SIMBA

Sun Earth Imbalance mission

Tjorven Delabie, KU Leuven

SIMBA

Educational value

Mission

Technical

Education

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 thesises

3 Larger student projects

Education

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12 Master thesises

3 Larger student projects

But they can do much more

Mission

Monitor essential climate variables

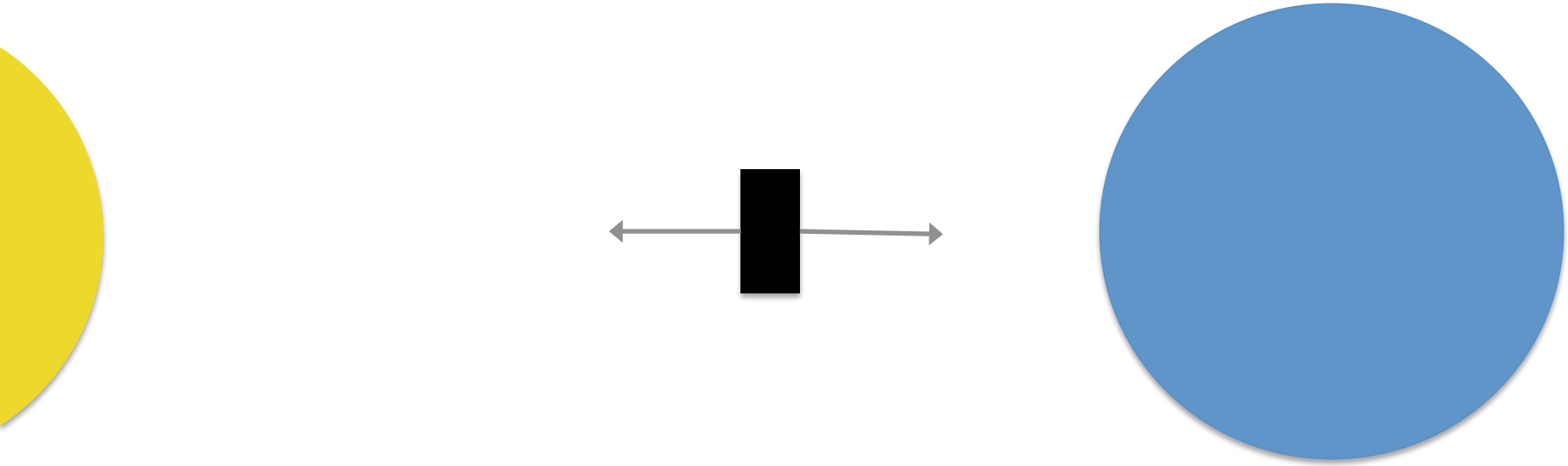
Mission

Monitor essential climate variables

