

Master Class

Attitude and Determination Control System

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GomSpace A/S

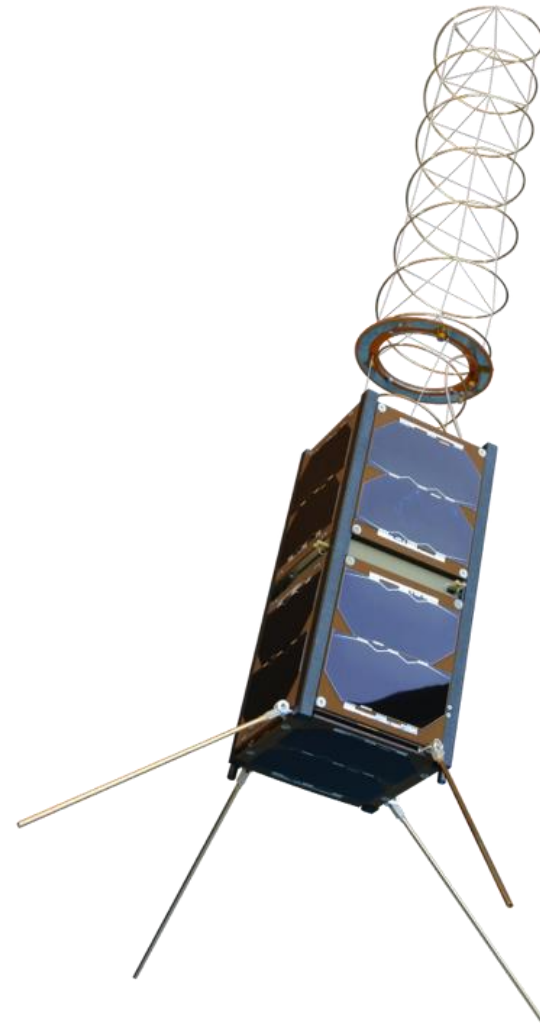
Munich, 28-30 November 2018



| ADCS INTRO |

ADCS Department

- Control and Automation backgrounds
- Mission Analysis
- Control system design
- Development projects
 - Sensors & Actuators
- ADCS System Simulation & Verification



| ADCS CONFIGURATION EXAMPLES |



Basic configuration

Onboard Gyro

Onboard Magnetometer

External Magnetometer

Coarse Sun Sensors

Fine Sun Sensors

Reaction Wheels

Magnetorquers

Additional Components

External Gyroscope

Additional Fine Sun Sensors

Earth Horizon Sensor

Star Tracker

Propulsion System

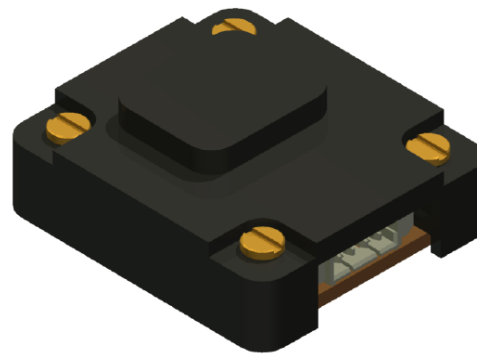
GPS



| ATTITUDE SENSORS |

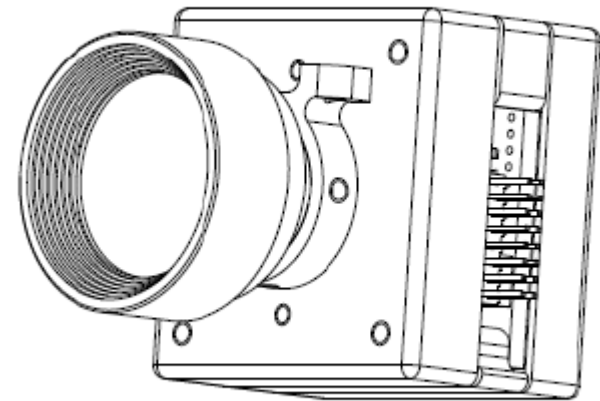


- Gyroscope
 - Measures the angular rate of the spaceship
 - A good way to propagate the KF
 - Noise vs. power
- Magnetometer
 - Compares the surrounding B-field with a reference
 - Sensitive to electric field (PSU, COM, residuals, ...)



