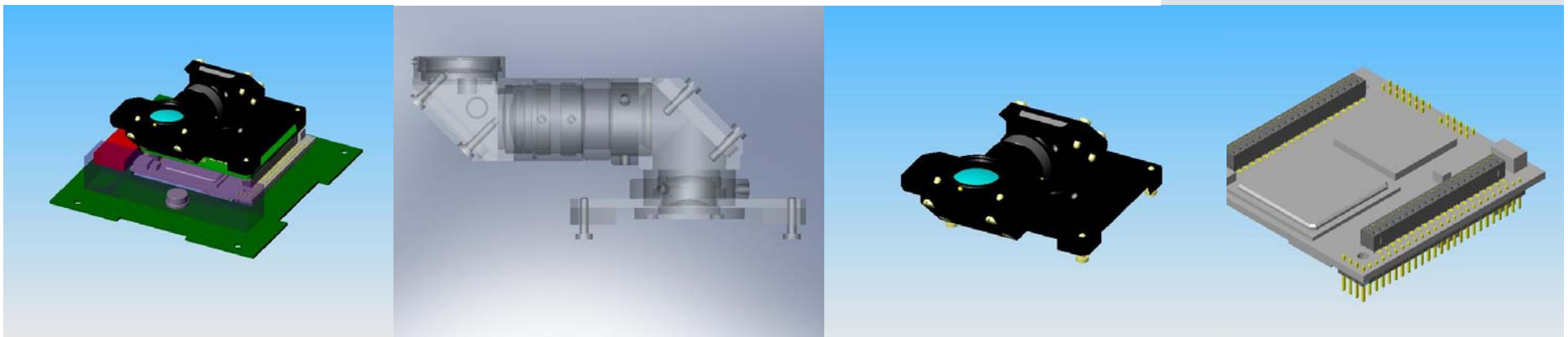
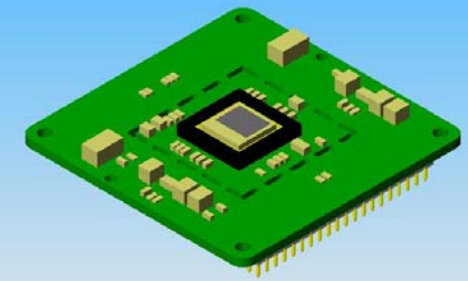
CICLOP - Earth Observation Camera



Camera Design

System consists of three distinctive components:

- Camera sensor board
 - up to 3MP high resolution color sensor in 4/3 image format
- Camera Processor Board
 - a powerful 600 MHz core, 64 MRAM digital signal processor capable of real time JPEG compression
- Custom lens mount system
 - in house, custom made system
 - 6 degree viewing angle

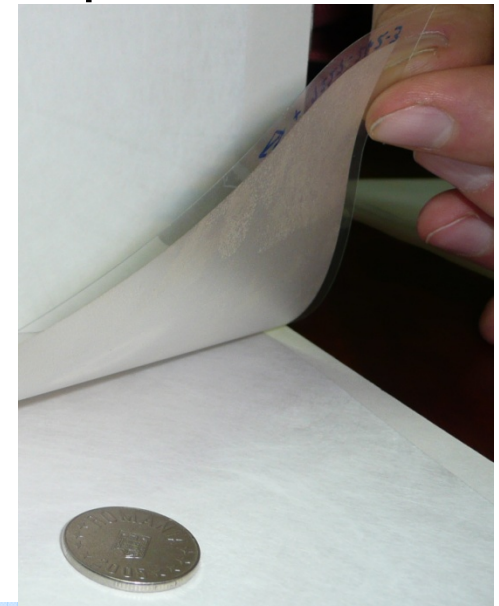
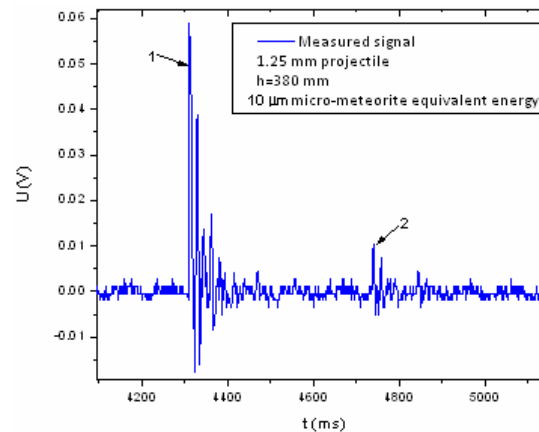
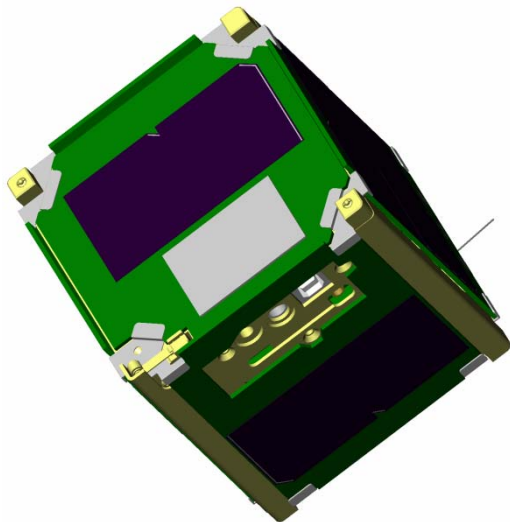