CubeSats can perform valuable missions

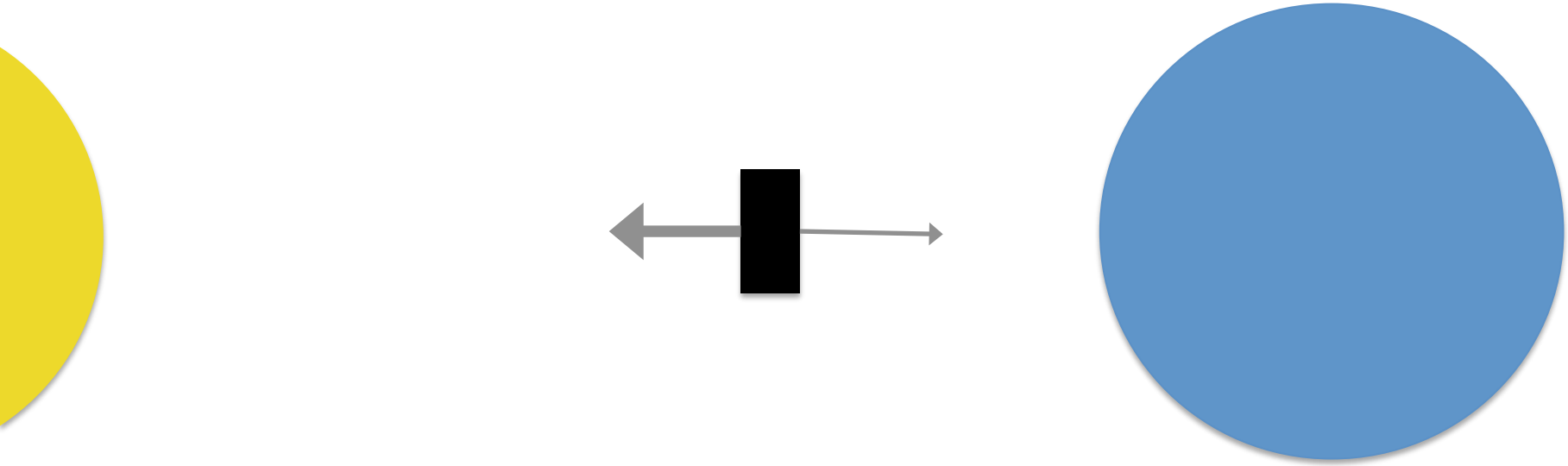
Mission

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



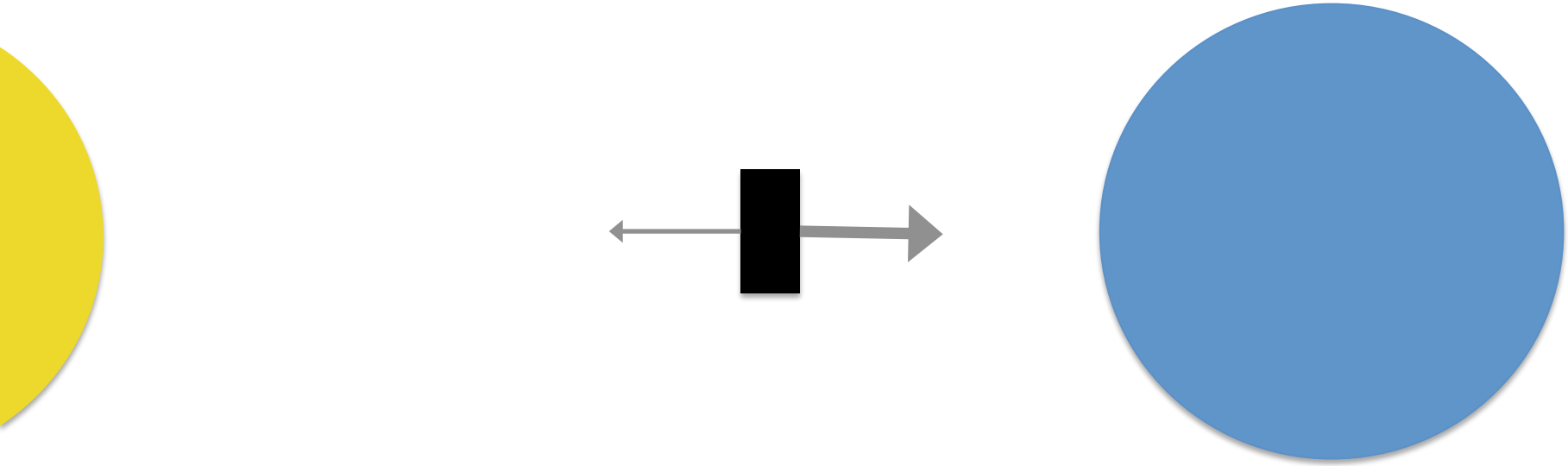
Mission

- Measure Solar irradiance



Mission

- Measure Solar irradiance
- Measure Earth radiation



Mission

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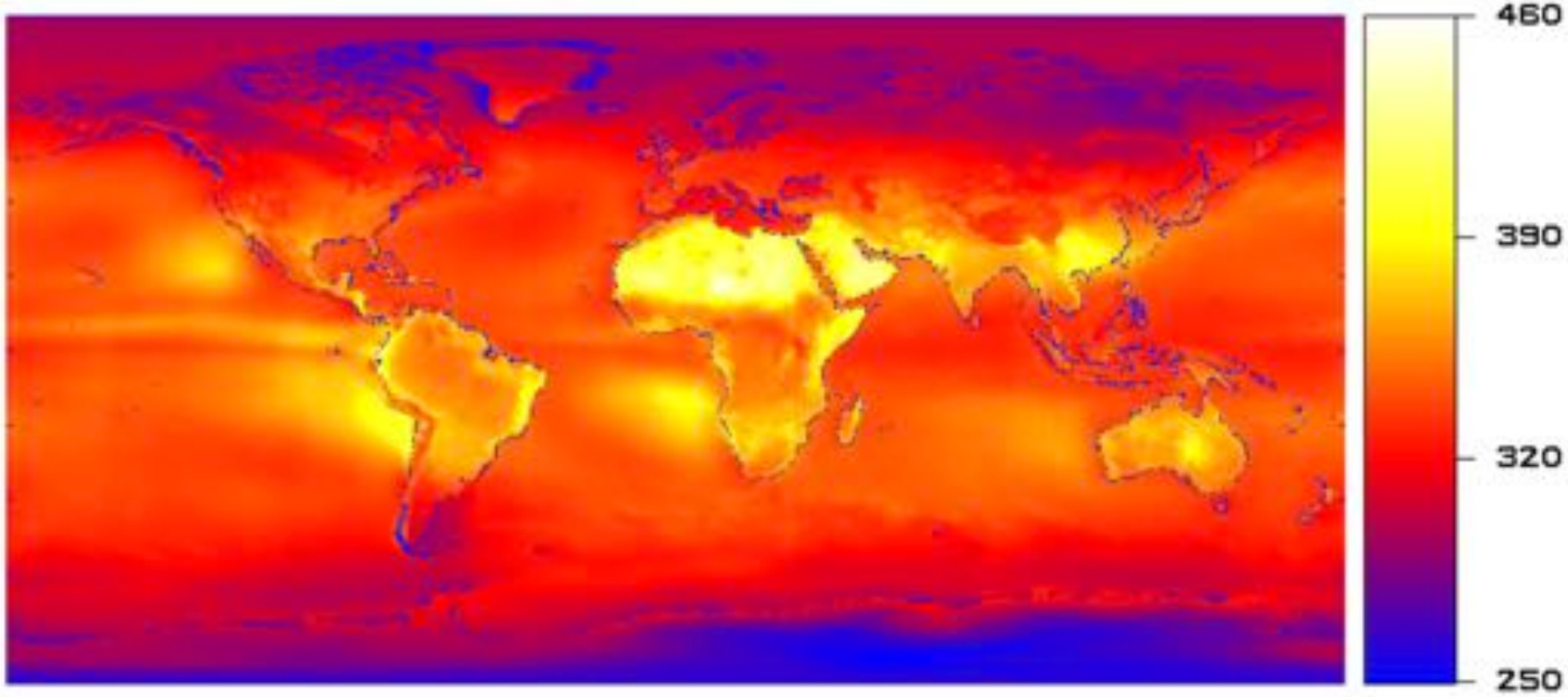
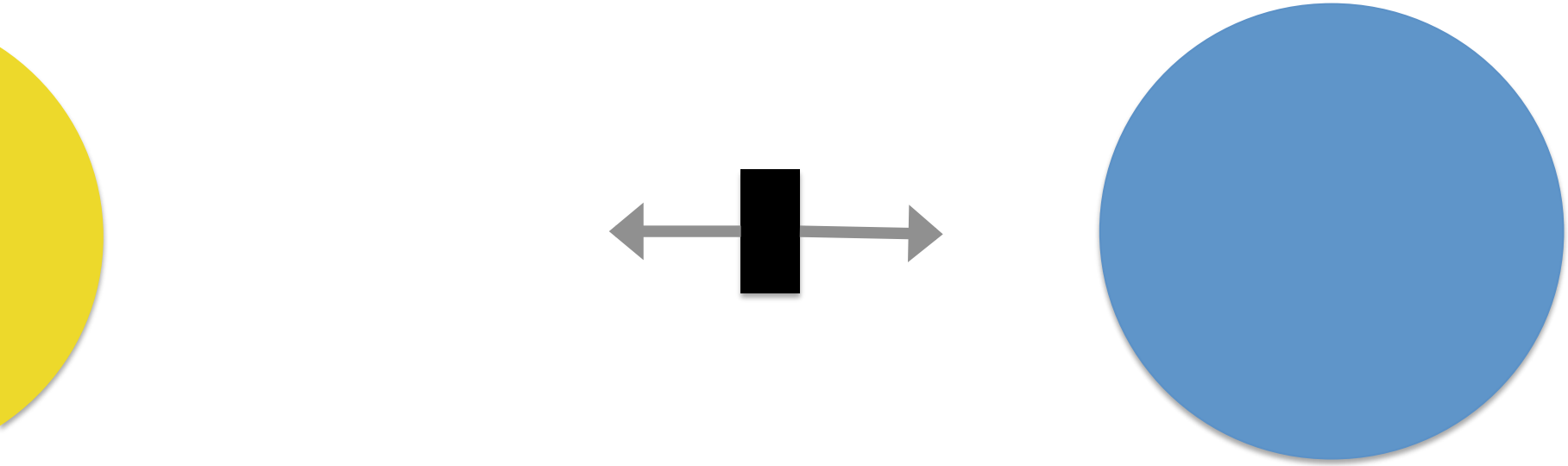
- Measure Earth radiation



