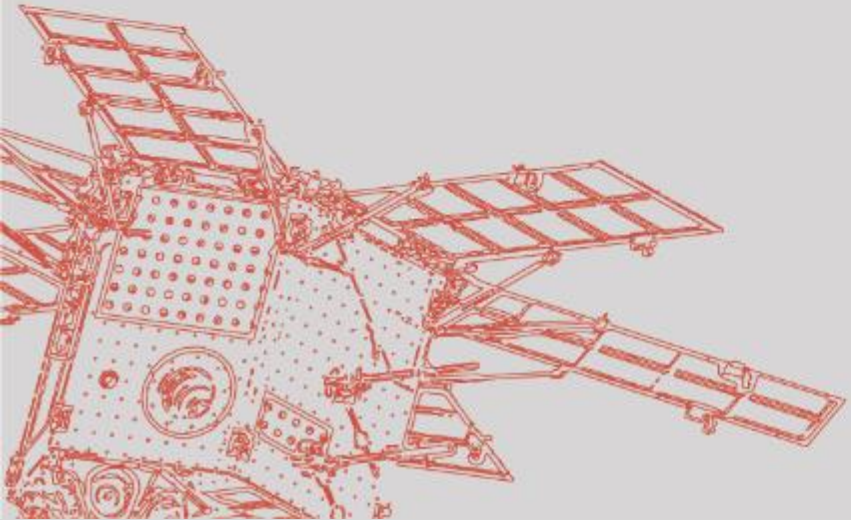
SPUTNIX

Russian private space company

Orbicraft Pro

Complete CubeSat kit
based on Raspberry-Pi

(source IAA-AAS-CU-17-10-05)
Speaker: Roman Zharkikh



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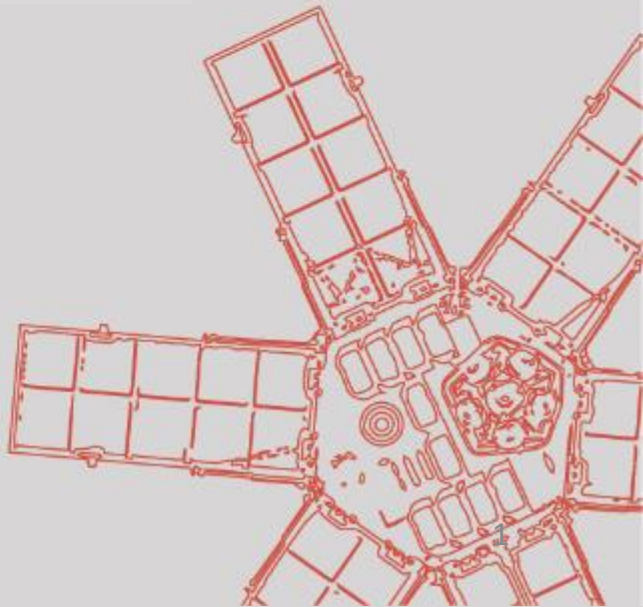
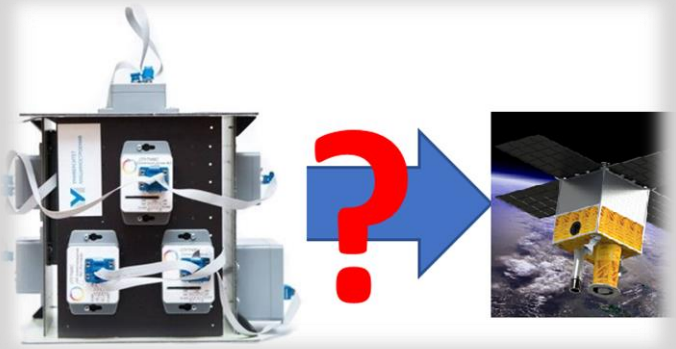
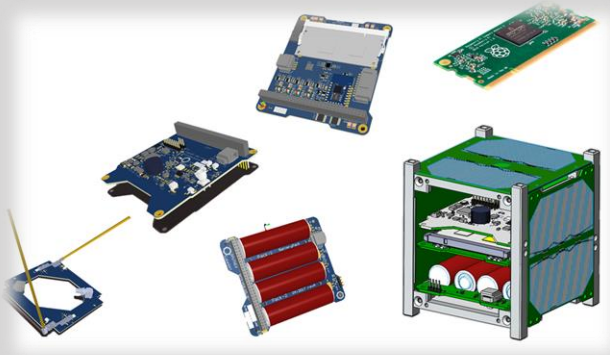


Contents:

1. CubeSat development background



2. Orbicraft Pro description

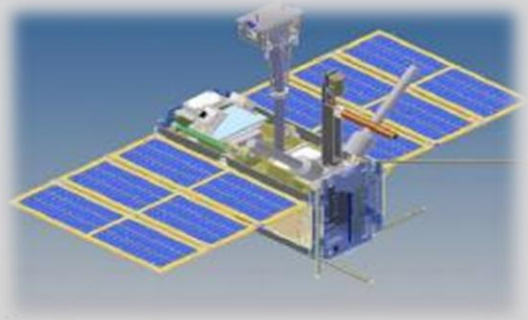


3. SiriusSat-1 mission activity

CubeSat development background: SPUTNIX experience

Altitude determination and control system for satellite "Chibis-M"

Development, manufacture and operation of the three-axis electrodynamic attitude determination and control system with magnetic damping (accuracy up to 1 degree)
Project Dates: 2012-2014



