Educational Activity Of Sapienza Space Systems And Space Surveillance Laboratory – S5lab

1st Symposium on Space Educational Activities

Padova, 9-12 December 2015

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- University Satellite Development
- URSA MAIOR nano-satellite
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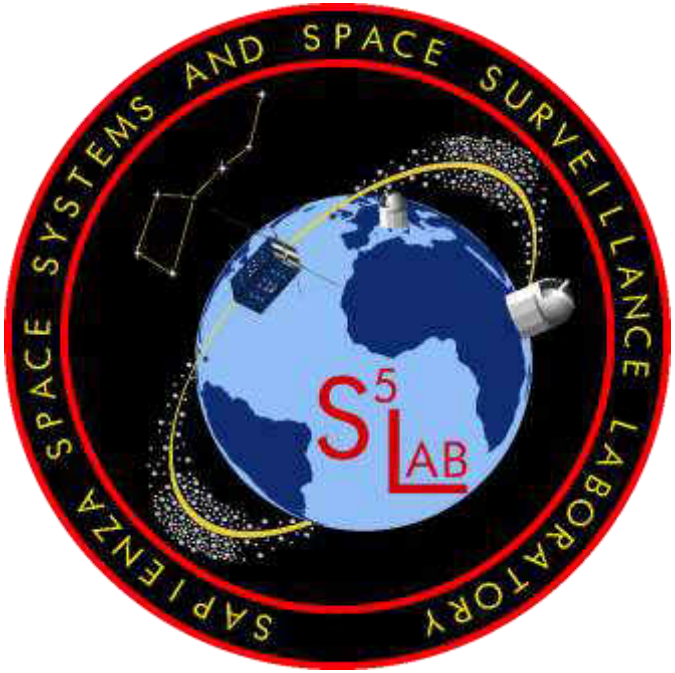

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S5Lab EDUCATIONAL ACTIVITY

❖ Satellite systems design

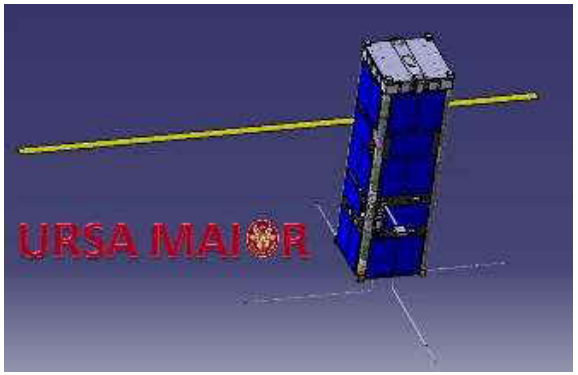
- Mission analysis
- On-board systems/sub-system
- Ground station operations
- Data handling and processing

❖ Space surveillance systems

- Optical observation systems
- Data analysis
- Orbit determination
- Active debris removal systems

ON-GOING SPACE PROJECTS

- **URSA MAIOR nano-satellite**



- **EQUO project**

- **REXUS/BEXUS programme**

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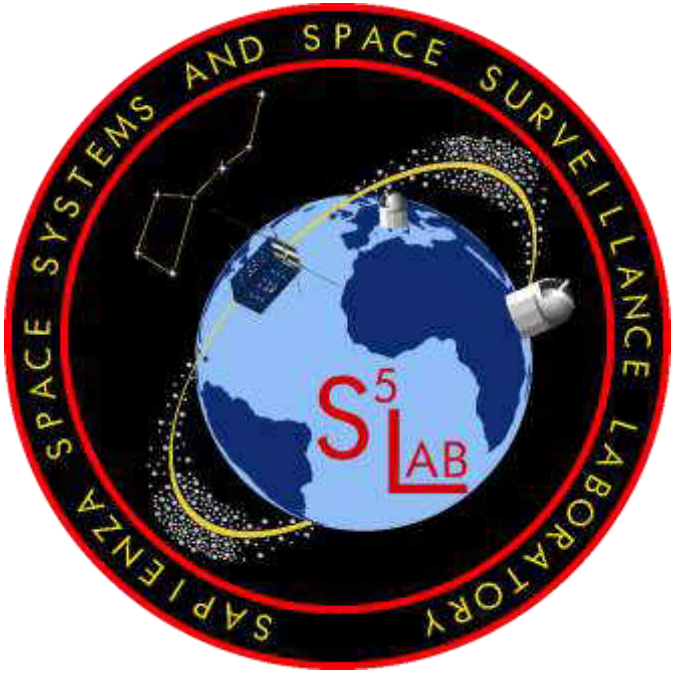

