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

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
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.

<table>
<thead>
<tr>
<th>Estimation/Control</th>
<th>Coa/Coa</th>
<th>Coa/Fine</th>
<th>Fine/Coa</th>
<th>Fine/Fine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pointing acc. Day (deg 1σ)</td>
<td>6.3</td>
<td>1.9</td>
<td>3.7</td>
<td>0.11</td>
</tr>
<tr>
<td>Pointing acc. Eclipse (deg 1σ)</td>
<td>6.4</td>
<td>4.9</td>
<td>4.1</td>
<td>0.11</td>
</tr>
<tr>
<td>Know. acc. Day (deg 1σ)</td>
<td>1.9</td>
<td>1.8</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Know. acc. Eclipse (deg 1σ)</td>
<td>3.4</td>
<td>4.8</td>
<td>0.04</td>
<td>0.01</td>
</tr>
</tbody>
</table>

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 mNms nominal, up to 6 possible
MTQ mag. Moment: 0.24/0.24/0.13 Am²

Budgets

Power Consumption: See table
Mass: 715 gram
Volume: PC104 format

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.