"TabletSat Aurora" - SPUTNIX technologies demonstration satellite

Launched on June 22, 2014 on the "Dnepr" LV
Satellite mass 26,5 kg
Average power consumption 60 W
TM&TC - UHF 9,8 Kbps
Payload downlink – X-band 64Mbps
Orientation and stabilization are better than 0.1° and 0.01°/s
Payload – EO camera, GSD of 15 m, frame size is 40 * 50 km
Project dates: 2013-2014

Laboratories for universities, research and educational centers

ADCS testing facilities and formation flying test-bed facilities for universities and research centers in Russia and CIS
Project dates: 2015-2017 (more than 5 labs)

CubeSat development background: Market demands

Key-products

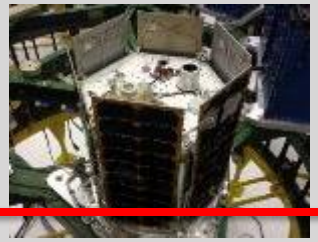
Accessory

Professional

Universities

Schools

Elementary school



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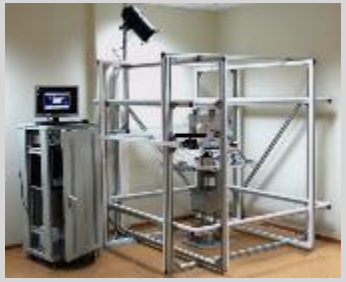
Satellite mockup with OBC, sensors, reaction wheel, EPS for schools



Microsatellites, ground radio stations, ADCS testing facilities

Advanced satellite mockup, orbital environment simulators, amateur ground radio

CubeSat development background: Selection of CubeSat

APPLICATIONS

University space activities

Amateur radio satellites

Other educational launches

BENEFITS

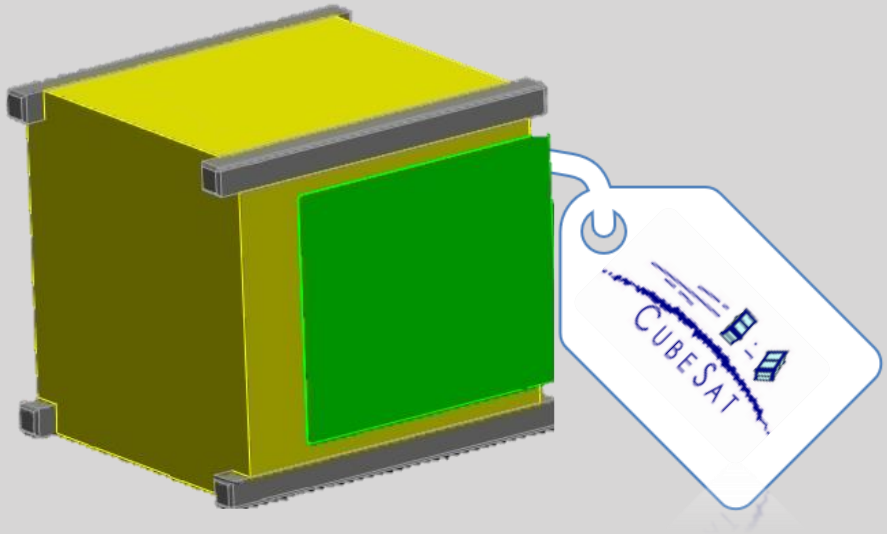
Compact and light

Low-cost

Infrastructure and community

Standardization

Free educational launches from Roscosmos



LIMITATIONS

Low energy

Payload size and weight

Low resolution components

Always secondary payload

POSSIBLE PAYLOADS

Low-resolution cameras

Radio transceivers

Particles detectors

Materials and equipment flight tests

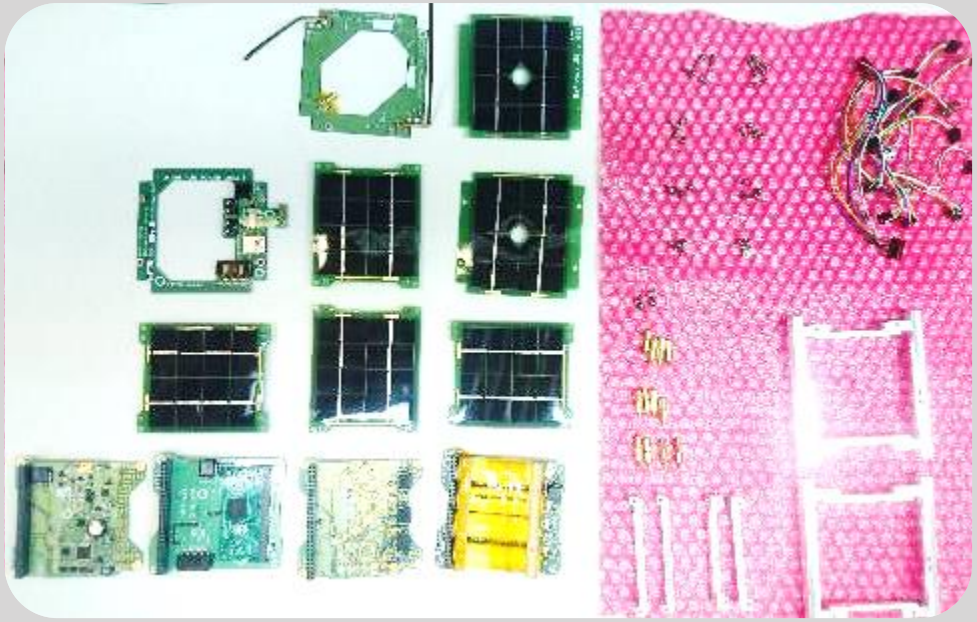
CubeSat development background: Development result - Orbicraft Pro kit

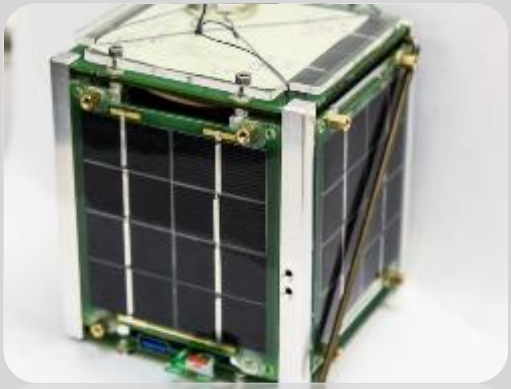
Why Raspberry?