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UNIVERSITY SATELLITE

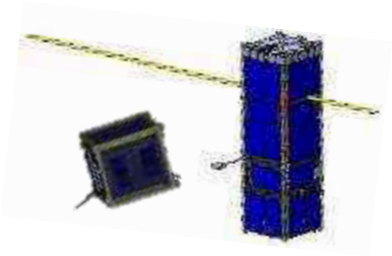
- It is a **functional spacecraft**, rather than a payload instrument or component. To fit the definition, the device **must operate in space with its own independent means of communications and command**

- **Untrained personnel** (i.e. students) performed a significant fraction of key design decisions, integration & testing, and flight operations

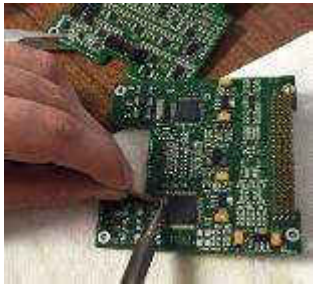
- **The training of these people was as important as** (if not more important) **the nominal "mission"** of the spacecraft itself

SMALL SATELLITE DEVELOPMENT

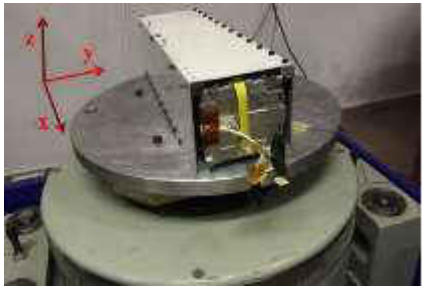
❖ Design



❖ Manufacturing



❖ Testing



❖ Operations

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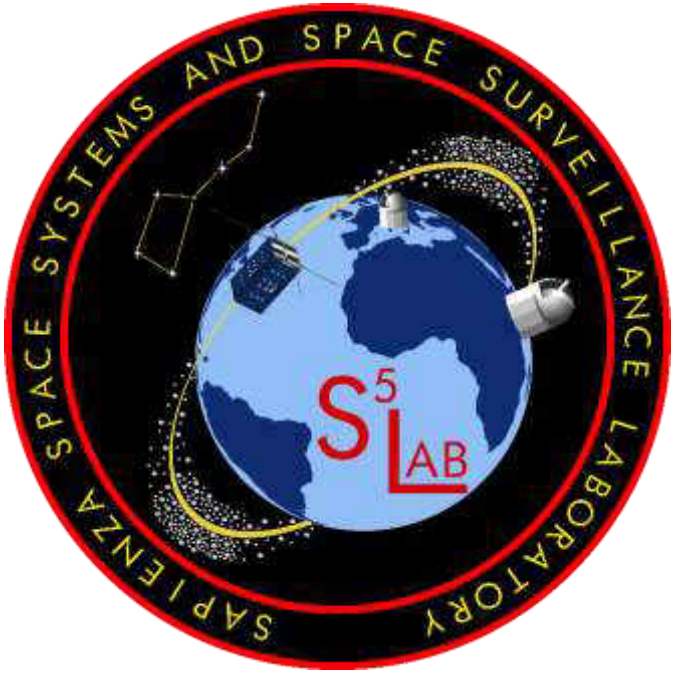

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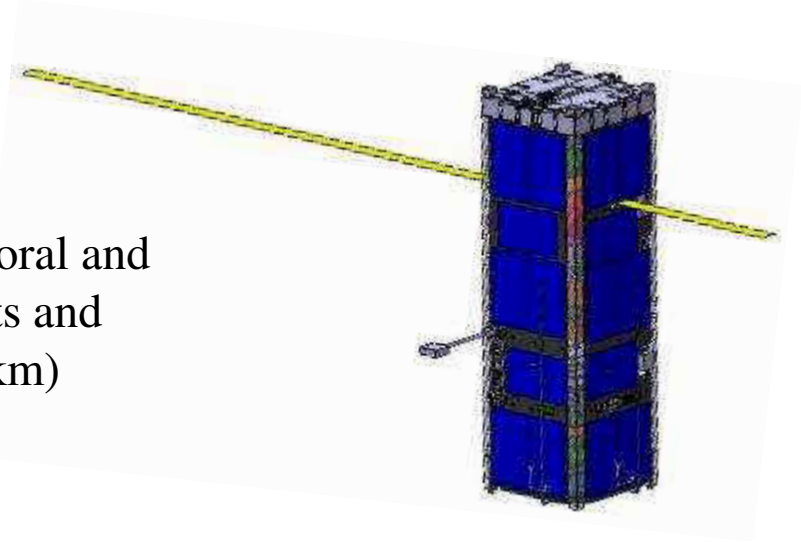
URSA MAIOR

