WildtrackCube-SIMBA
an experimental university-class Cubesat for efficient wildlife tracking in Kenya

Fabio Santoni
DIAEE – Sapienza University of Rome, Rome, Italy

KENYA SPACE AGENCY
Possibilities beyond our skies

Agenzia Spaziale Italiana

58th Scientific and Technical Subcommittee, 22 April 2021

Motivation and objectives of WildTrackCube-SIMBA

(**S**ystem for **I**mproved **M**onitoring of the **B**ehavior of **A**nimals)

- General need for accurate data to support decision-making aimed at improving living conditions and sustainable economies
- Thousands of **human-wildlife conflict incidents** reported every year in Kenya, involving crop raiding, livestock depredation, property damage, and even injuries or loss of human lives, with **socioeconomic impact** on rural areas, where crops and livestock represent the main livelihood.
- Wildlife poaching and trafficking (mainly ivory and rhino horn)

- **Main need: monitor animal movements** to respond more effectively to human-wildlife conflict incidents
- **Ground-based radio-telemetry** is a valuable tool for tracking animal movement and behavior, but **not very useful for long-distance migrants**
- **Traditional satellite-based systems** cover large areas, but very expensive for large-scale long-lasting missions
- **Specifically developed satellite-based systems using GPS tags on the animals and Cubesats as datarelay, have a strong potential of extending the covered area effectively and at a reasonable cost**
- **WildTrackCube-SIMBA aim**: developing the appropriate tools and **demonstrate the technology on a 1U Cubesat**

Team composition

The team involves students and professors from university institutions in Italy and Kenya:

- **Sapienza Space Systems and Space Development Laboratory (S5Lab)**

  Sapienza University of Rome, Italy

- **School of Environment and Natural Resource Management**
- **School of Engineering and Technology**

  Machakos University, Kenya

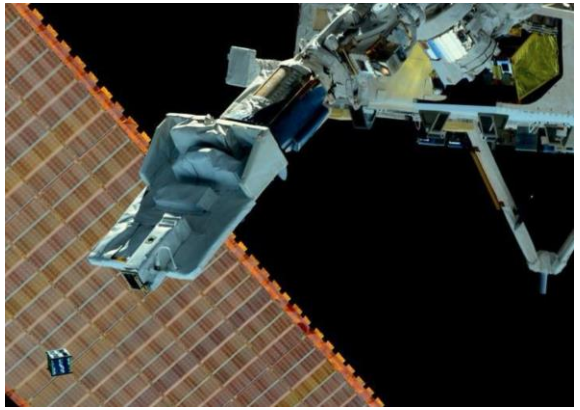
- **School of Biological Sciences**

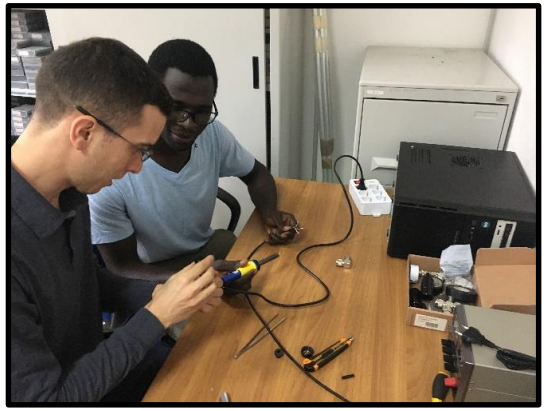
  University of Nairobi, Kenya

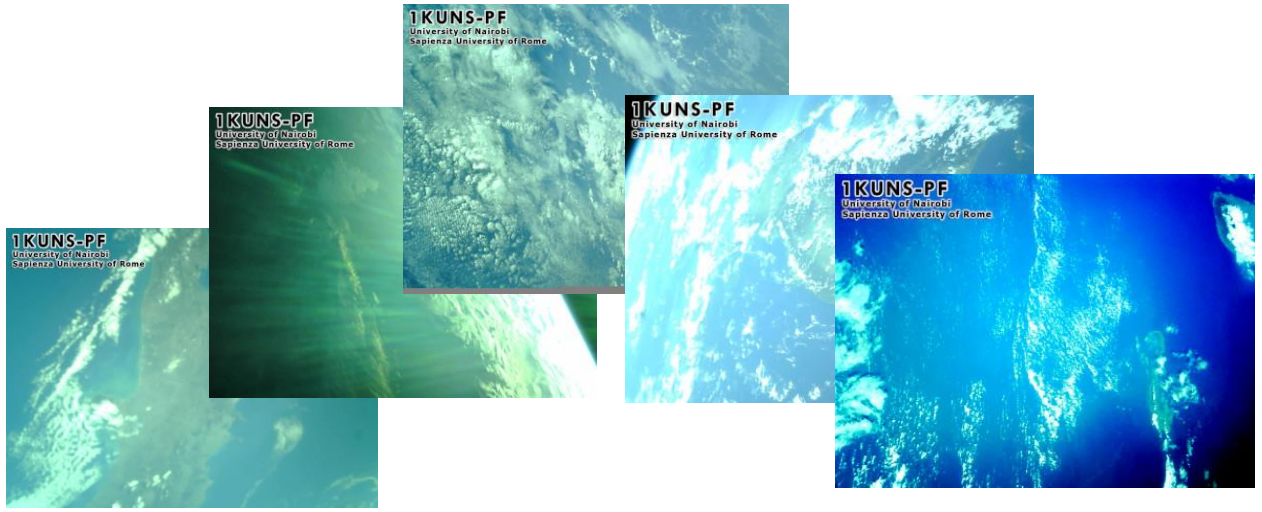
These three institutions established a strong cooperation in space programs, collaborating in the development of small satellites, space projects, capacity building activities and by jointly establishing an International Course in Capacity Building in Astronautics, in which professors and students from both countries are involved, with the participation and support from Italian Space Agency and Kenya Space Agency

Previous collaboration experience in jointed Italy-Kenya student-built satellites

- Sapienza University of Rome has a long collaboration experience with Kenya Universities
- A result of previos collaboration is the launch and operation of the first Kenya University nanosatellite **1KUNS-PF (https://1kuns-pf.ns0.it)**, the first beneficiary of the **UNOOSA-JAXA KiboCube program**, developed jointly with University of Nairobi.
- Deployed in orbit May 11, 2018; operational for more than two years; re-entered June 12, 2020
- WildtrackCube-SIMBA inherits and develops the lessons learned in the 1KUNS-PF capacity building program