- **Easy-programming with open-source community**
- **Compatible with junior Orbicraft construction set**
- **Tiny power consumption and size**

Why kit?

- **Convenient and visual for starter education**
- **Involve students with hand-working process**
- **Reduces costs on assembly and tests for universities**
- **Flexible for different payloads**

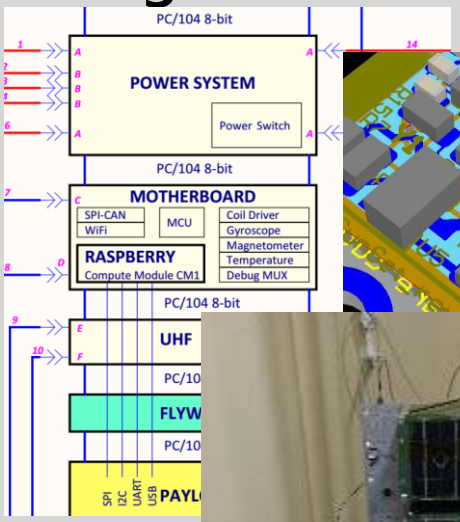


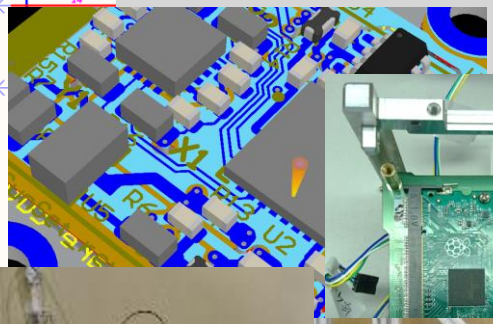


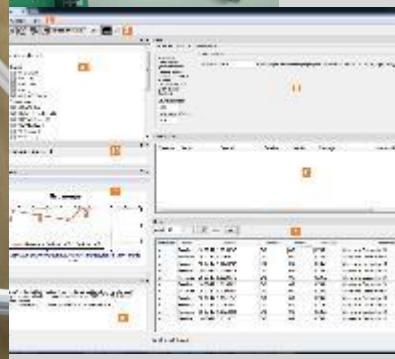
CubeSat development background: Development process

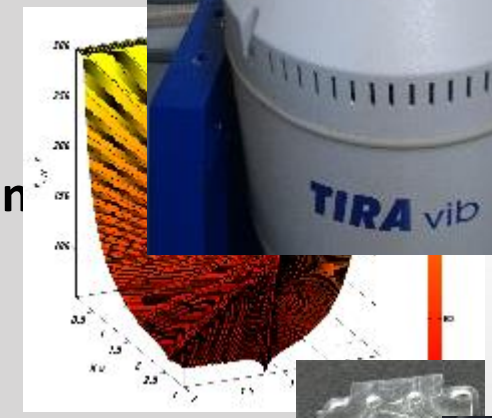
Stages:

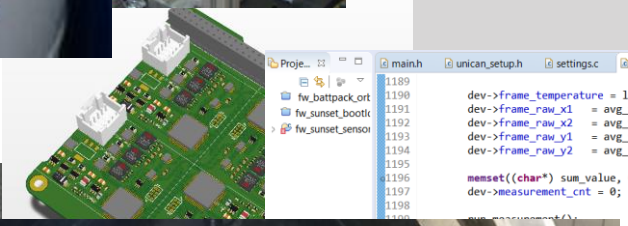
1. CubeSat 1U and 3U development
    1. Architecture design
    2. Samples production
    3. Software development
    4. Functional tests
    5. Mechanical and vacuum tests
2. Attitude control system
    1. Design and calculations
    2. Sun sensor production
    3. Reaction wheels module production
    4. Firmware development
    5. 3U CubeSat integration
    6. Functional tests
    7. Additional Mechanical and vacuum tests
3. Final preparations
    1. Kits content and configurations
    2. Documentation