Mission

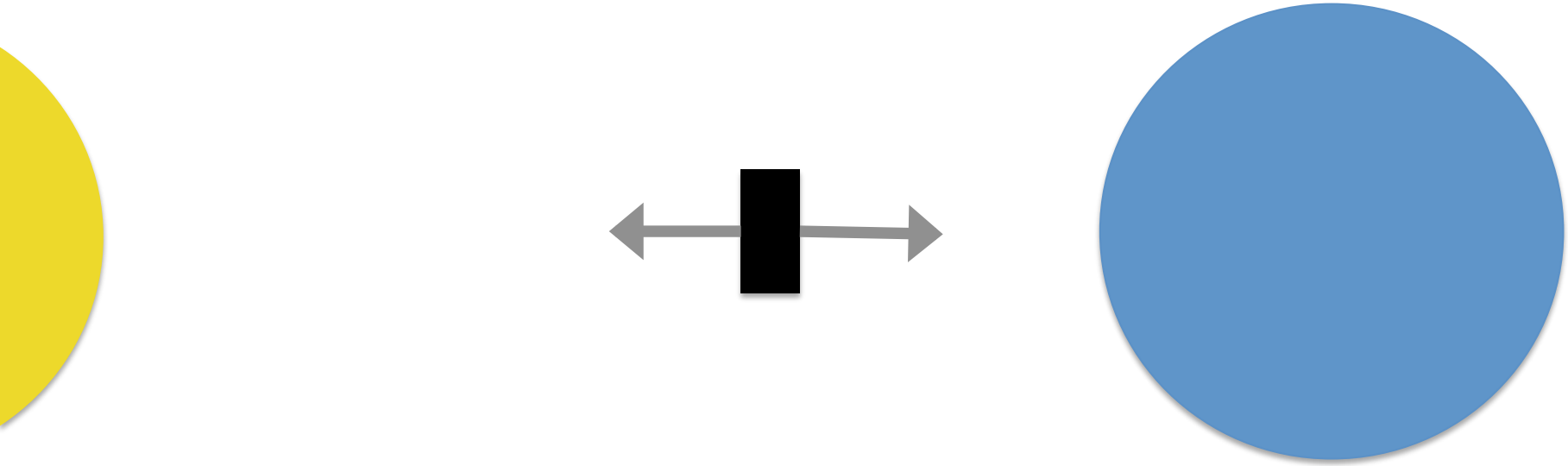
- Measure Solar irradiance
- Measure Earth radiation
- Measure Earth radiation imbalance