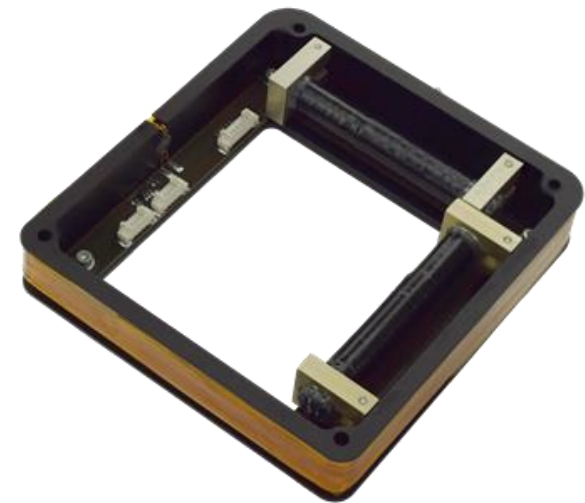
ATTITUDE SENSORS

- Sun Sensors
 - Coarse and fine
 - Dependent on sunlight
- Star Tracker
 - Requires volume and power
 - Must point to dark sky



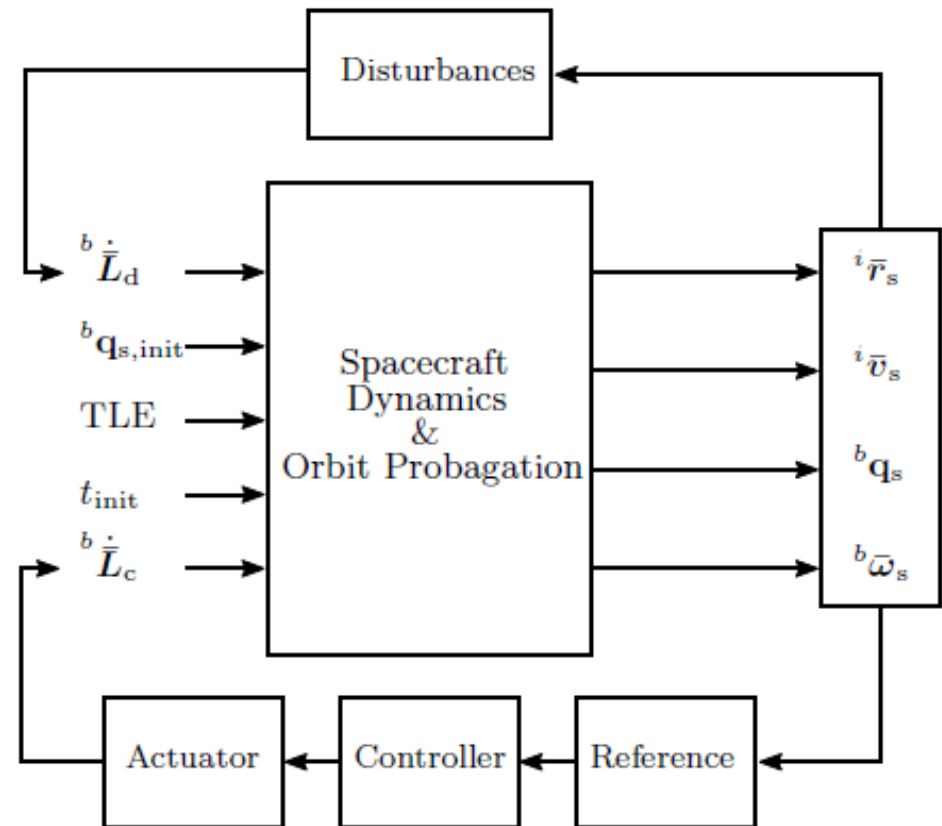
| CUBESAT ACTUATORS |

- Reaction wheels
 - High torque
 - Momentum storage
 - Risk of saturation
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- Magnetorquer
 - Used for BDOT
 - Essential when using reaction wheels (Desaturation)