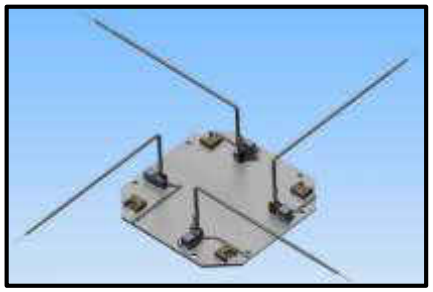
University of Rome la SApienza Micro Attitude In ORbit testing

QB50 Project

QB50 scientific project aims to **study** in-situ temporal and spatial variations of a number of key constituents and parameters in the **lower thermosphere** (400 km) **with a network of 50 CubeSats**

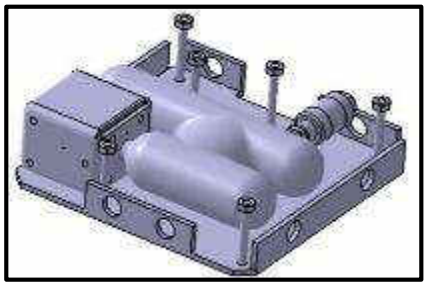


Scientific/Technological Payloads



mNLP

ARTICA



MEMIT

STRUCTURE DESIGN

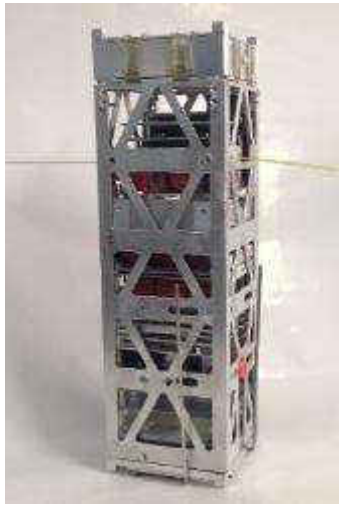
URSA MAIOR structure main features

- **Custom-designed single-piece structure**

- It was realized from an **alluminum** profile with 100mm x 100mm x 2mm of section

- The four faces are characterized by **triangular-shaped holes** manufactured by the S5Lab milling machine

- **alluminum profile Thickness**: 2 mm



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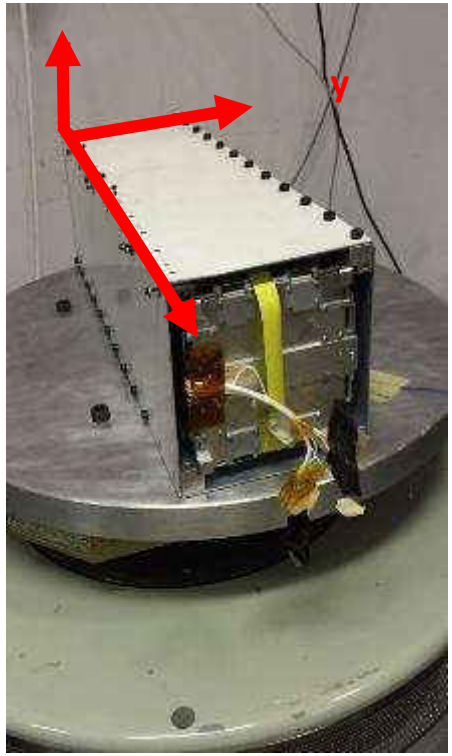
STRUCTURE MANUFACTURING

- The **alluminum profile** was properly **milled in order to obtain triangular-shaped holes** in the four faces in order to **maximize the stiffness-to-weight ratio while preserving a continuous path for heat conduction and a high degree of accessibility**