Mission

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

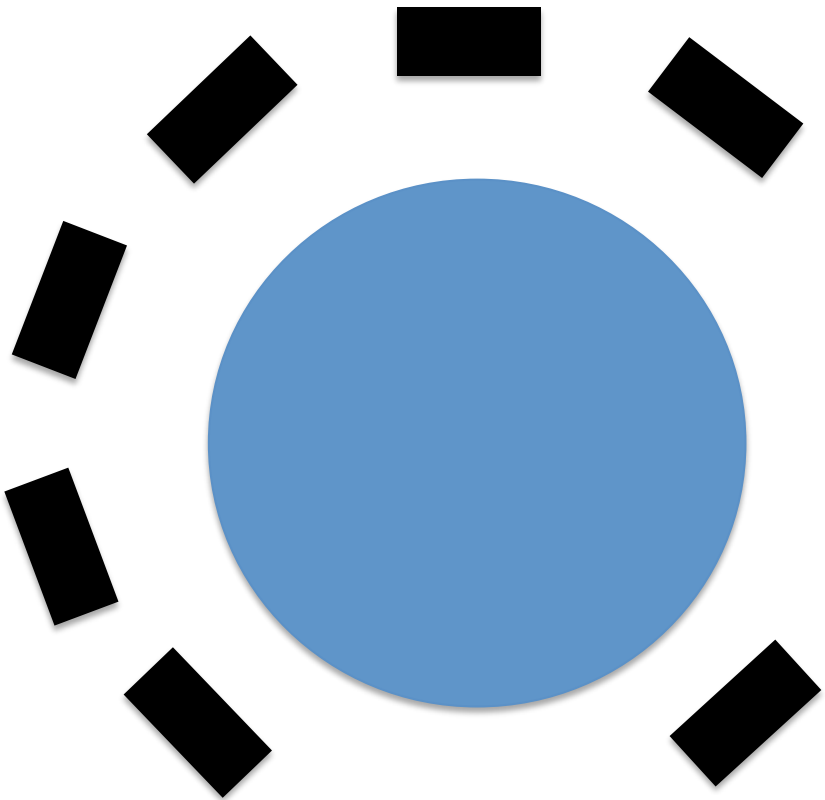
Preferably long-term → 3 years



Mission

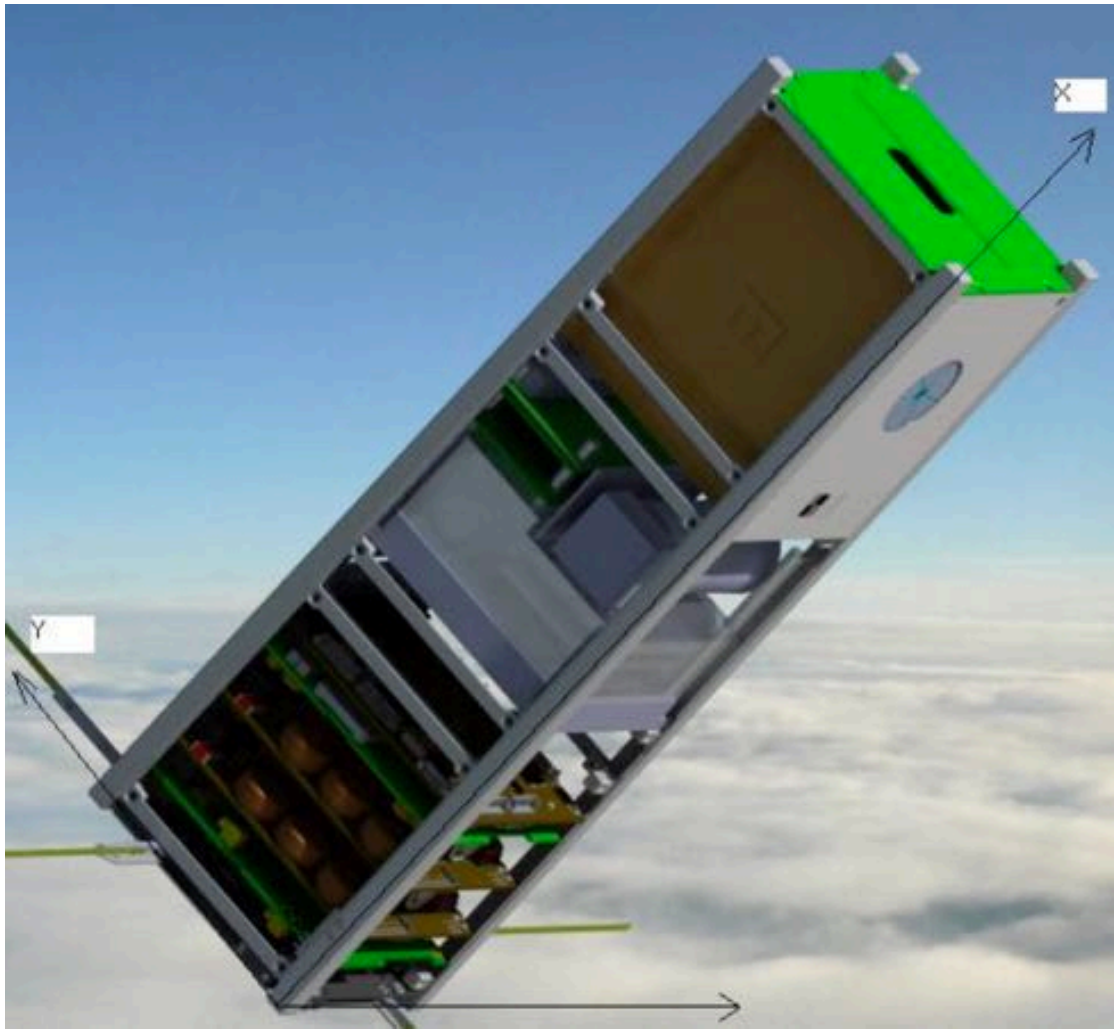
Long term goal

CubeSats make broad coverage around Earth an economically viable option



The CubeSat

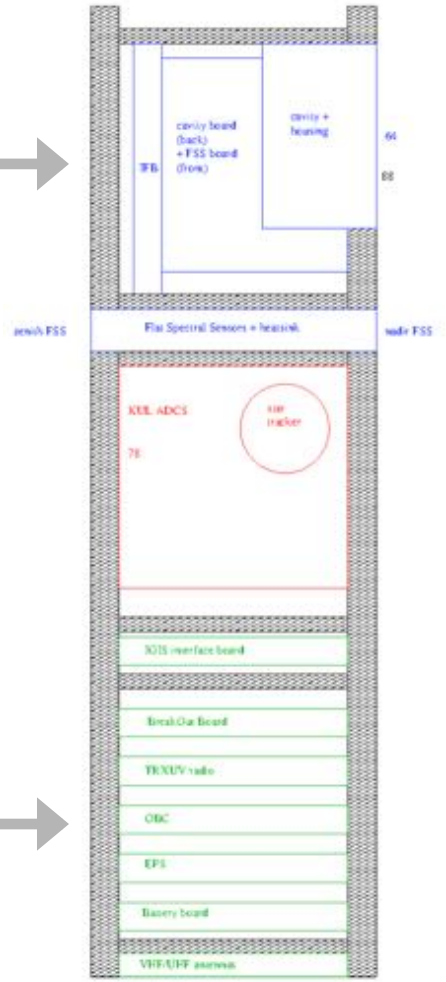
SIMBA is a 3 unit CubeSat (30x10x10 cm)



The CubeSat

SIMBA can be divided into 3 main parts

Payload
RMIB

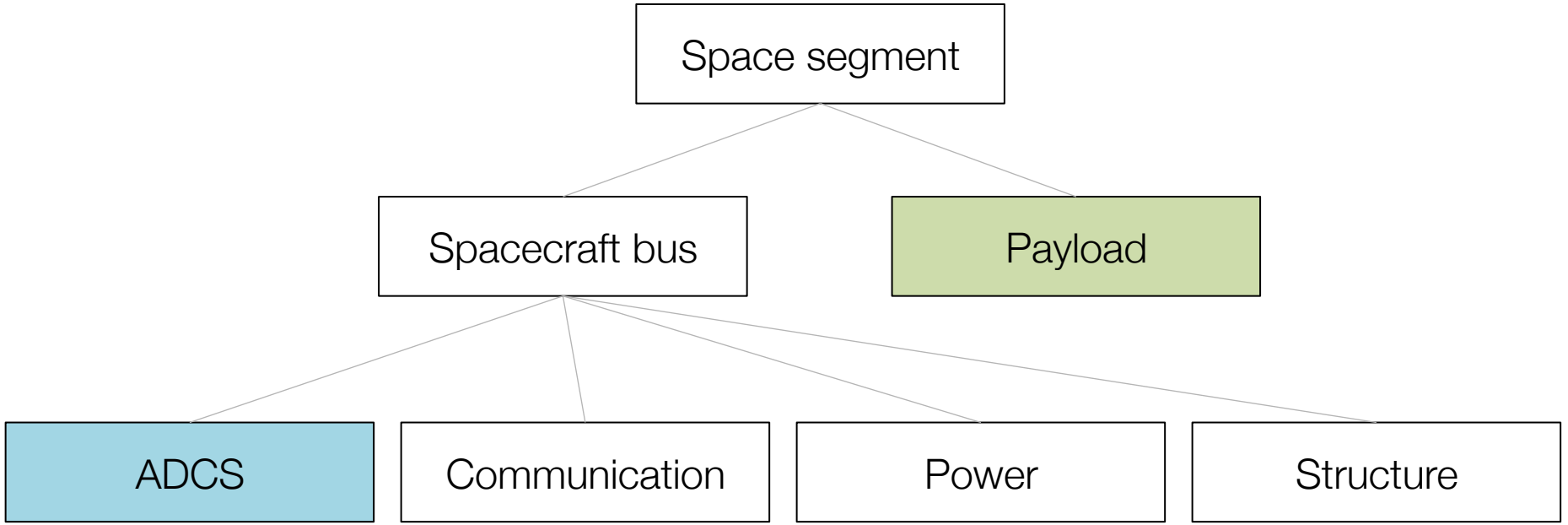


ADCS
KU Leuven

Spacecraft bus
ISIS

The CubeSat

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



The CubeSat (sidestep)

Standardization

The CubeSat (sidestep)

Standardization

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

The CubeSat (sidestep)

Standardization

- Dimensions (e.g. 3U)
- Connectors
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- …