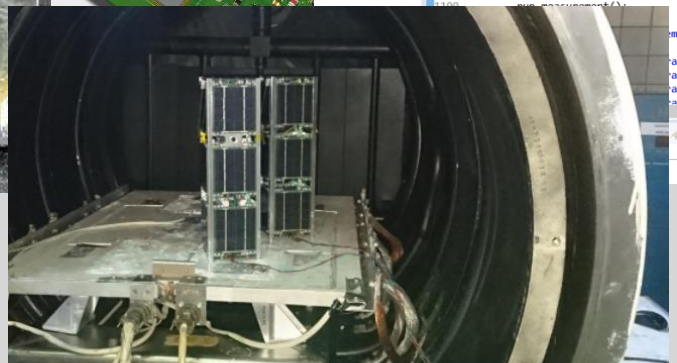










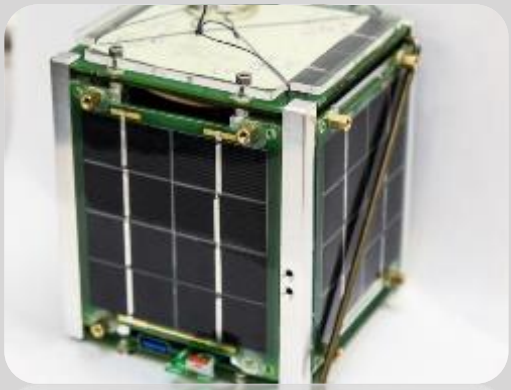


Orbicraft Pro description: Configurations

Configuration	Educational	Experimental	Flight	Scientific
Description	**Basic** CubeSat kit for manual assembly and adjustments (DIY)	**Assembled** and verified by manufacturer CubeSat unit, ready for payload integration and testing	Assembled, verified, and **calibrated** by manufacturer unit, passed all qualification testing with or w/o payload.	Fully tested **flight** unit with installed and calibrated 3-axis orientation system and GaAs solar panels.
CubeSat 1U model (included options)	**SXC1**	**SXC1-A** (AS included)	**SXC-F** (AS, TF, TM included)	
Options	GA1	TF, GA1	GA1	
CubeSat 3U model (included options)	**SXC3**	**SXC3-A** (AS)	**SXC3-F** (AS, TF, TM)	**SXC3-MAX** (AS, GA3, OSS, TFF, TM)
Available options	GA3	TF, GA3, OSS, TFF	GA3	

ADCS	**3-axis orientation system** including 6 sun sensors and reaction wheels module with 4 wheels
GA1	Set of 4 side and 2 end **GaAs** panels for 1U CubeSat
GA3	Set of 12 side and 2 end **GaAs** panels for 3U CubeSat
AS	Unit **assembly** and verification on manufacturer site
TF	Basic **functional testing**: PSU cycling, radio channel, electromagnetic angular velocity damping test
TFF	Testing from TF option and 3-axis **orientation system examination** with protocol
TM	Space **qualification tests** with approved protocol: vacuum, thermal and mechanical impact tests

Orbicraft Pro description: Technical data



Orbicraft SXC1-A

- Dimensions – 1U CubeSat
- Weight – 0.8 kg
- Payload power – up to 0.25 W
- Sensors: gyro, magnetometer, temperature
- Computer: Raspberry-Pi
- RAM – 1 GB, ROM – 4 GB
- Electromagnetic coils set

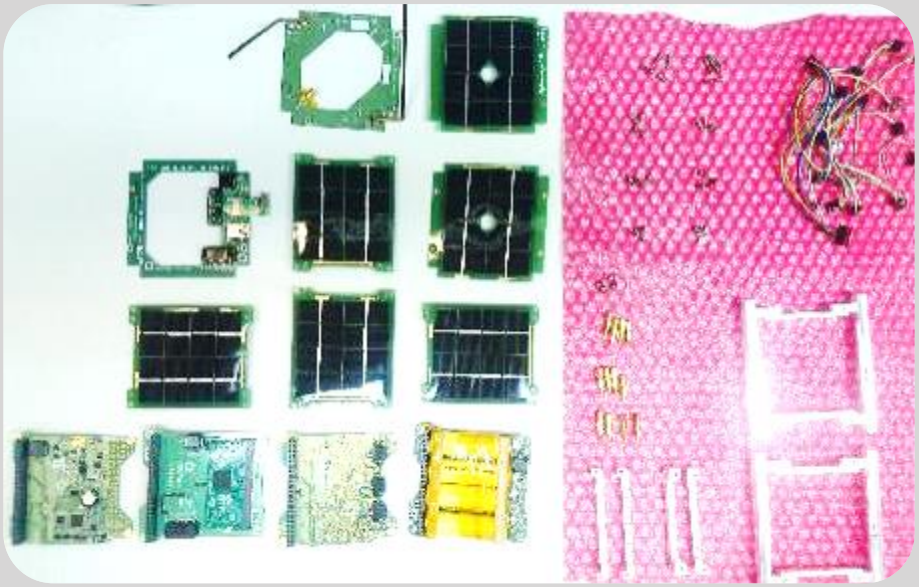
Orbicraft SXC3-A

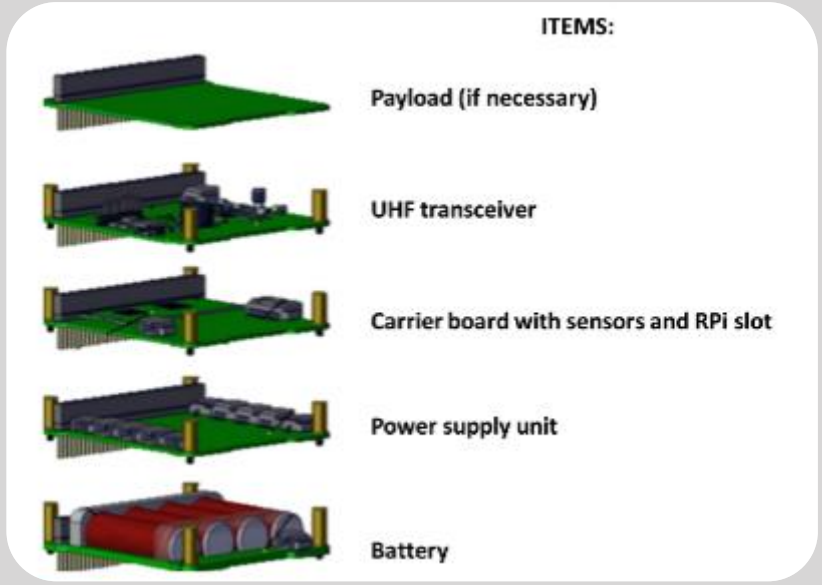
- **Dimensions – 3U CubeSat**
- **Weight – 1.35 kg**
- **Payload power – up to 0.75 W**
- Sensors: gyro, magnetometer, temperature
- Computer: Raspberry-Pi
- RAM – 1 GB, ROM – 4 GB
- Electromagnetic coils set