VIBRATIONAL TESTING CAMPAIGN



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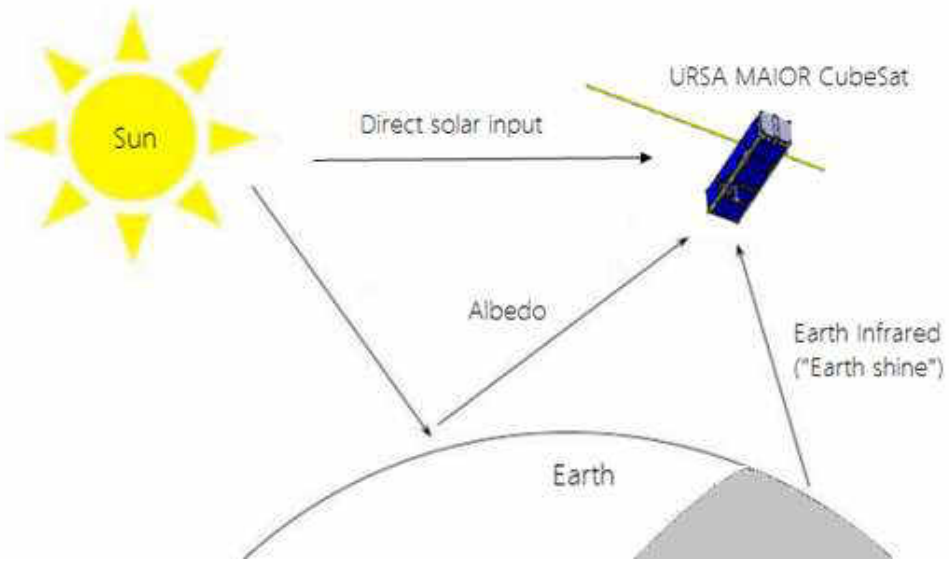
THERMAL ANALYSIS

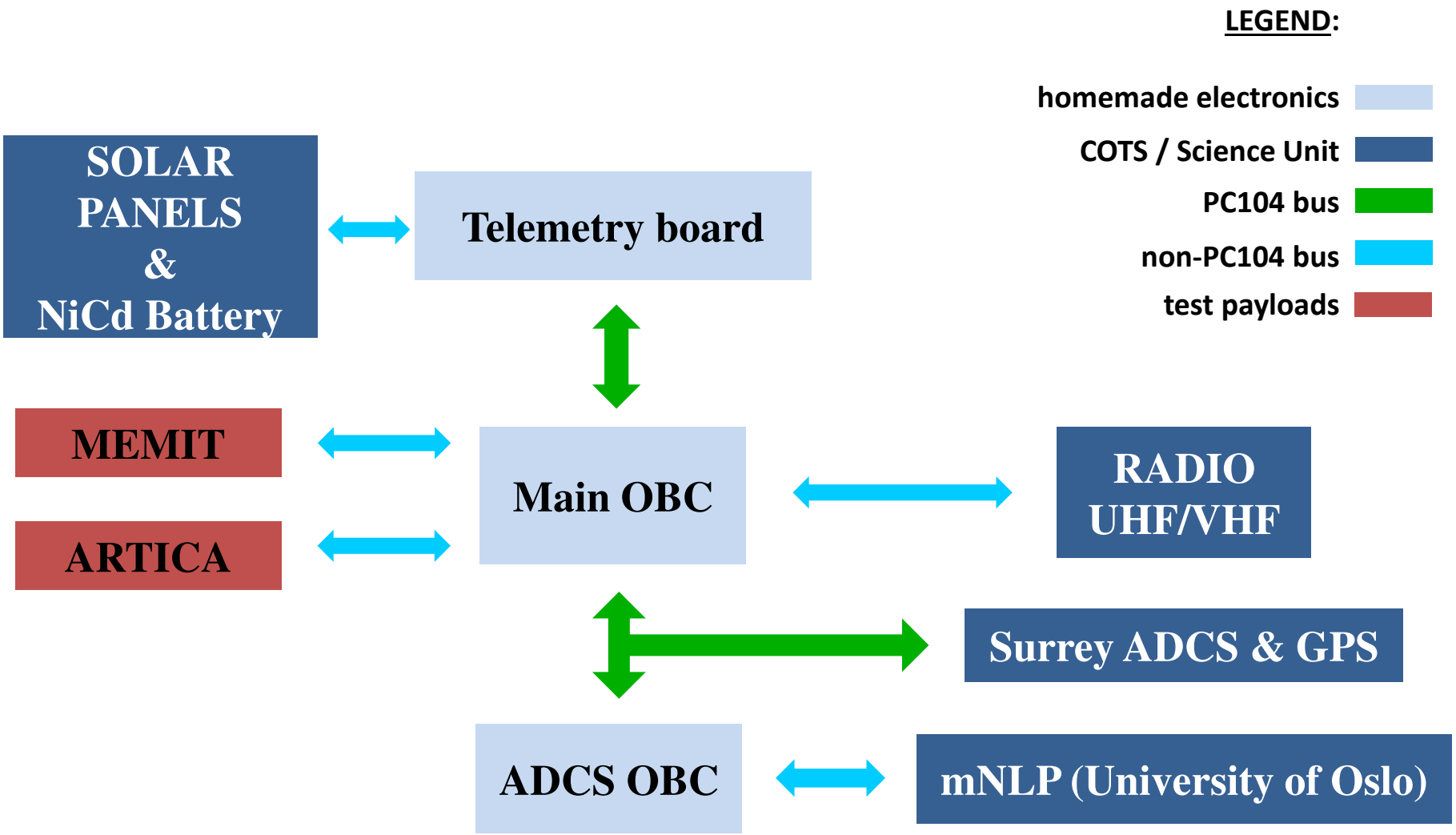
The **Thermal Analysis** was performed using a **numerical tool** and a **specialised software**, considering the satellite's thermal exchange between its external surfaces and the Sun, the Earth and the deep space and for the cubesat a **constant thermal capacity**