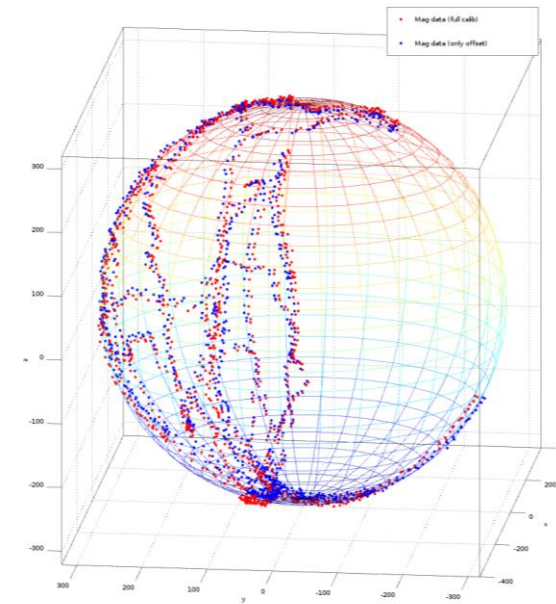
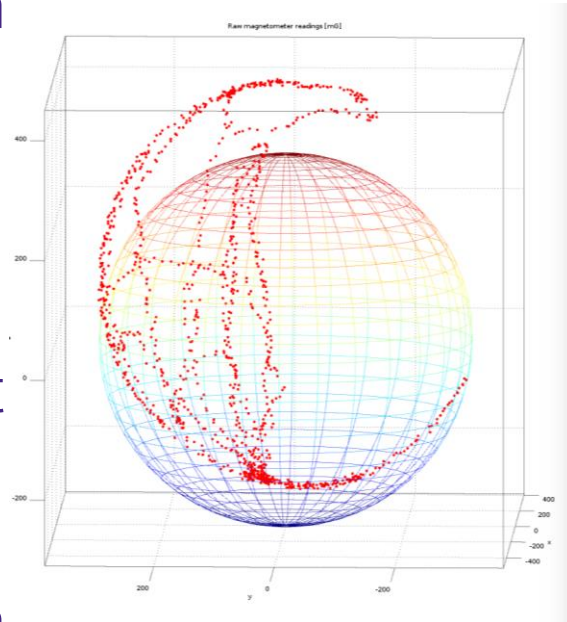
| ADCS SIMULATION |

- Orbit Propagation (SGP4)
- Spacecraft dynamic and kinematic model
- Sensor & Actuator models
- Disturbance models
- OBC Emulator
 - Test and verification of ADCS Software through Simulink
 - Tuning through parameter system



| ADCS CALIBRATION |

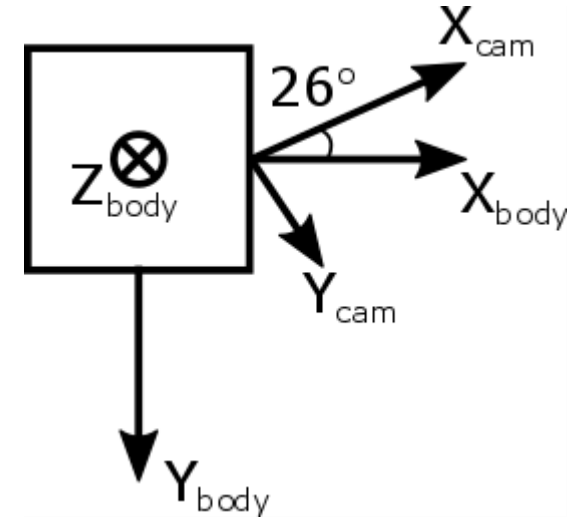
- Magnetometer Calibration
 - Ground Calibration
 - In orbit calibration
- Gyro Calibration
 - Bias
 - Thermal offset Drift
- FSS Calibration
 - Ground Calibration
 - In orbit calibration
 - Based on magnetometer