Launch opportunity for WildtrackCube-SIMBA

WildTrackCube-SIMBA was proposed by the international student team and awarded as winner of a launch opportunity offered by IAF and GK Launch Services at the 70th IAC in October 2019:

« WIN A FREE LAUNCH OF 1U CUBESAT

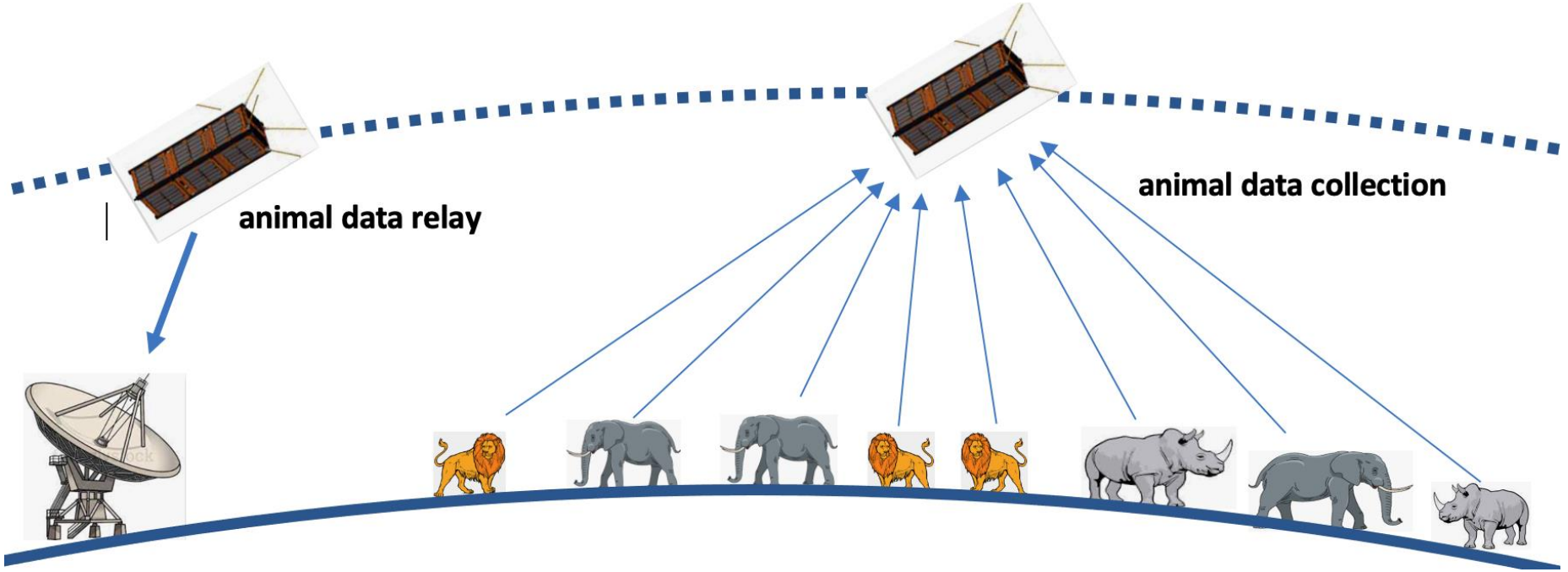
ON THE FIRST COMMERCIAL MISSION OF GK LAUNCH SERVICES »

System architecture

The animal data are collected by the Cubesat when the animals are in visibility, using a low power, low data rate spread spectrum coded data channel.

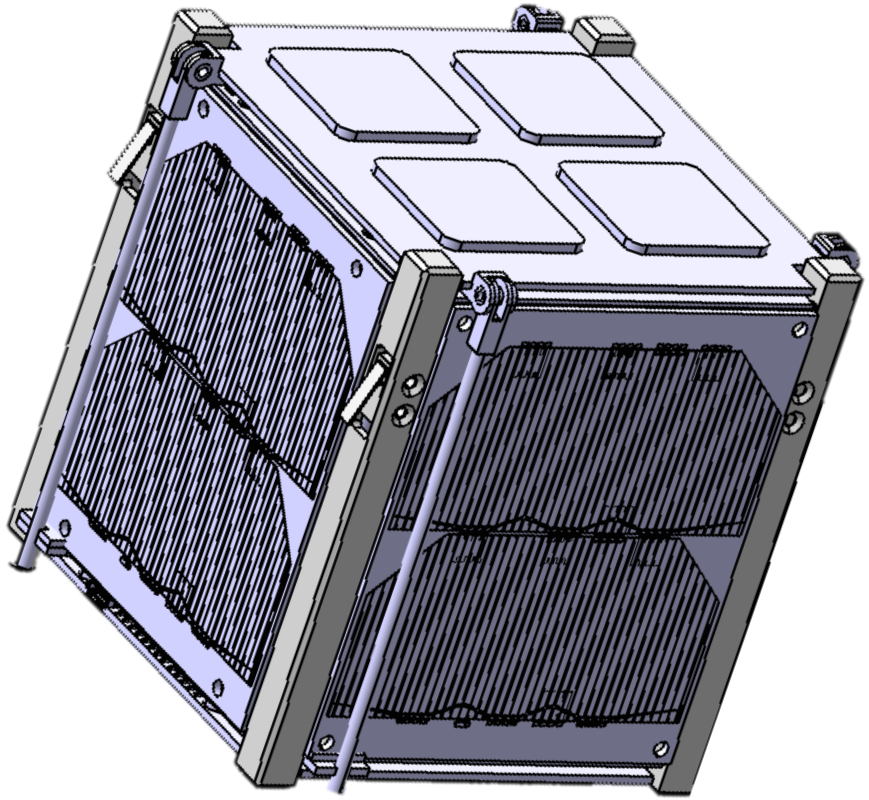
The stored data are downloaded to the animal data gathering ground station.

The novelty of the proposed technique is in the low-power (low-data rate) of the use spread spectrum modulation, allowing for long life and reduced maintenance of the collars.