- **Thermal Analysis carried out taking into account:**

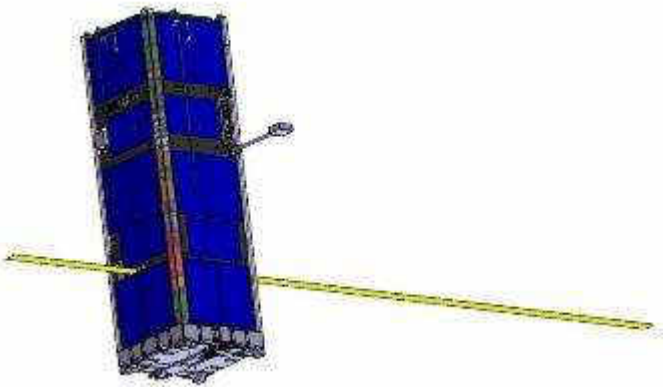
  - ✓ Albedo effects
  - ✓ IR radiation of the Earth
  - ✓ Constant thermal capacity
  - ✓ Different values of Emissivity and Absorptivity of the solar panels and the aluminum panel of the small faces



SUBSYSTEMS OVERVIEW

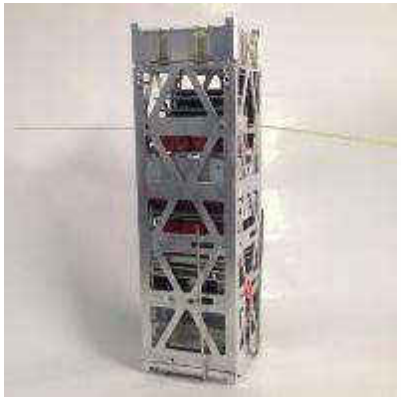


DEVELOPMENT OVERVIEW

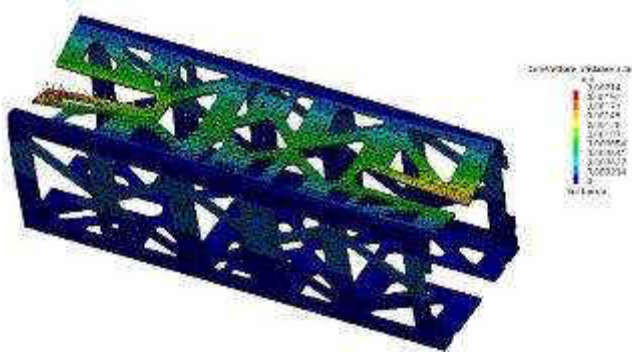


URSA MAIOR CAD

URSA MAIOR mock-up



URSA MAIOR
Flight model



URSA MAIOR FEM

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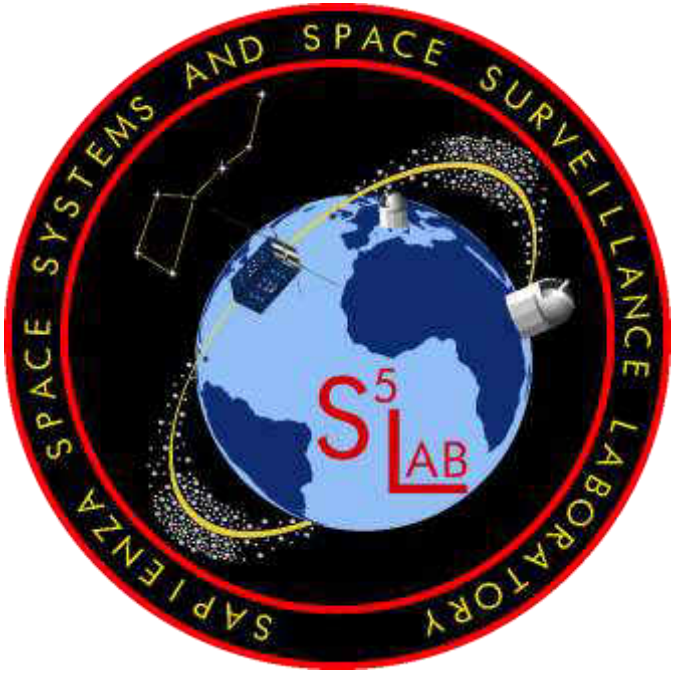

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EQUO

EQUatorial italian Observatory

Equatorial Italian Observatory is a project in cooperation between ASI and Sapienza Space Systems and Space Surveillance Laboratory (S5Lab).