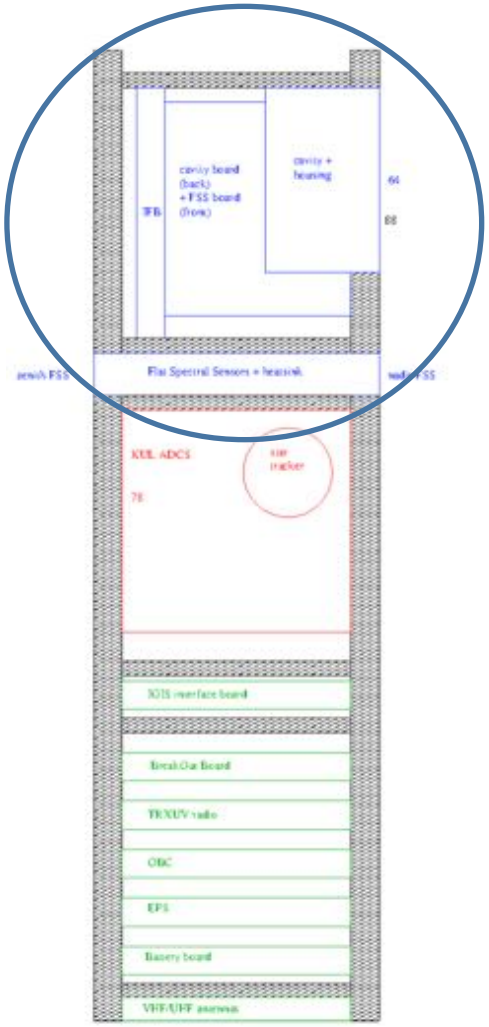
You can buy components:

- Fast development

You can sell components

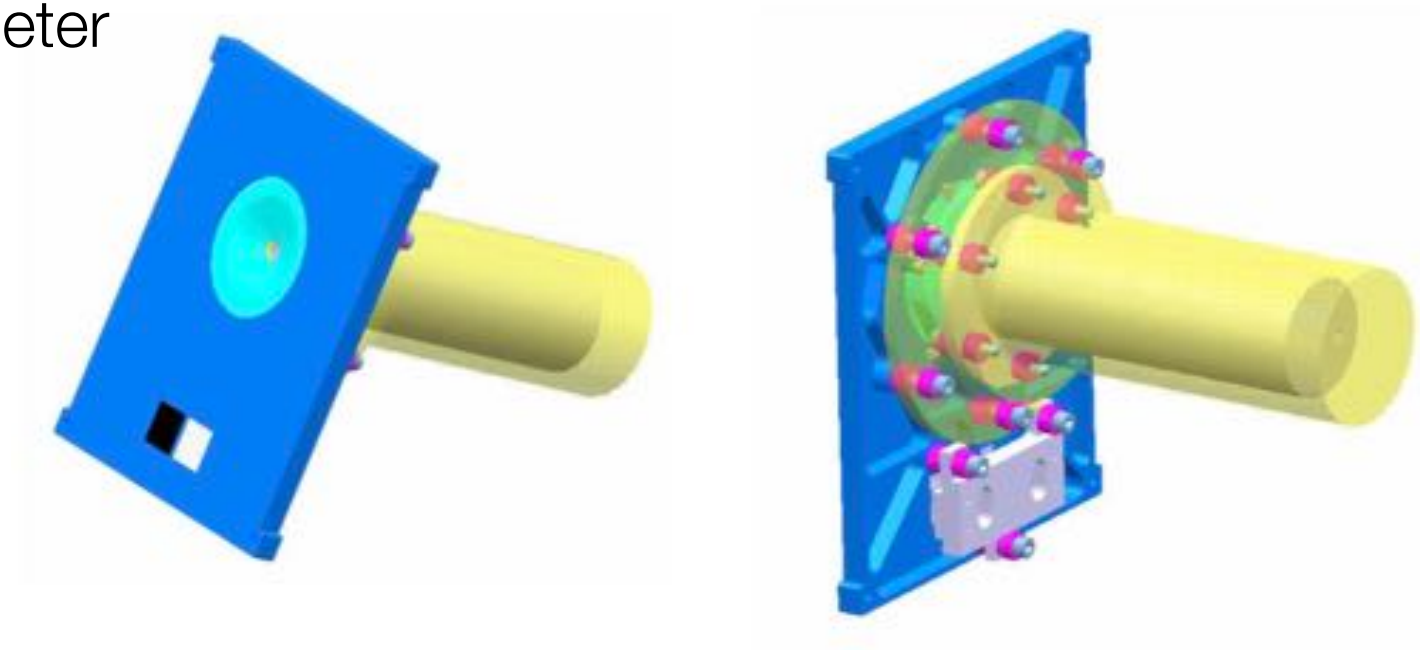
- Business potential

The Payload

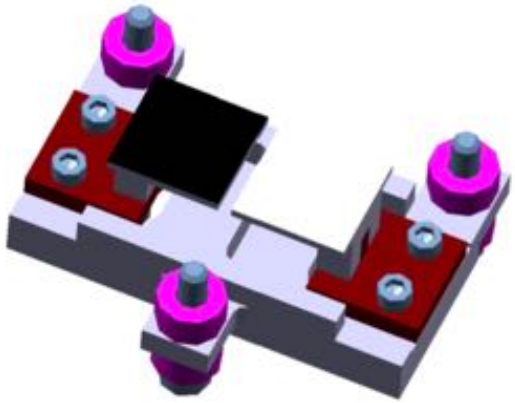

cavity board
(back)
+ FSS board
(front)
cavity +
housing
66
88
IFB
Flat Spectral Sensors + heatsink
XUL ADCS
XDS interface board
Break Out Board
TRXUV radio
OBC
EPS
Battery board