Overall performance

- Focal distance – 57 mm
- Solid Angle - 6°
- Expected picture area 50 x 70 Km
- Pixel area 21 x 28 m
- Up to 3 Mp image

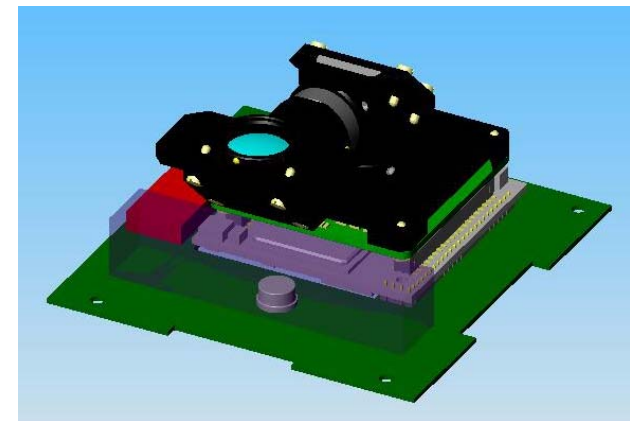
SAMIS

- A study on the micrometeorites in Low Earth Orbit
- Impact sensor: a highly sensible 50 x 37 mm piezo-film
- Micrometeorite collision generates an electrical impulse proportional with the energy of the impact
- The signal is conditioned using a charge amplifier and than read at the ADC



DOSE-N

- The purpose of experiment:
 - The measurement of the total dose of cosmic radiation.
 - A semiconductor sensor (PIN diode) and a scintillating material are used as a detector
 - Measurements are made at regular time intervals
- Expected results:
 - The total dose as a function of coordinates on LEO (latitude, longitude, altitude)



Ground Stations

■ BUCHAREST

- UHF equipment is operational since February 2007
- Multiple CubeSats contacts (April '07 Dnepr and May '08)
- Equipment
 - Yaesu G5500 Azimuth & Elevation Rotators with GS-232B interface
 - Icom IC-910H dual band radio transceiver
 - Kamtronics Kam-XL modem
 - Directional Yagi antennas 14 dB
 - PC – tracking, radio control and data storage
- New equipment for 2.4 GHz operations



■ Cluj-Napoca radio station

- 4 m dish
- Tracking rotators (azimuth and elevation)
- MHX-2400 module
- Amplifier





Summary & Follow Up

Our satellite:

- Built for redundancy (2 transceivers, 2 OBCs)
- Complex systems with simple back-ups
- 3 science experiments (most complex camera on a CubeSat)
- Validation of several CubeSat components (momentum wheels, EPS)

Follow up

- A second satellite
- Formation flying (swarms of CubeSats)

..... Waiting for Vega

• Expected results! 😊

● Cluj-Napoca

● Bucharest