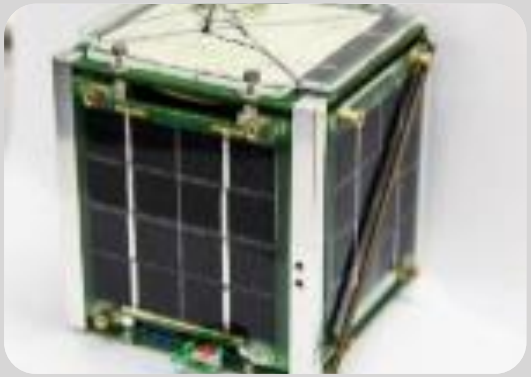
Orbicraft SXC3-A +ADCS

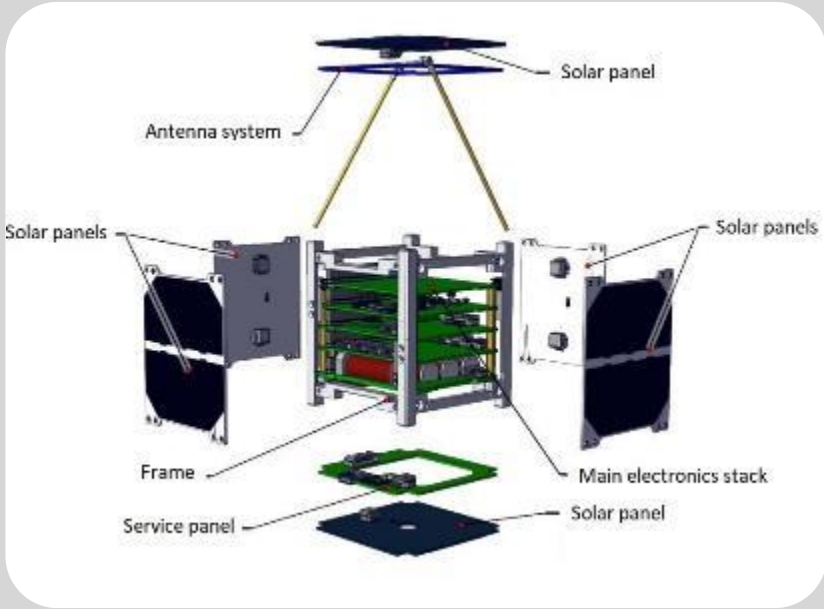
- Dimensions – 3U CubeSat
- **Weight – 1.8 kg**
- **Payload power – up to 0.5 W**
- **Sensors: sun**, gyro, magnetometer, temperature
- Computer: Raspberry-Pi
- RAM – 1 GB, ROM – 4 GB
- Electromagnetic coils set
- **Reaction wheels – 4 pcs.**

Orbicraft Pro description: Assembly









SiriusSat-1 mission: Collaboration

Educational center SIRIUS – organization, facilities

SINP MSU – payload idea and design.

SPUTNIX –CubeSat kit and system engineering

Two groups of bright and talented students with their leaders working on satellite systems and payload

3 weeks of July 2017 for everything!

SiriusSat-1 mission: Participants

SINP MSU offered to run a space **mission** for space particles detection and registration **for the space weather monitoring**

Mission subjects:

- Particles from the Earth radiation belts
- Charged particles distribution over LEO

Research relevance:

- Current particle distribution model validation
- LEO radiation monitoring
- The space weather forecast

SPUTNIX took on the role of **industrial partner** in spacecraft development

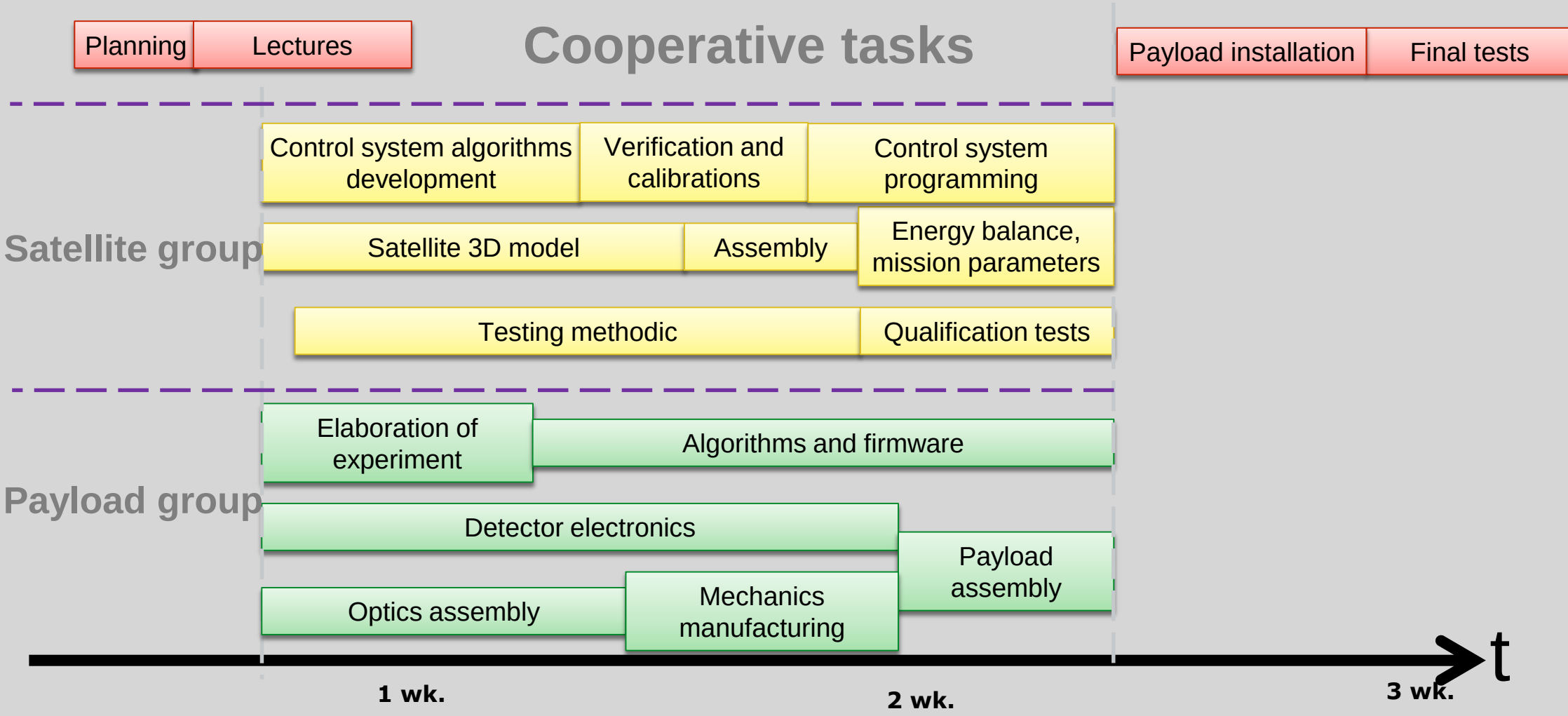
Hardware:

- Orbicraft Pro SXC1 kits

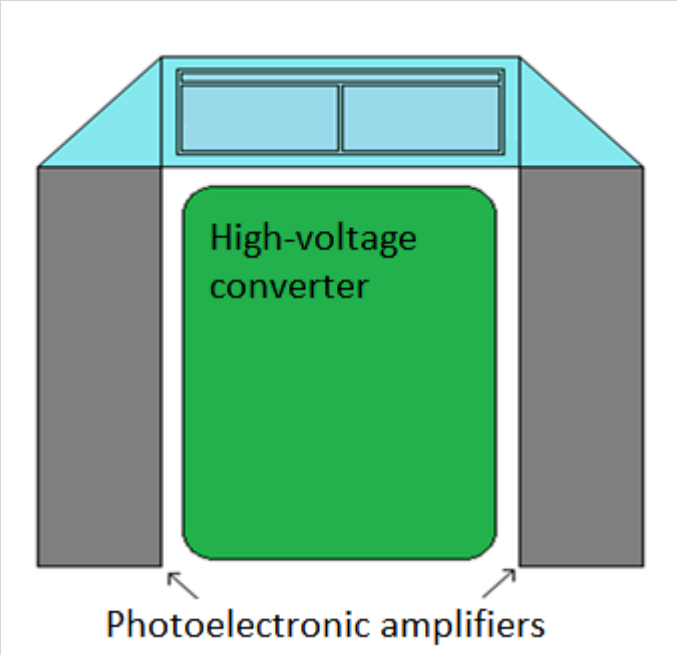
Engineering:

- Tutorials and classes for students
- Assembly and verification assistance
- Software and firmware examples