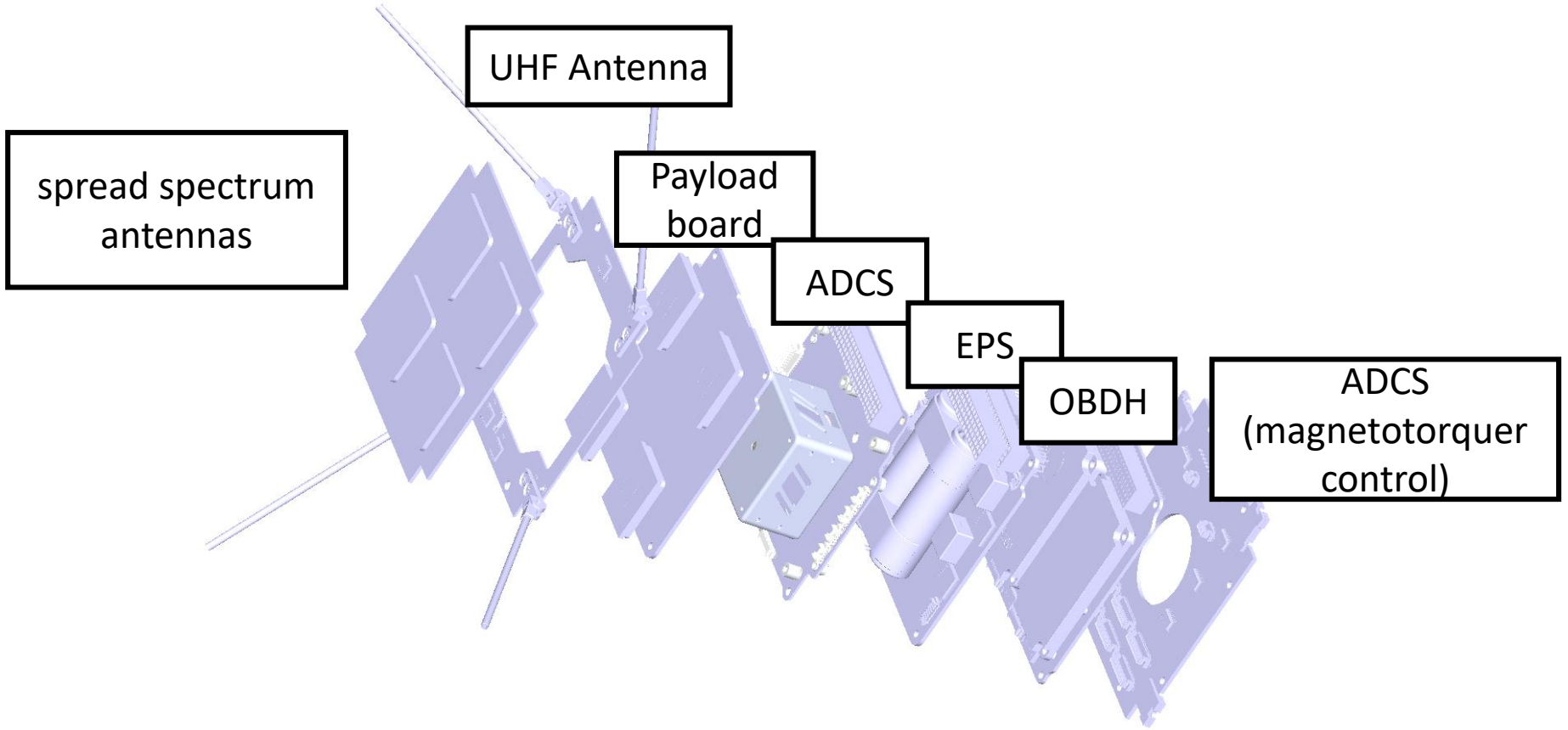


1U Cubesat testbed: Satellite design

- 1U CubeSat;
- Nominal development time of six months, from launch award announcement to satellite delivery to the launch authority
- Commercial bus components, in order to save development time and meet the strict timeline
- Maturity and experience acquired with 1KUNS-PF and IKUNS-B/LEDSAT;
- Payload: adaptation of terrestrial commercial Spread Spectrum receivers for wildlife data acquisition