Its main purpose is to develop and start operations of an **Equatorial Observatory** at the Broglio Space Center in Malindi, Kenya, intended **for observation of space debris**

agenzia spaziale italiana

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OBSERVATORY LOCATION

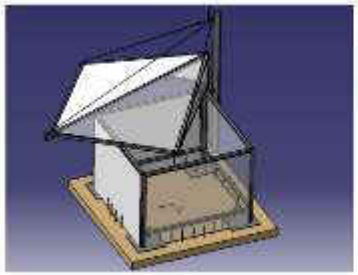
EQUO observatory will consist of **two observation sites**:

- **EQUO-OG**, located at the BSC base camp
- **EQUO-OS**, located on the San Marco off-shore platform

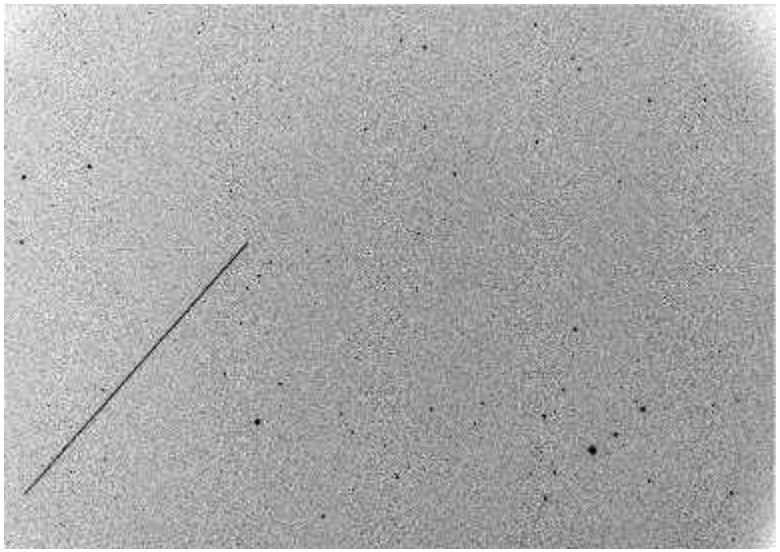
OBSERVATORY COMPONENTS

The **main components of the observatory** are:

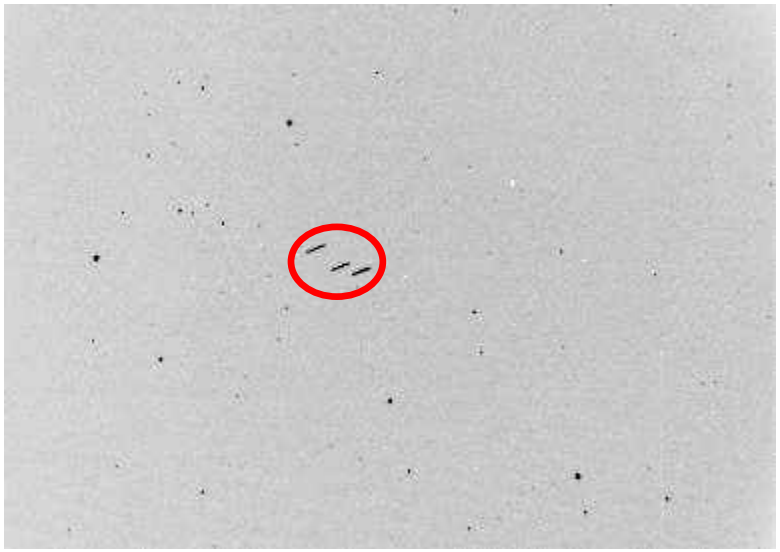
- **Telescope**
- **Mount**
- **Computer**
- **CCDs**
- **Software**
- **Dome**