SiriusSat-1 mission: Schedule

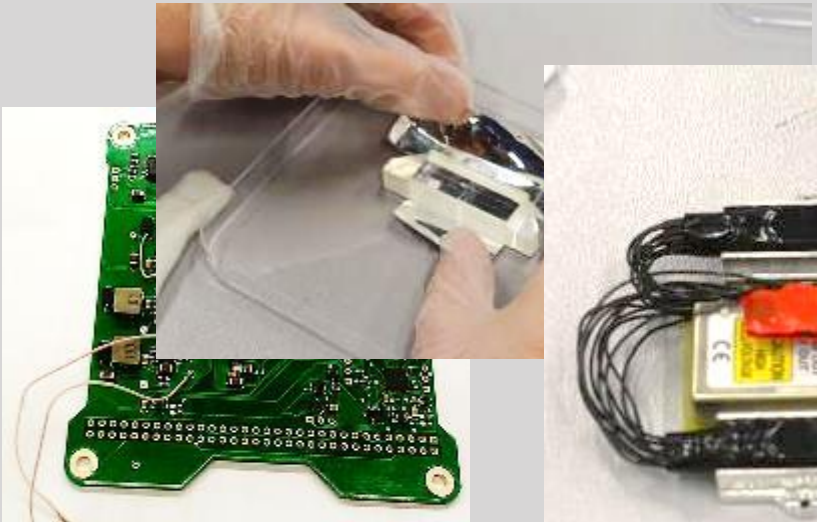


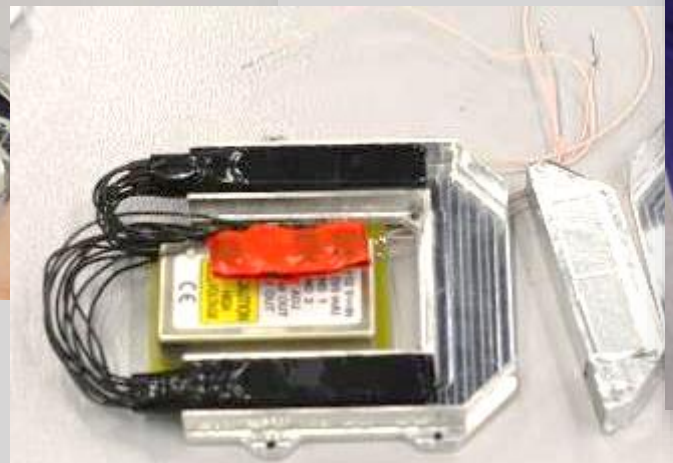
SiriusSat-1 mission: Payload

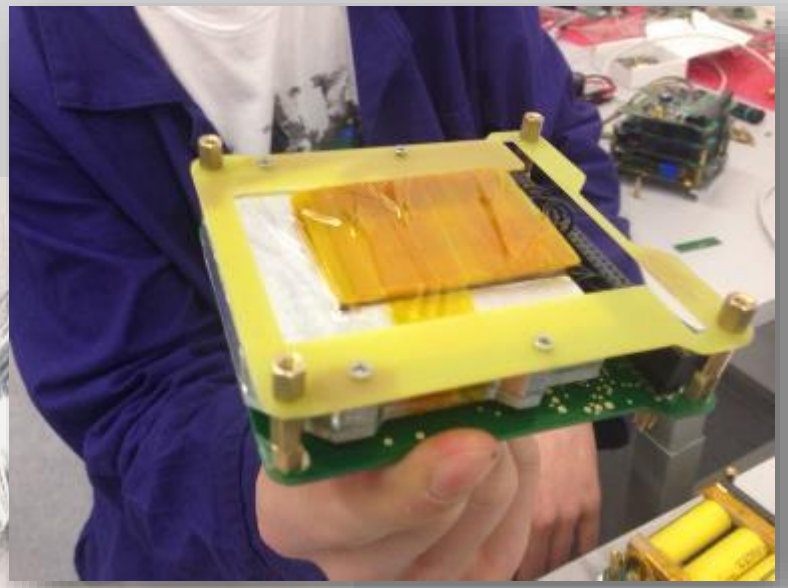


CubeSat compatible particle detector

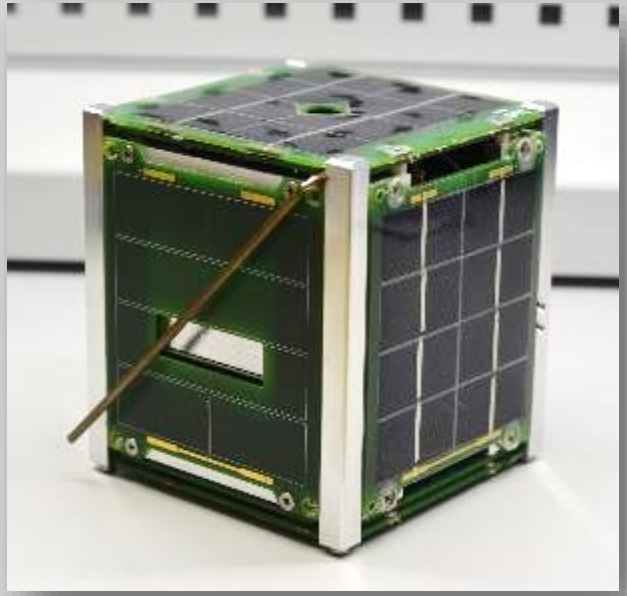
Weight	196 g
Power consumption	0.59 W
Count speed	50 us
Interface	CAN; USART
Dimensions	98 x 96 x 14 mm
Particle energy	Protons: 1-100 MeV Electrons: 0.1-40 MeV Gamma-quants: 0.03-2 MeV