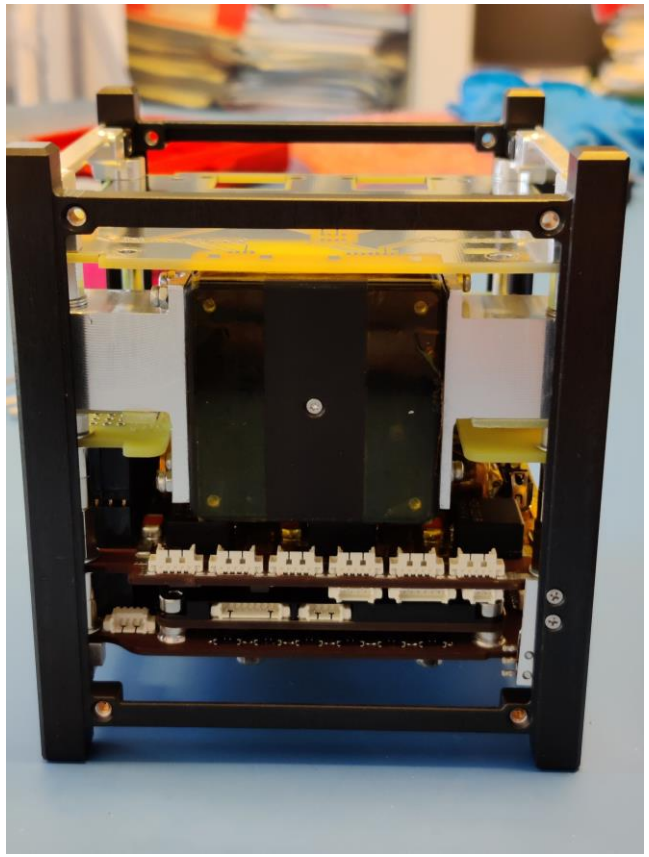


Satellite exploded view



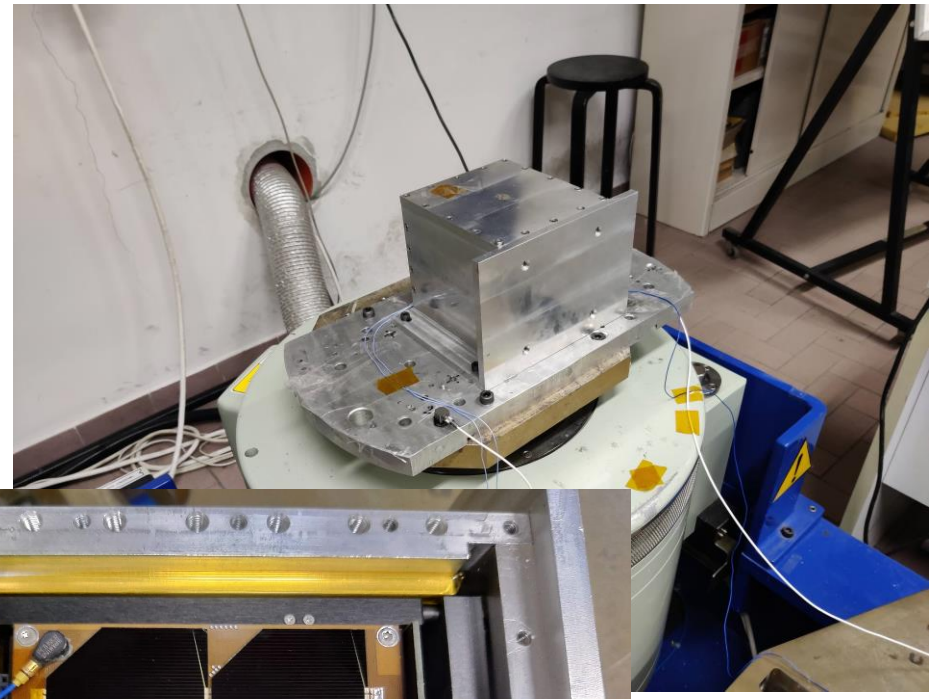
Satellite assembly

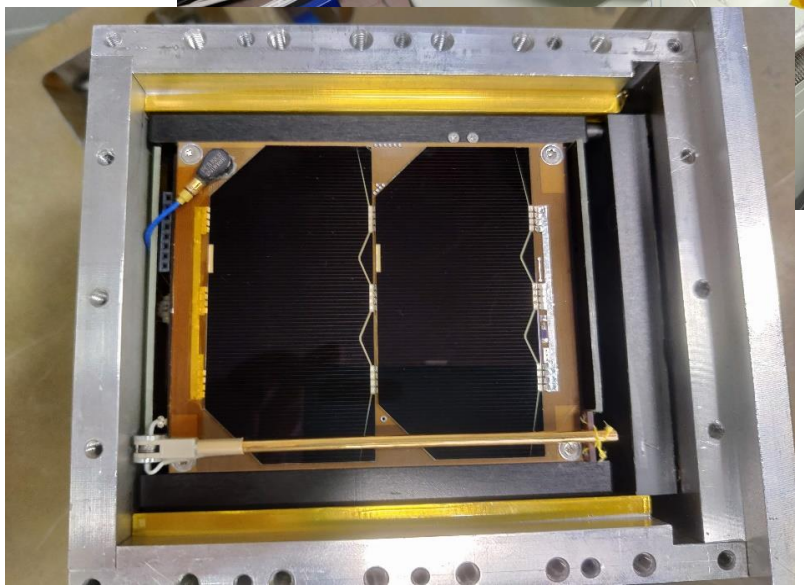
- Performed by following the assembly procedure of all COTS components and the defined procedure for in-house developed components
- Followed by health and rapid functionality checks



Satellite vibration testing

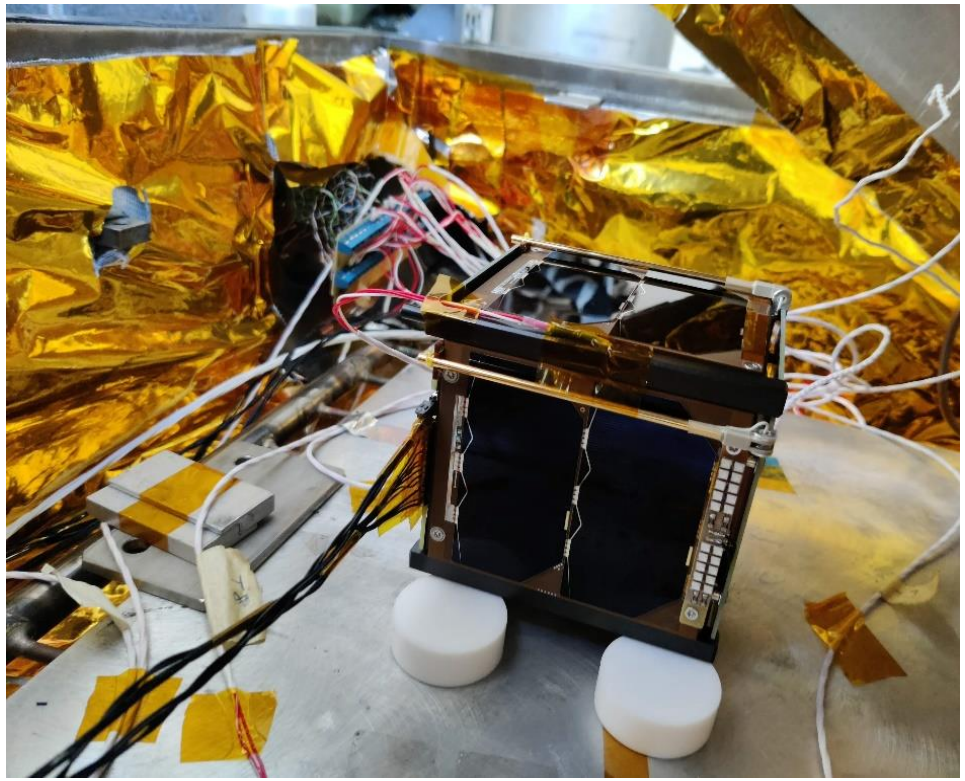
- Vibration testing (random, sine, quasi-static and shock as required by launch provider), performed in December 2020
- The post-test health checks and functional testing verified survivability to launcher vibrational environment