STAR TRACKER – EXAMPLE



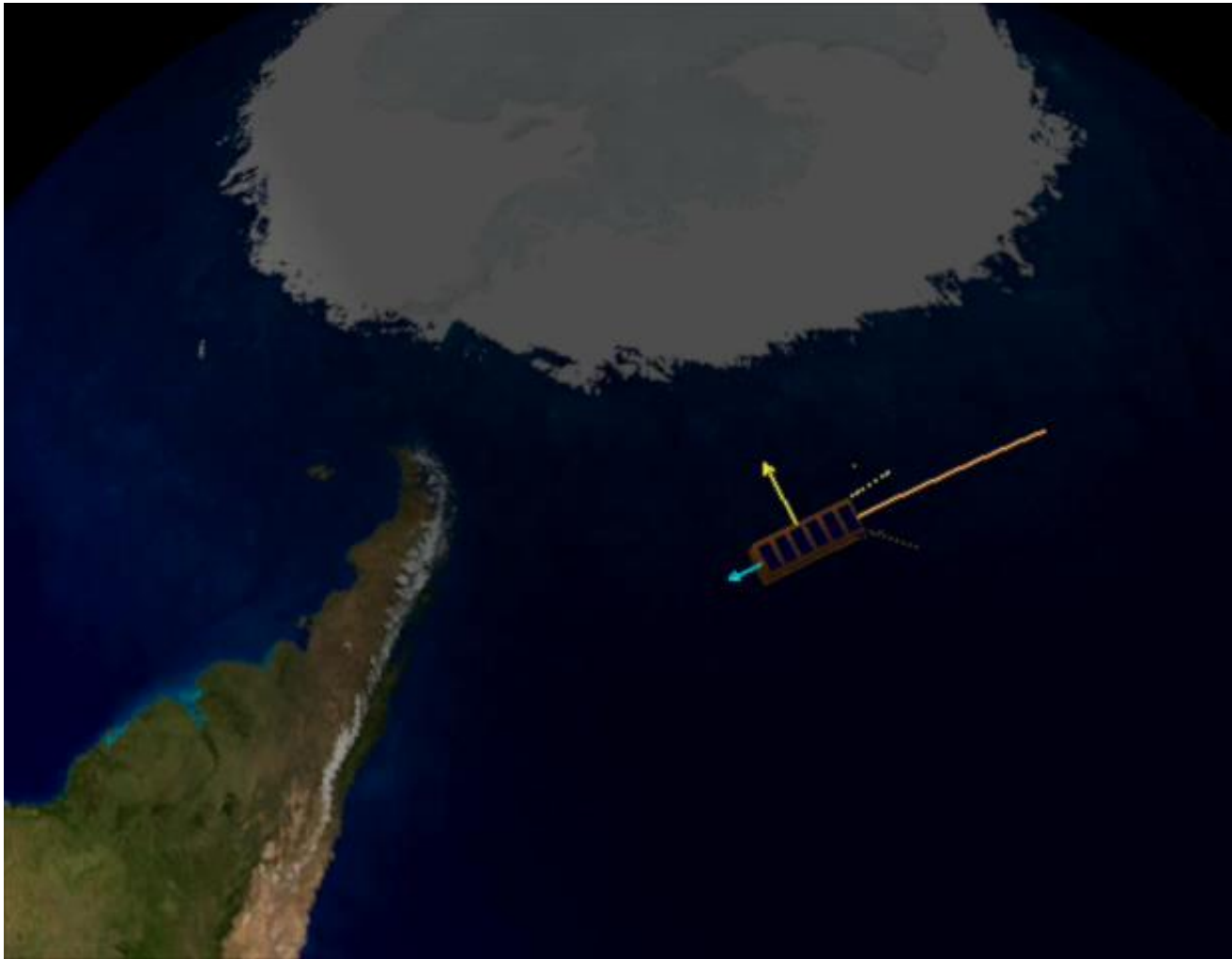
- Theoretical absolute max. slew rate of Satellite @ 500 km, 7.613 km/s
 - Slew rate < 0.9 deg/s
- Hyperion ST210
 - Maximum slew rate (pitch, yaw) > 0.3 deg/s
 - Maximum slew rate (roll) > 0.6 deg/s
- Rotation of ST will maximize the slew rate to 0.671 deg/s



SPECIFICATIONS

Performance		
Attitude determination accuracy (pitch, yaw)	30	arcseconds (3σ)
Attitude determination accuracy (roll)	200	arcseconds (3σ)
Update rate	5	Hz
Maximum slew rate (tilt/tilt)	> 0.3	$^\circ/s$
Maximum slew rate (roll)	> 0.6	$^\circ/s$





| Questions? |

