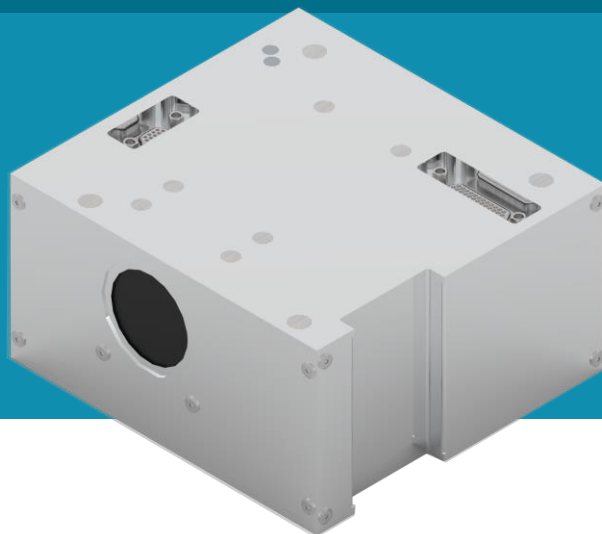


# KU Leuven ADCS

Accurate and Agile Attitude Determination and Control for CubeSats

The KU Leuven ADCS offers high-precision attitude determination and control in a compact package. The star tracker with innovative algorithms and the precision-engineered reaction wheels bring unprecedented agility, pointing knowledge and pointing performance to CubeSats.



## ADCS Features

### Precise Attitude Determination

- 3 Gyroscopes + 6 Photodiodes + 3 Magnetometers + Star Tracker.
- Flexible Extended Kalman Filter.

- ✓ High accuracy and agility
- ✓ Using COTS hardware
- ✓ Easy interfacing

### Agile Attitude Control

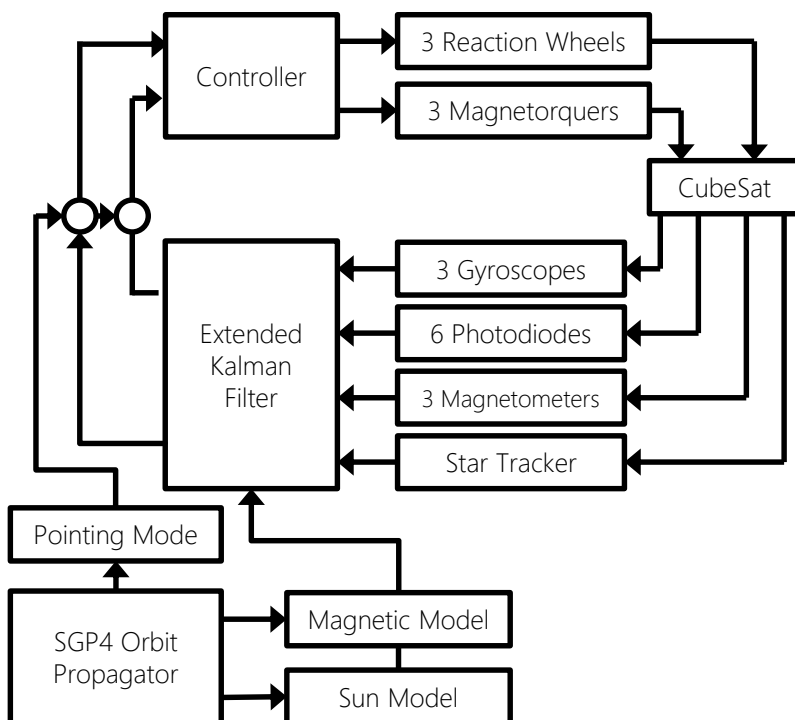
- Three reaction wheels and three magnetorquers.
- Fine PID controller, Coarse controller, B-dot, Thomson-spin.

### High Autonomy

- SGP4 Orbit propagator.
- Autonomous Nadir, Zenith, Sun, and LLA pointing.
- Autonomous desaturation of reaction wheels.
- Autonomous mode switching possible.

### High Robustness

- Extensive test campaign shows high robustness of components.
- Highly robust star tracker algorithms.



# KU Leuven ADCS

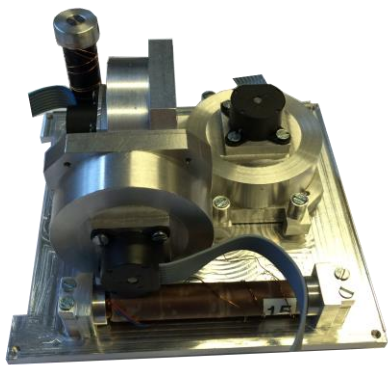
Accurate and Agile Attitude Determination and Control for CubeSats

## Performance

- The star tracker and three reaction wheels offer accurate pointing control.
- A coarse determination (no star tracker) and a coarse pointing mode (only using 1 reaction wheel) increase robustness.
- Extensive ESA-validated simulations were run using a highly representative simulation environment to assess the performance.

Estimation / Control	Pointing acc. Day (deg 1σ)	Pointing acc. Eclipse (deg 1σ)	Know. acc. Day (deg 1σ)	Know. acc. Eclipse (deg 1σ)
Coa/Coa	6.3	6.4	1.9	3.4
Coa/Fine	1.9	4.9	1.8	4.8
Fine/Coa	3.7	4.1	0.04	0.04
Fine/Fine	0.11	0.11	0.04	0.04

*The results in this table were generated based on a 3U CubeSat with a 600km sun-synchronous orbit.*



Detumbling: from +60deg/s

RW torque: 0.5 mNm

RW momentum capacity: 4 mNm nominal, up to 6 possible

MTQ mag. Moment: 0.24/0.24/0.13 Am<sup>2</sup>

Estimation/ Control	Power cons. (mW)
Detumbling	940
Coa/Coa	1000
Coa/Fine	1300
Fine/Coa	1125
Fine/Fine	1400

## Budgets

Power Consumption: See table

Mass: 715 gram

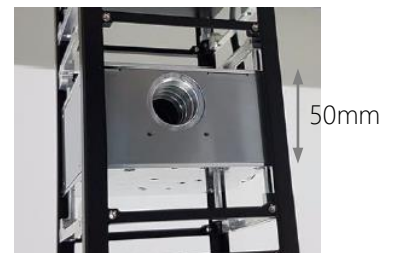
Volume: PC104 format

Easy to mount in CubeSat frame.

## Interface

Power Interface: +5V, +3.3V

Data Interface: I2C, CAN



## Qualification

The components of the KU Leuven ADCS are vibration tested with loads representing all typical CubeSat launchers. The reaction wheels have undergone accelerated lifetime tests in thermal vacuum, showing a lifetime of 3+ years.