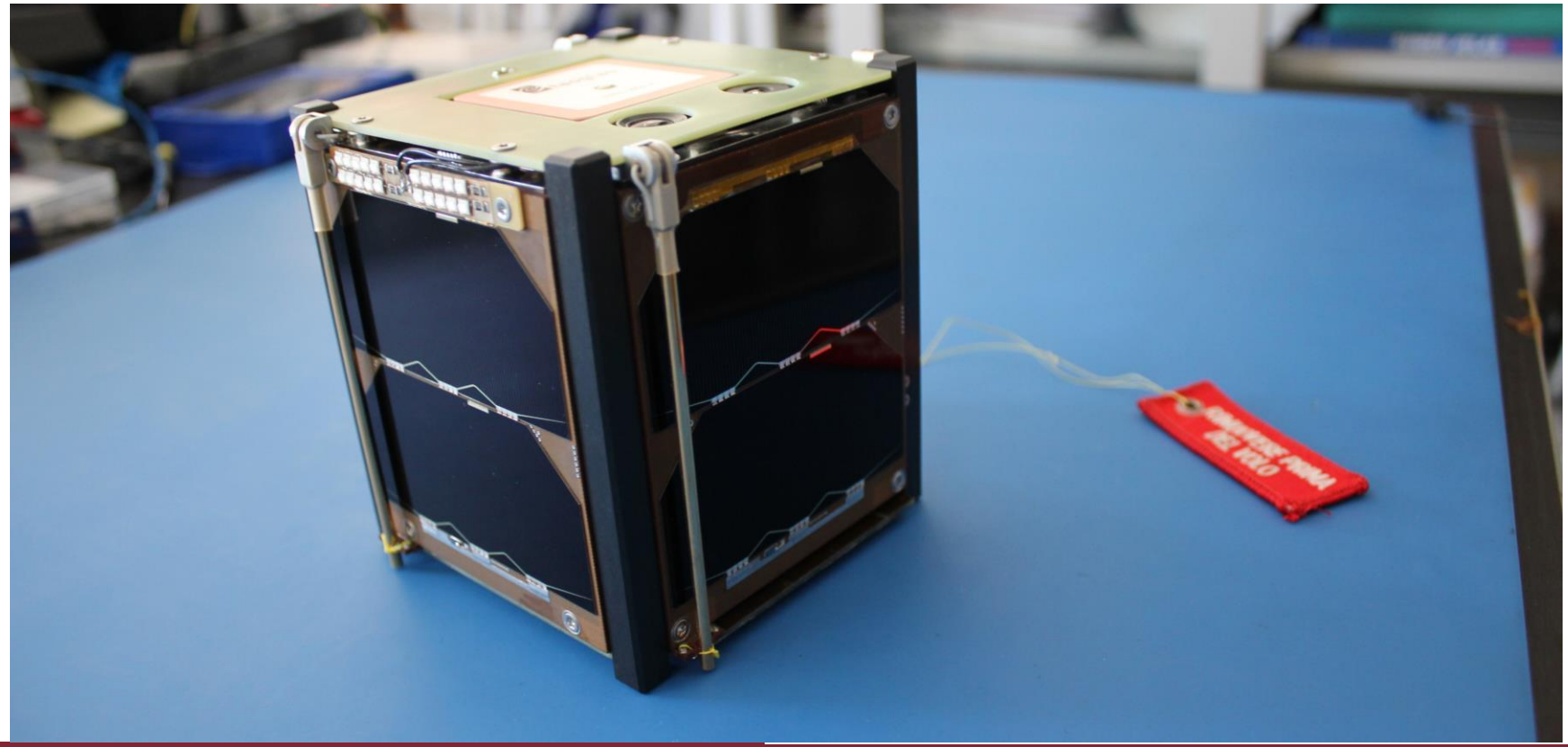
Satellite thermal-vacuum testing

- A thermal vacuum test proved the compliance of the nano-satellite with the orbital environment
- Health checks and functional testing before, during and after the thermal vaccum testing proved that the satellite was able to operate in orbit



Satellite integration campaign

- Satellite shipped to Moscow in mid-January 2021;
- Integration campaign on 11-12 February 2021;

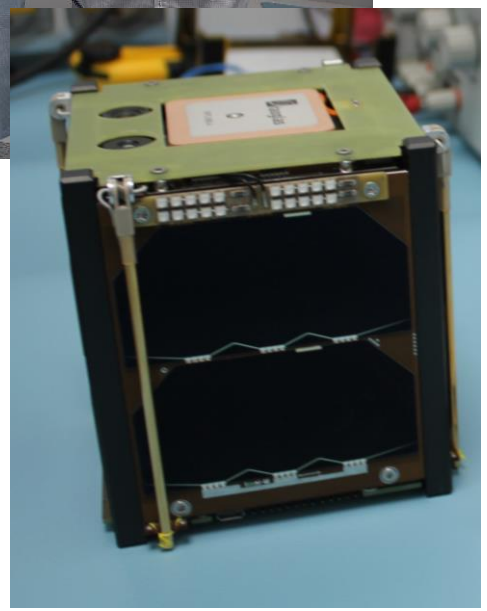


Satellite integration campaign

A team of students was in Moscow at the GK Launch Service facilites for:

- satellite pre-integration checks
- functional verification
- arming the satellite for LEOP
- integration of the satellite in the 12U satellite deployer

