SIMBA
Sun Earth Imbalance mission

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SIMBA

Educational value

Mission

Technical
CubeSats are great for education

- Strong involvement of master thesis students.
- Involvement over the entire process and over the different subsystems.
- Popular subject.
- Hands-on experience opens doors (e.g. ESA national traineeship).

12 Master theses
3 Larger student projects
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3 Larger student projects

But they can do much more
Mission

Monitor essential climate variables
Mission

Monitor essential climate variables

CubeSats can perform valuable missions
Mission

Comparison of incoming solar and outgoing terrestrial radiation with a single cavity radiometer
Mission

- Measure Solar irradiance
Mission

- Measure Solar irradiance
- Measure Earth radiation
Mission

- Measure Solar irradiance
- Measure Earth radiation
Mission

- Measure Solar irradiance
- Measure Earth radiation
- Measure Earth radiation imbalance
Mission

• Measure Solar irradiance
• Measure Earth radiation
• Measure Earth radiation imbalance

Preferably long-term → 3 years
Mission

Long term goal

CubeSats make broad coverage around Earth an economically viable option
The CubeSat

SIMBA is a 3 unit CubeSat (30x10x10 cm)
The CubeSat

SIMBA can be divided into 3 main parts

Payload
RMIB

ADCS
KU Leuven

Spacecraft bus
ISIS
The CubeSat

CubeSat philosophy: Focus on one novel system, outsource the rest.

Space segment

- Spacecraft bus
  - ADCS
  - Communication
- Payload
  - Power
  - Structure
The CubeSat (sidestep)

Standardization
The CubeSat (sidestep) Standardization

- Dimensions (e.g. 3U)
- Connectors
- Mass
- Power Usage
- ...

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Standardization

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- ...

You can buy components:
- Fast development
You can sell components:
- Business potential
The Payload
The Payload

Radiometer

BOS sensor
The Payload

The same radiometer is used to measure the radiation.
The Payload

The payload needs to be pointed accurately.
The ADCS
The ADCS

The Attitude Determination and Control System points the CubeSat.
The ADCS

The Attitude Determination and Control System points the CubeSat.

State of the Art
Pointing accuracy ≈ 10°
Pointing Knowledge ≈ 3°
The ADCS
The Attitude Determination and Control System points the CubeSat.

State of the Art
Pointing accuracy ≈ 10°
Pointing Knowledge ≈ 3°

Our System
Pointing accuracy ≈ 5°
Pointing Knowledge ≈ 1°
The ADCS: state of the art

Sensors

- Magnetometer
- Gyroscope
- Coarse sun sensors
  - (Earth sensor or fine sun sensor)

Actuators

- 3 magnetorquers
- (1 reaction wheel)
The ADCS

Sensors

• Magnetometer
• Gyroscope
• Coarse sun sensors
• Star tracker

Actuators

• 3 magnetorquers
• 3 reaction wheels
The ADCS (sidestep)

Miniaturization
The ADCS (sidestep)

Miniaturization

Small, low-power, low-cost:
- Processors
- MEMS sensors
- Actuators
The ADCS (sidestep)

Miniaturization

Small, low-power, low-cost:  
- Processors  
- MEMS sensors  
- Actuators

Despite small size, CubeSats are powerful
The ADCS
The ADCS

Star Tracker

Gyroscope

Magnetometer and Coarse sun sensors outside of the ADCS
The ADCS

- Magnetorquer
- Reaction wheel
The Spacecraft bus
The Spacecraft bus

- Built by ISIS, a CubeSat integrator
- Reuse of existing technology
- Deployable solar panels
Conclusion

• CubeSats are great for education.

• **Standardization** and **Miniaturization**: CubeSats can be built rapidly and for a low cost, while being powerful.

• Valuable science missions can be flown on CubeSats.

• CubeSats enable broad-coverage Earth observation.

• SIMBA measures essential climate variables.

• The KU Leuven ADCS opens up the CubeSat platform for more demanding missions.