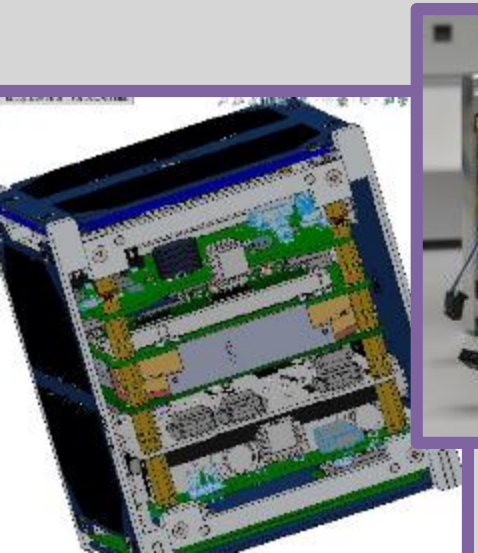


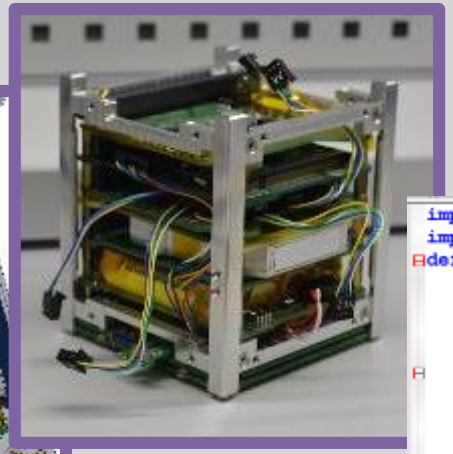
SiriusSat-1 mission: CubeSat satellite



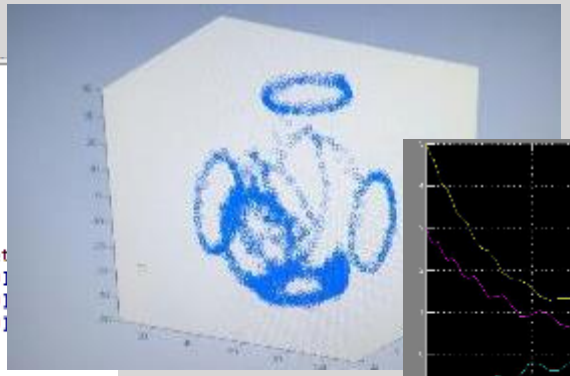
SiriusSat-1 satellite

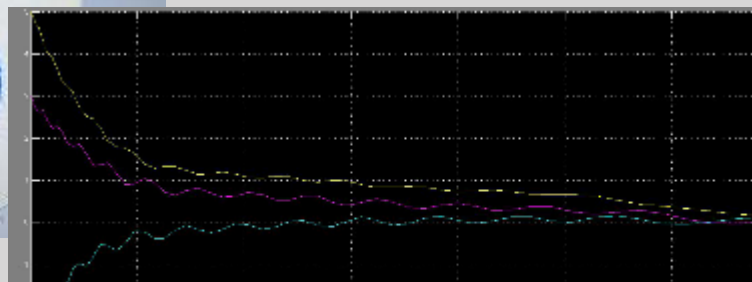
Weight	0.95 kg
Dimensions	CubeSat 1U
Radio	435 MHz
Stabilization system	Electromagnetic coils
Active lifetime	6 month





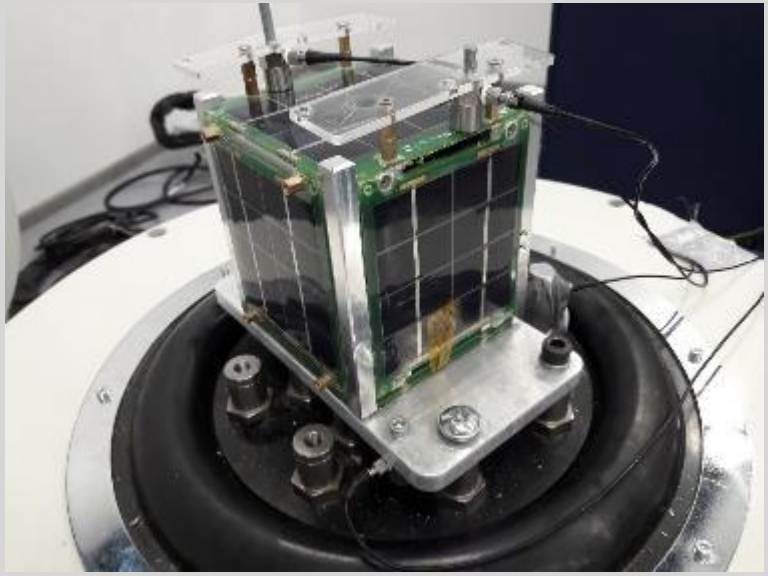
```
import time
import sys
def control():
    summx=0
    summy=0
    summz=0

    for i in range(100):
        output = hyro_get
        Mx = output[0][0]
        My = output[1][0]
        Mz = output[2][0]

        summx+=Mx
        summy+=My
```





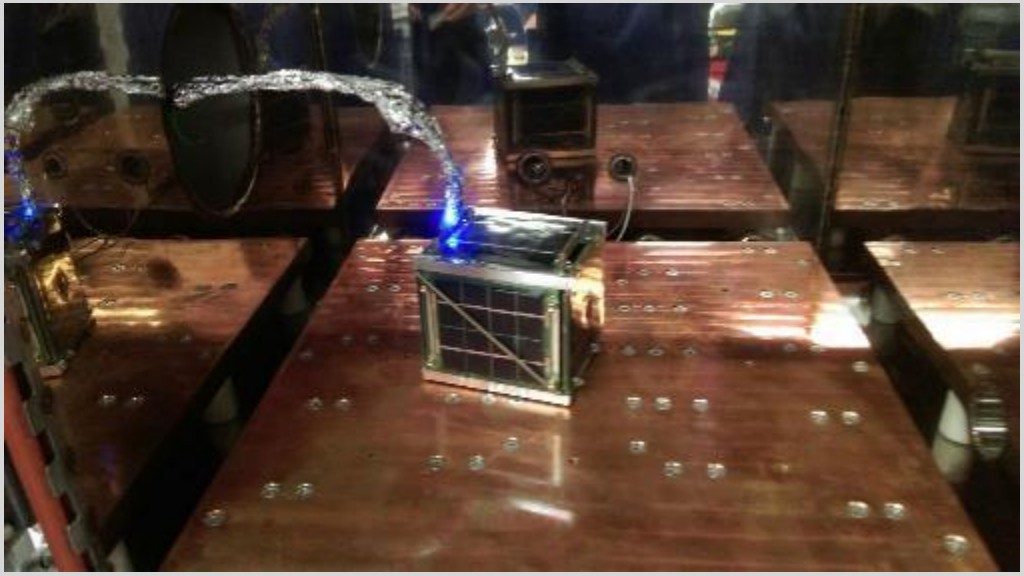
SiriusSat-1 mission: Testing

Vibration



Passed

Vacuum and temperature



Passed

SiriusSat-1 mission: Mission and launch

1. Free educational launch with Roscosmos in 2017

2. Participant of RKK Energy “Radioscaf” program 2018

3. Launch to ISS on May 2018 with Soyuz rocket

4. Cosmonauts to throw the Sirius Sat out of their home in autumn 2018

Conclusion:

Goals of the platform:

- Robust and solid serial design – successful, but some parts need review
- Educational applications – successful
- Low-cost universities CubeSats – yet no experience
- Space missions – waiting for flight qualification in 2018

Perspective:

- 2 launches per year since 2018 with Radioscaf
- Strongly depends on the SiriusSat-1 mission

Thank you for your attention!

SPUTNIX

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