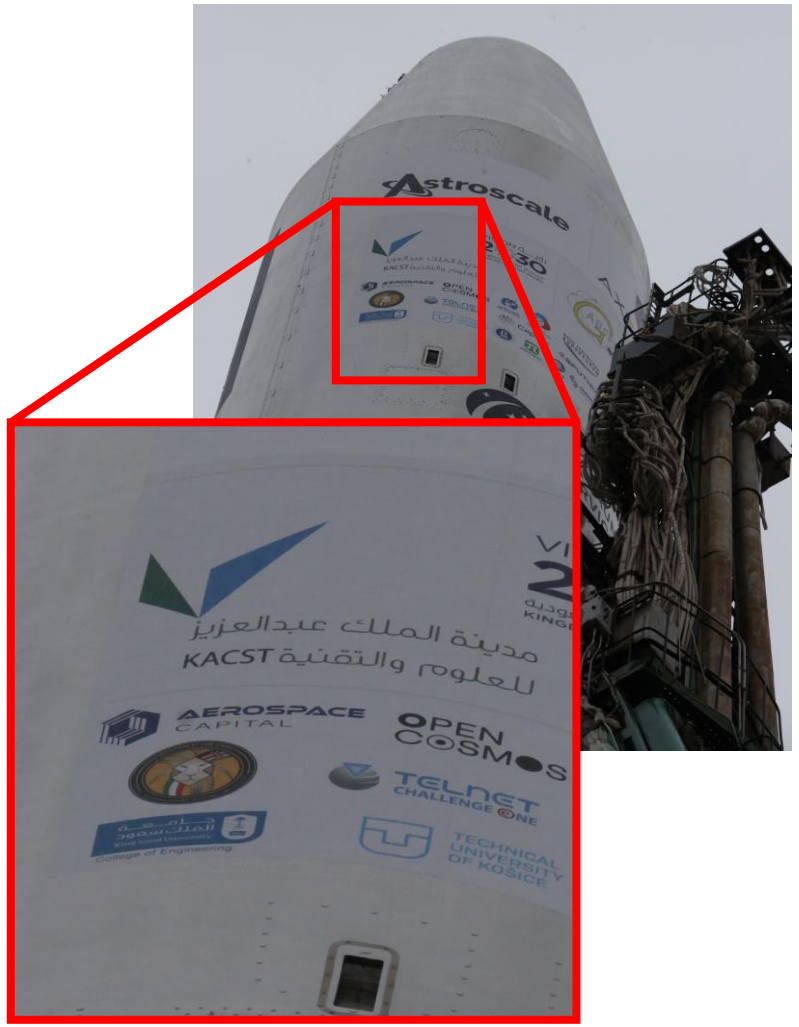
The students had direct responsibility for the conduction of the requested integration activities for the satellite.

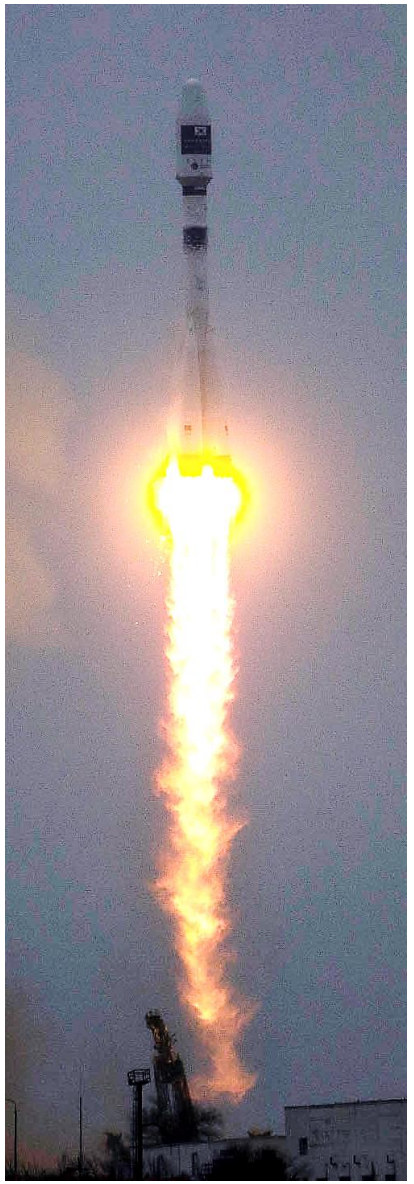


Launch from Baikonour Cosmodrome

- Satellite launched on
  22 March 2021
  at 11:07 local time (6:07 GMT)
  on board a Souyz launcher
  from the Baikonour Cosmodrome

- Main payload CAS500-1
- Multiple launch of 37 small satellites

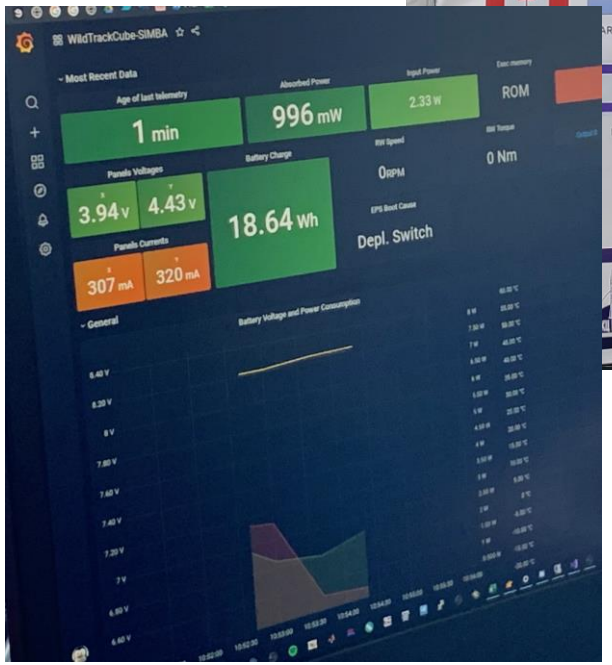




Launch from Baikonour Cosmodrome

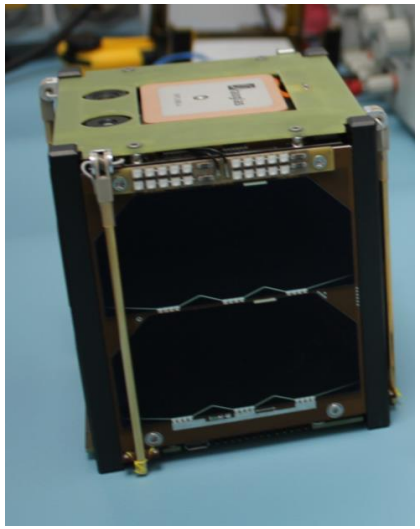
- Spacecraft deployed in orbit nearly 3 hours after the lift-off