OBSERVATION TEST CAMPAIGN



Koronas-Foton SSN 33504
(2015-06-19 22:57:00 UTC with 2 sec exposure time)



Eutelsat Hot Bird 13B, 13C, 13D
(2015-09-22 18:32:38 UTC with 6 sec exposure time)

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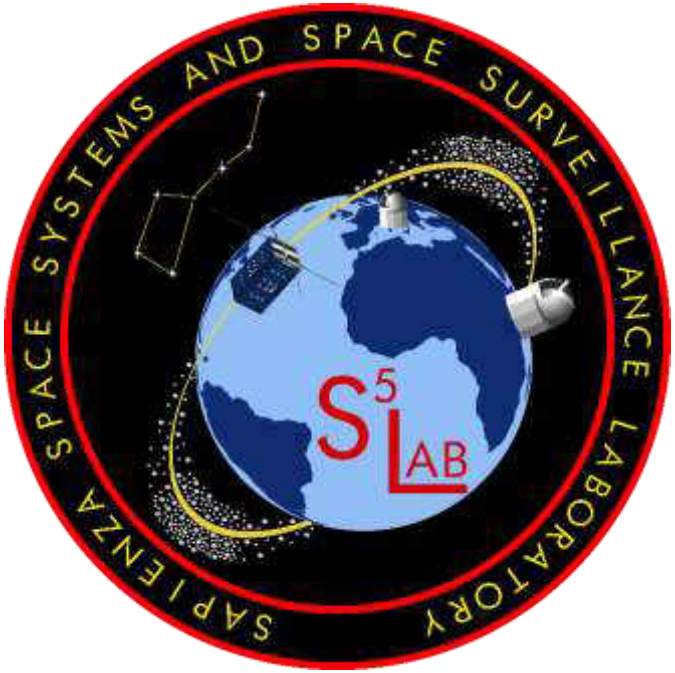

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REXUS/BEXUS

Rocket and Balloon Experiments for University Students

The **REXUS/BEXUS** is realised under a bilateral Agency Agreement between the German Aerospace Center (DLR) and the Swedish National Space Board (SNSB) and **allows students** from universities and higher education colleges across Europe **to carry out scientific and technological experiments on research rockets and balloons**

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IRIDIUM

Investigating Radiation Impact an Damages In UV-sensitive Materials

- Stratospheric balloon mission, 3-5 h flight
- Pre-flight tests
- Post-recovery tests
- Laboratory tests

- UV damages on sensitive materials
- 25-30 km of altitude
- Collaboration with DAEMON
- Wide outreach programme

- Follow the Sun

STRATONAV

STRATOspherical NAVigation experiment

- Test a COTS VOR receiver in a Stratospherical Ballon Mission
- Possibility to extend Extension the radio Navaids for stratospherical flight

- High altitude measurements
- Optimal VOR stations frequencies
- Test a low-cost system
- Wide Outreach Campaign

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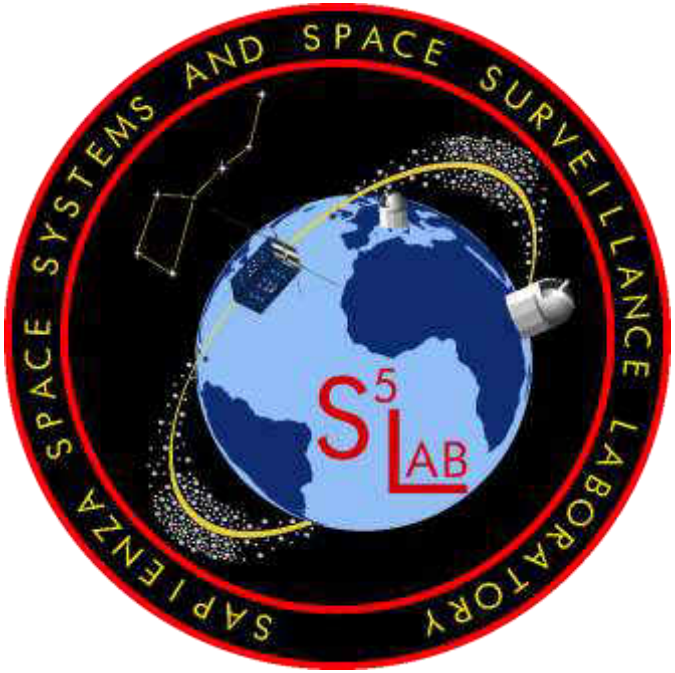