The Payload

Radiometer

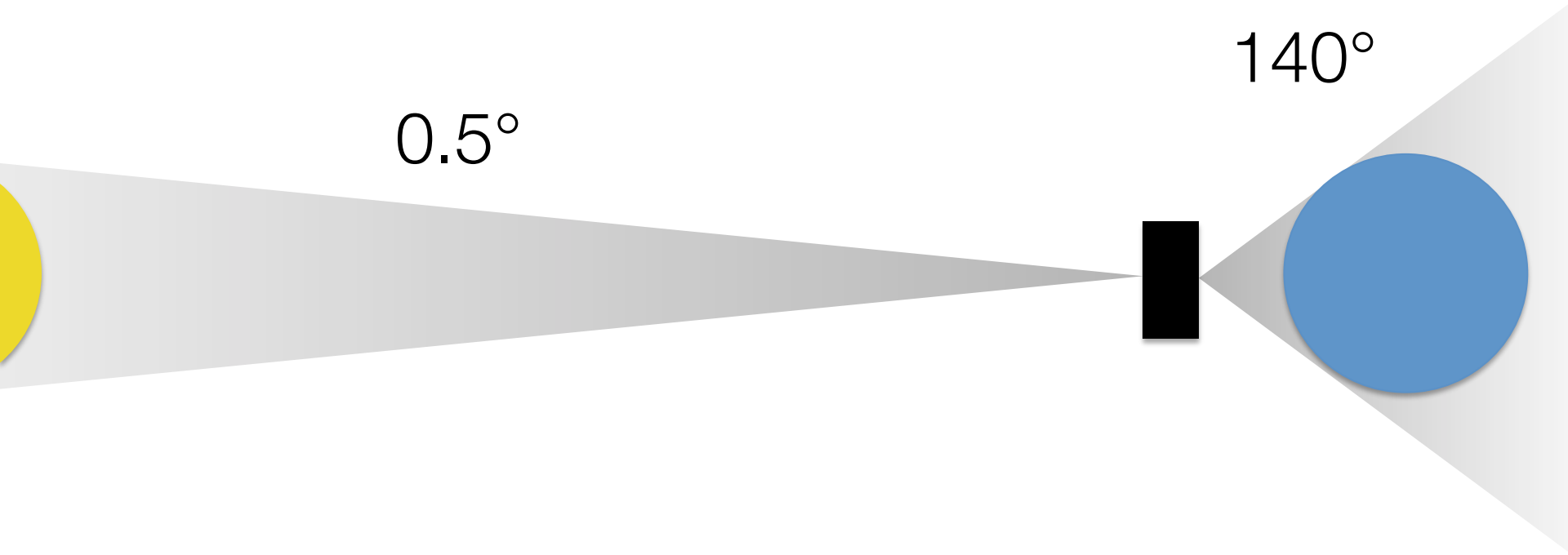


BOS sensor



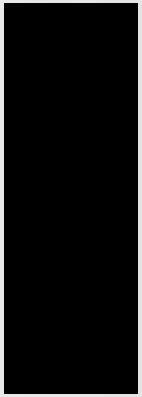
The Payload

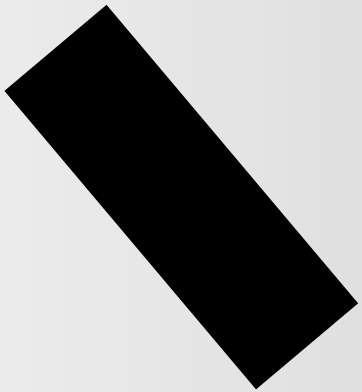
The same radiometer is used to measure the radiation.



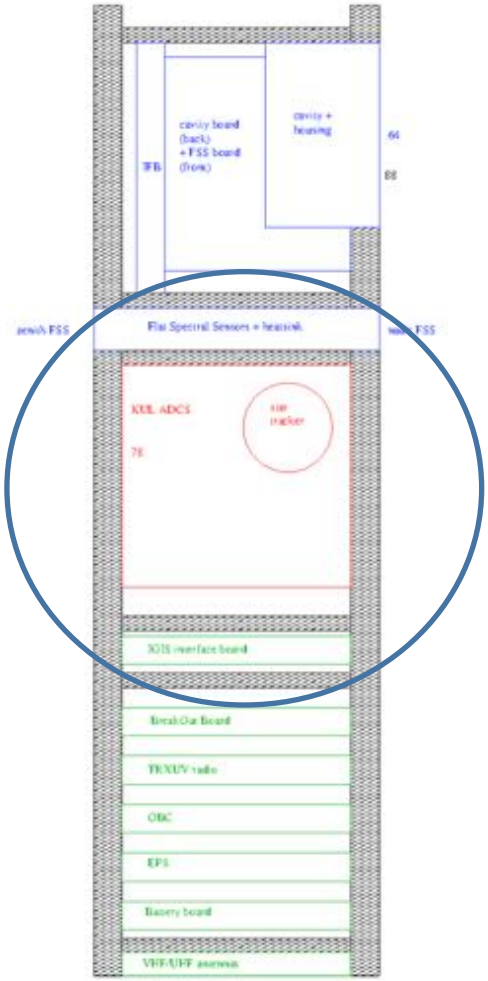
The Payload

The payload needs to be pointed accurately.





The ADCS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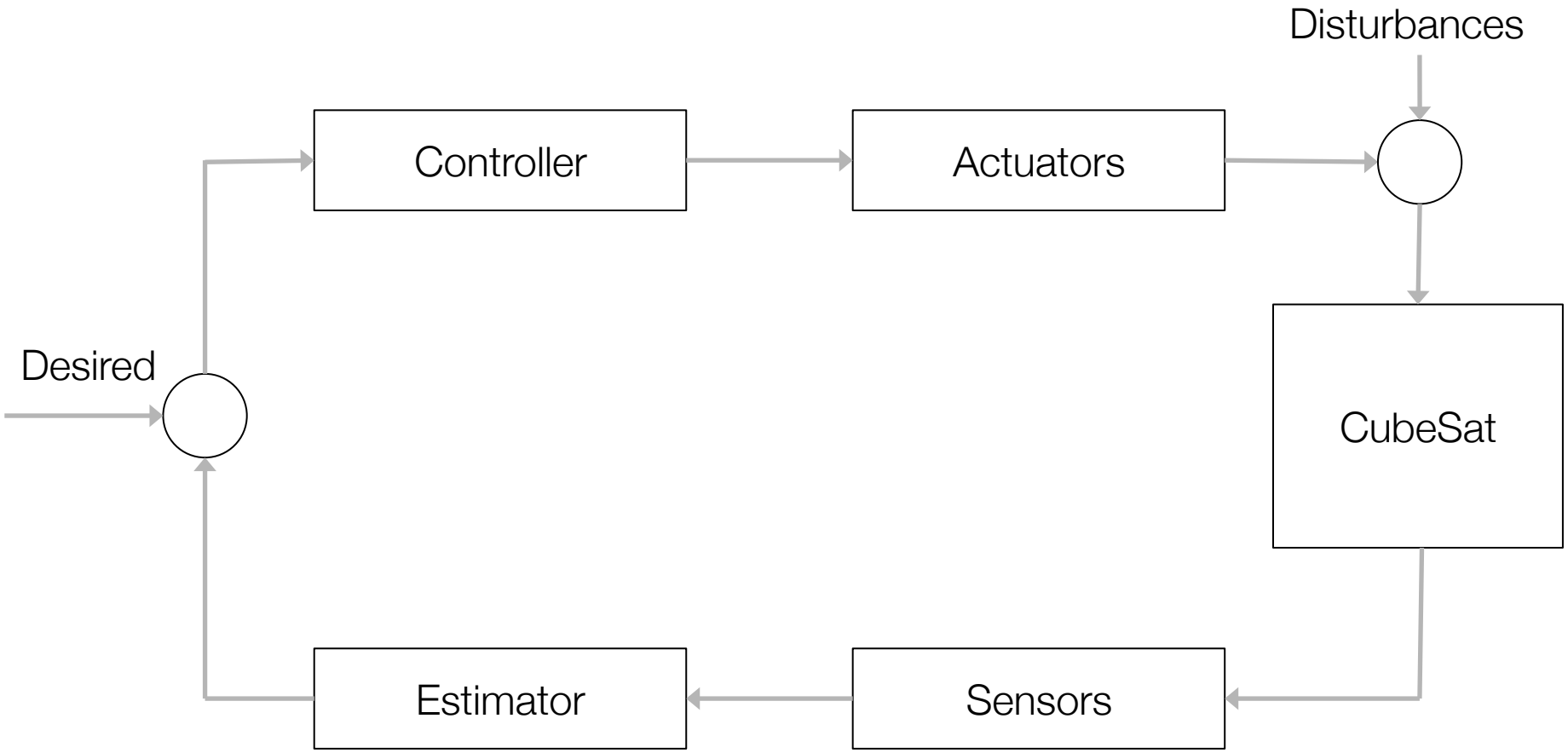
OBC
EPS
Battery board