- First telemetry received approximately 20 minutes after deployment in orbit



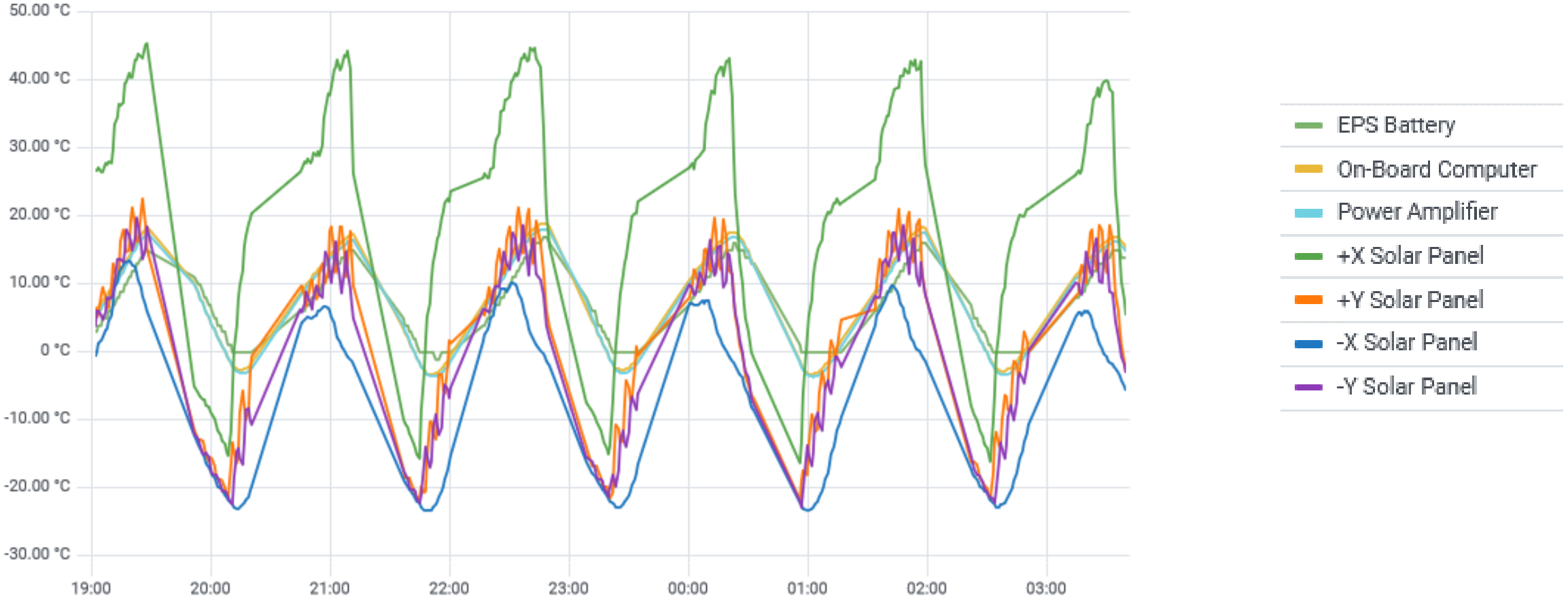
First operations and Commissioning

- The satellite commissioning is ongoing, including verification of all functionalities, sensor calibration, attitude actuators performance assessment