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S5Lab FACILITIES

- **MANUFACTURING PHASE** (Structure and Electronics)

Engineering Faculty Workshop

S5Lab Milling Machine

S5Lab Electronic Laboratory and related equipment

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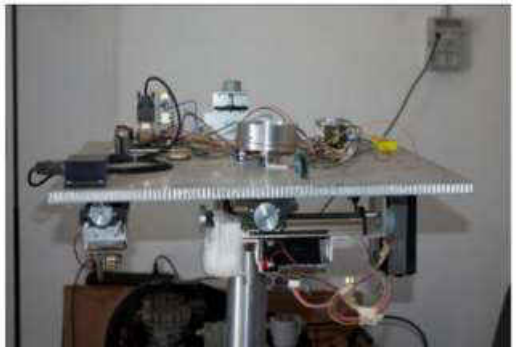
S5Lab FACILITIES

- **TESTING PHASE**

Low-Vacuum Chamber

S5Lab Sun Simulator

S5Lab 3D Helmholtz coil system
(Magnetic field simulator)



S5Lab frictionless air bearing system for spacecraft attitude dynamics and control testing

S5Lab 3 DoF ADCS test-bed equipped with
Control Moment Gyros (CMGs)

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S5Lab FACILITIES

- **OPERATIONAL PHASE:**

S5Lab Remotely controlled space debris observatory

S5Lab URBE Airport GS

S5Lab GS management facilities

S5Lab CREW


STRATONAV
STRATOspherical NAVigation Experiment
STRATONAV

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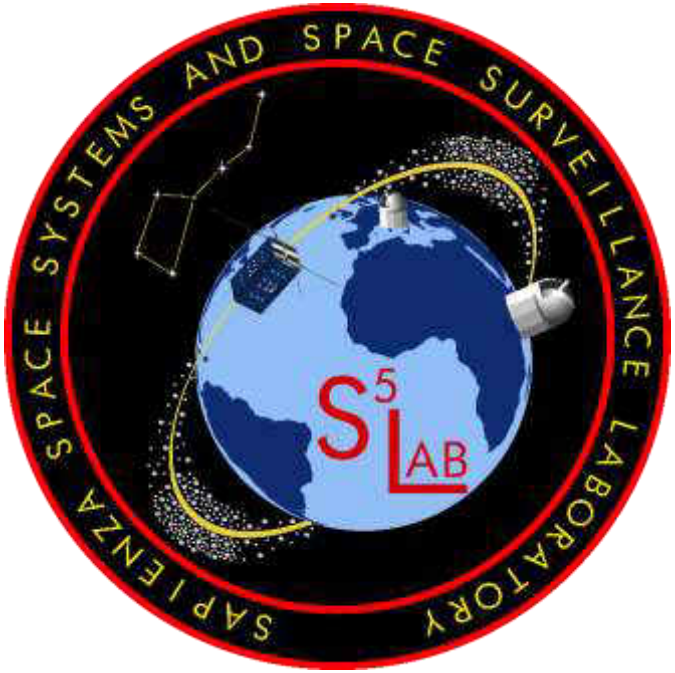

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CONCLUSIONS

• **S5Lab Educational Activity** at University of Rome “La Sapienza” plays a key role in the education and training aerospace engineering students involving them into S5Lab on-going projects related to both satellite systems design and space surveillance systems

• The **main on-going projects at S5Lab** concern research programs and international competitions (i.e. URSA MAIOR, EQUO, IRIDIUM and STRATONAV) have been described

•An overview about the **Sapienza Space Systems and Space Surveillance Laboratory facilities** has been presented in order to illustrate the laboratory equipment and to show its potentialities

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QUESTIONS?