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)

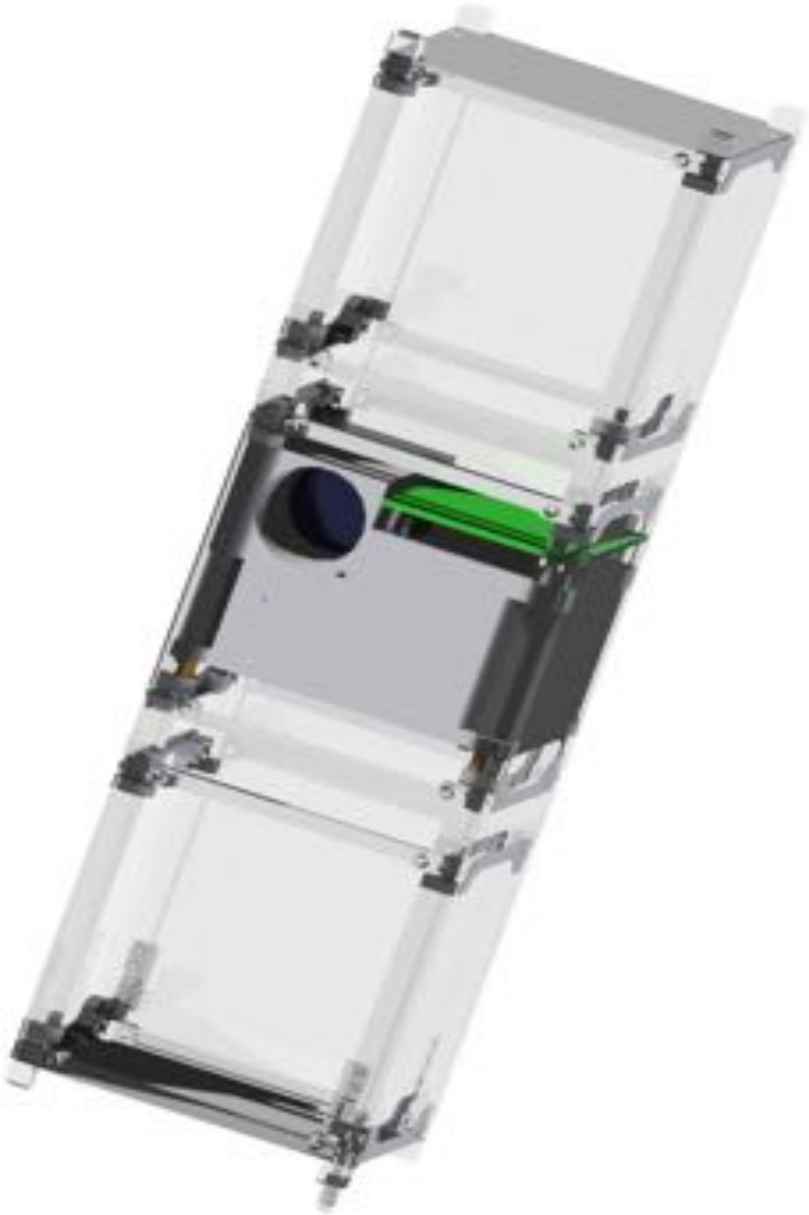
Miniaturization

Small, low-power, low-cost:

- Processors
- MEMS sensors
- Actuators

Despite small size, CubeSats are powerful

The ADCS



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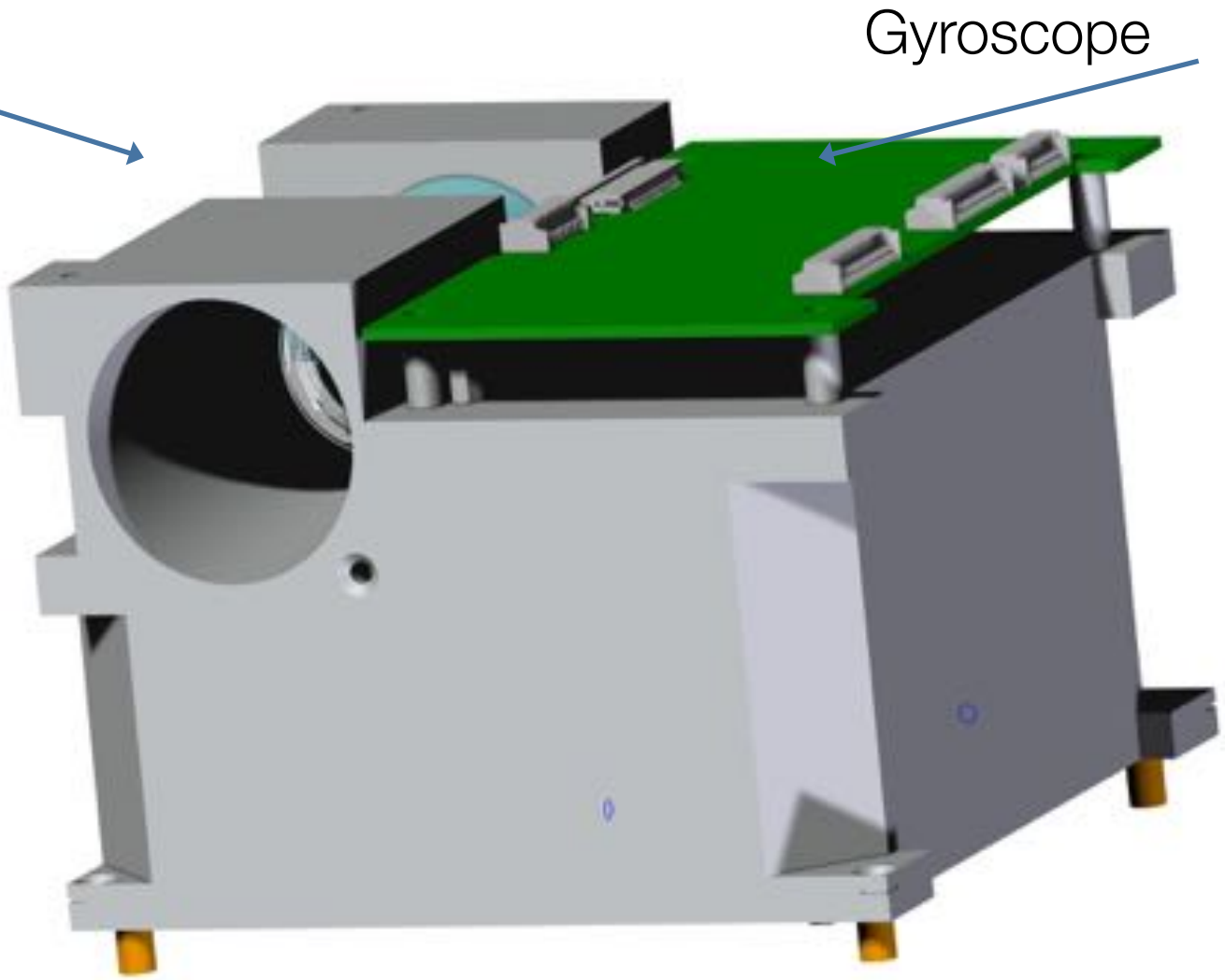
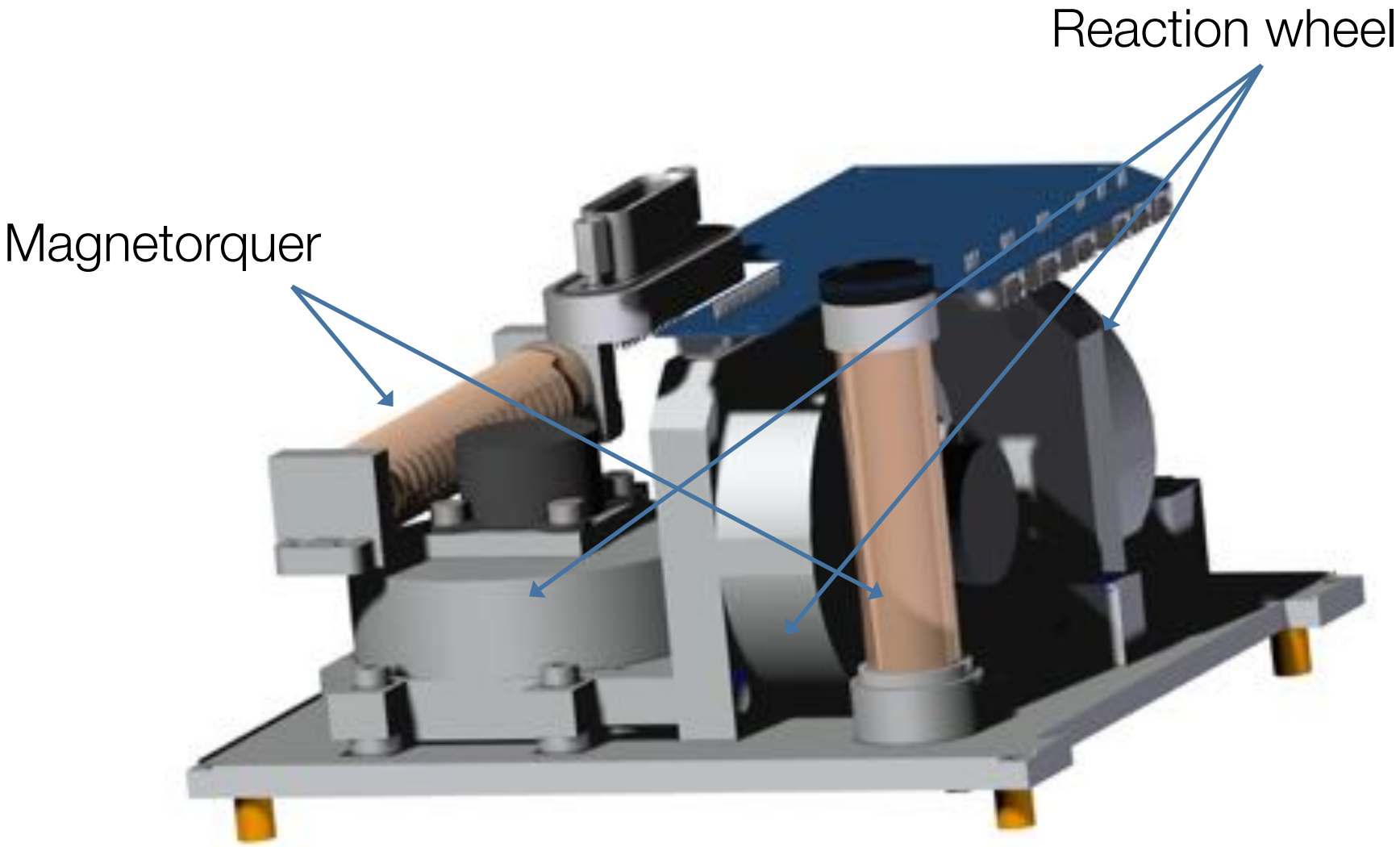
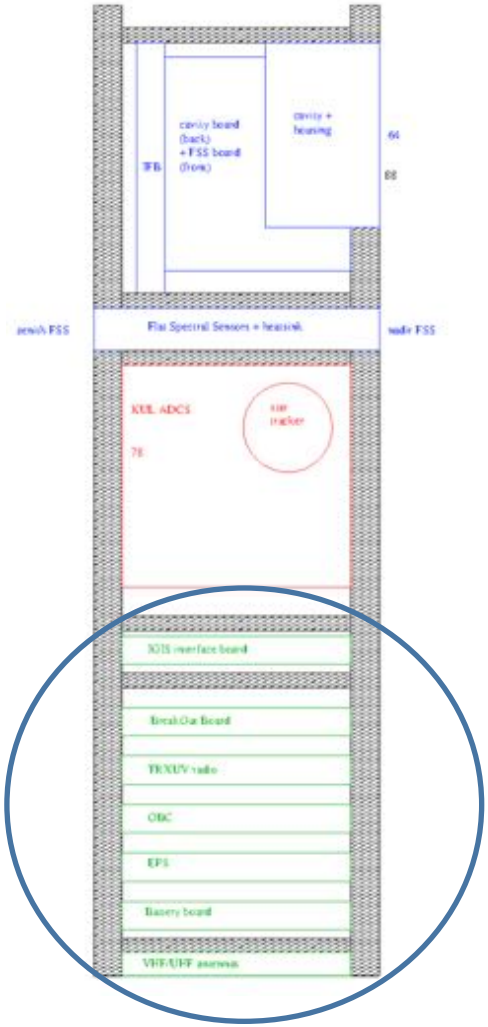


Magnetometer and Coarse sun sensors outside of the ADCS

The ADCS



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.