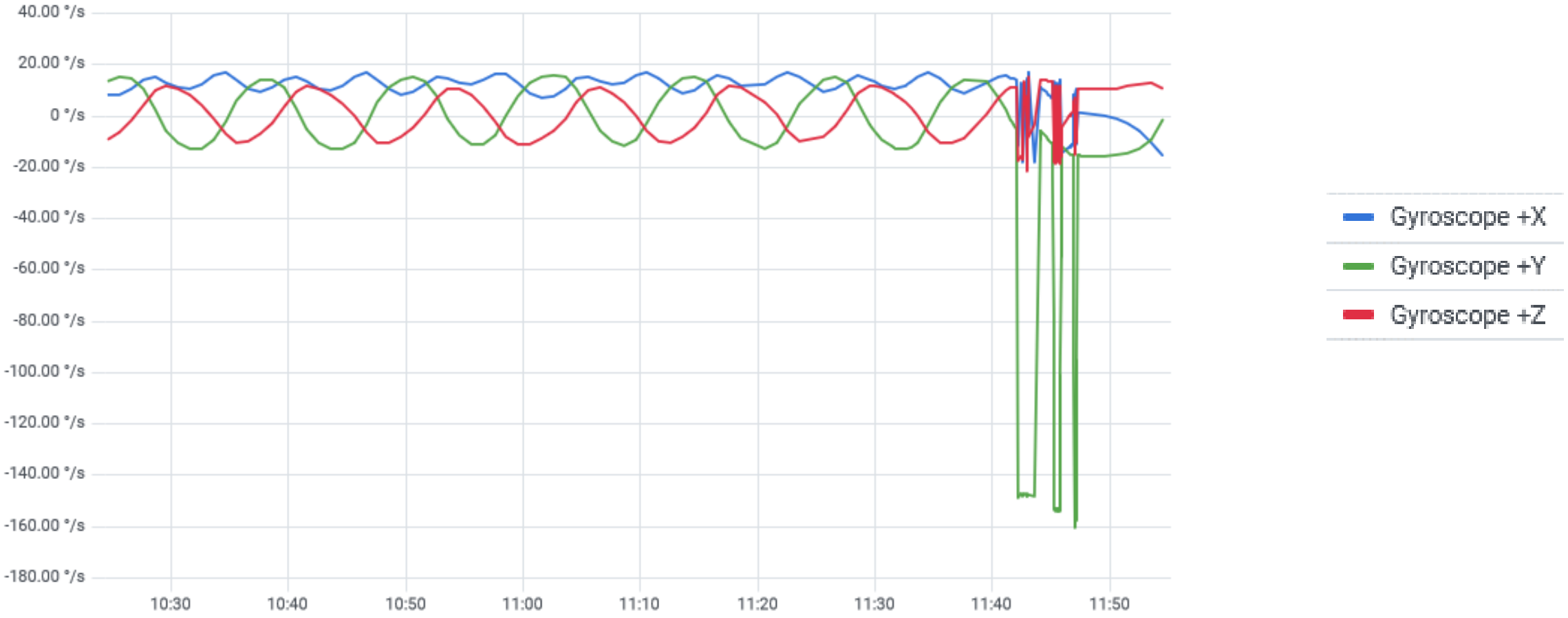
Example of telemetry data

- Temperatures



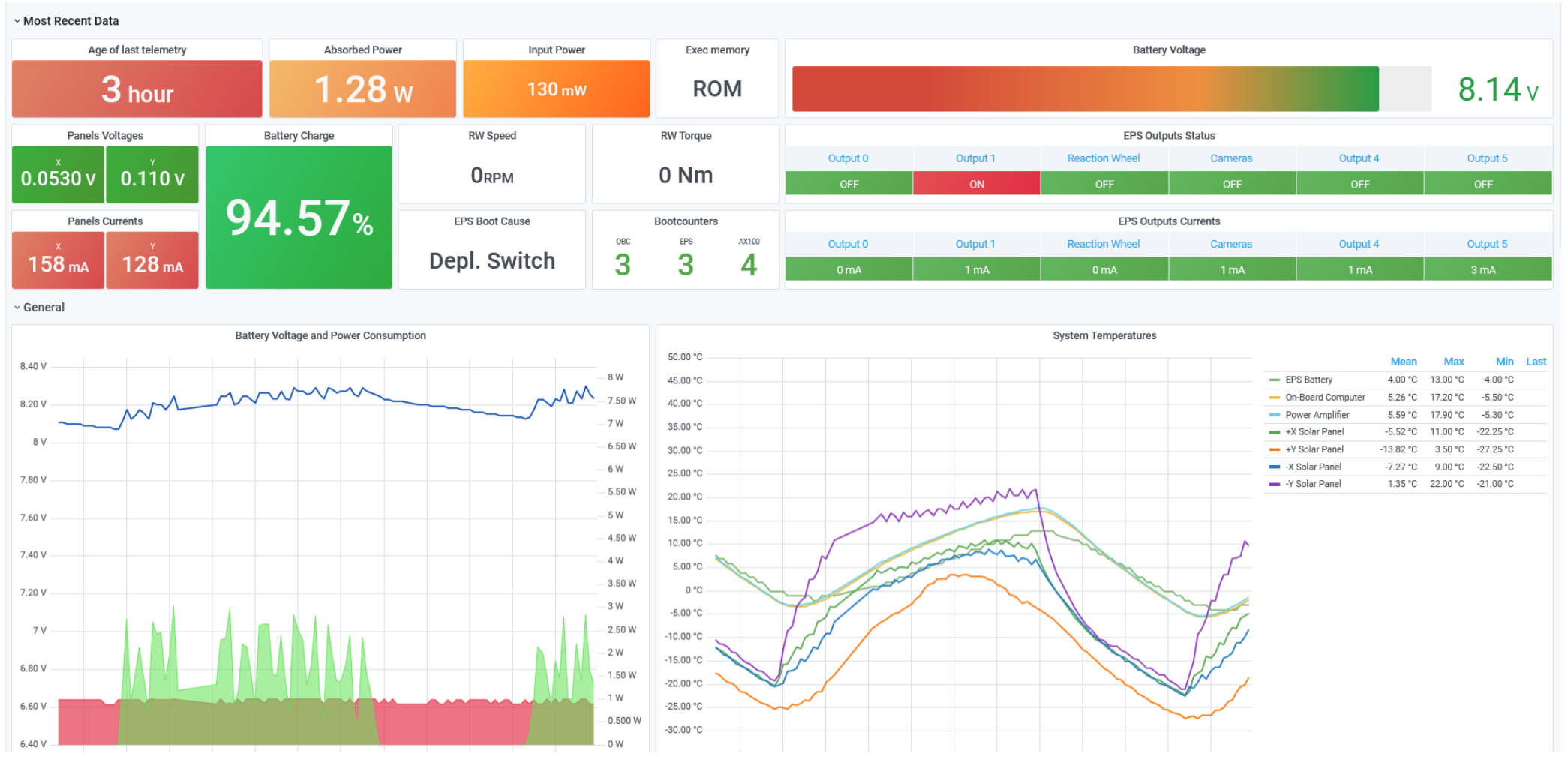
Example of telemetry data

- Angular velocity measurments from the on-board solid state gyro during preliminary reaction wheel testing



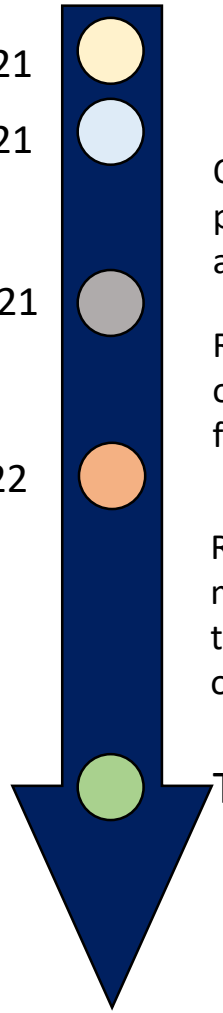
Example of telemetry data

- Main dashboard view for telemetry visualization



Mission development timeline

- Operations expected duration: about 3 years



Launch: 22 March 2021

Commissioning end: 22 May 2021

On-board RF system verification – communication with multiple prototypes of spread spectrum transceivers, decreasing the gain at ground to ensure proper communication

October 2021

RF system operations with different prototypes of animal tags: operations one at a time for verification of system performances – further prototypation of tag RF devices

April 2022

RF operational tests with multiple tags deployed: memory and data management and down link operations tests, first deployment of tags and verification on the on-ground operations. First deployment on animals

December 2021

The tracking system concludes demonstration

Conclusions

- The university satellite WildTrackCube-SIMBA mission was described
- The mission aims at demonstrating an effective and potentially low cost technique for wildlife monitoring, based on low-power spread spectrum technique
- The mission goals fit with the goals of Agenda 2030, mainly addressing **Life on Earth**, and, indirectly, **Quality Education** and **Industry, Innovation and Infrastructure**
- The satellite was launched on the first GK commercial launch on March 22, 2021, as the winner of a international contest promoted by IAF and GK Launch Services
- Commissioning is ongoing, showing nominal operations after one month from deployment in orbit
- The mission is a valid tool for fostering international cooperation among young students and professionals in the framework of the Italy-Kenya collaboration agreement

Thank you for your attention

fabio.santoni@uniroma1.it