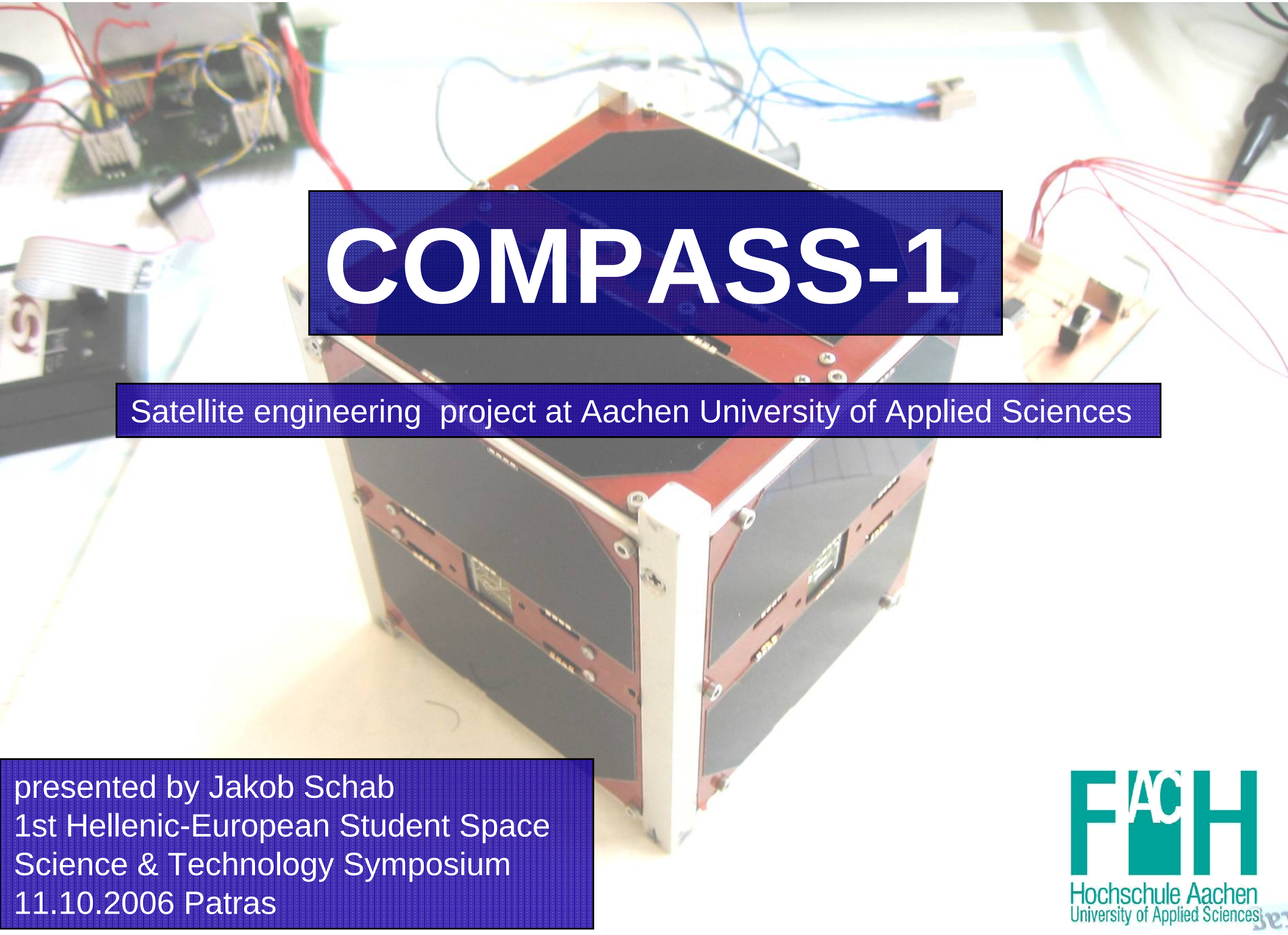


COMPASS-1

Satellite engineering project at Aachen University of Applied Sciences

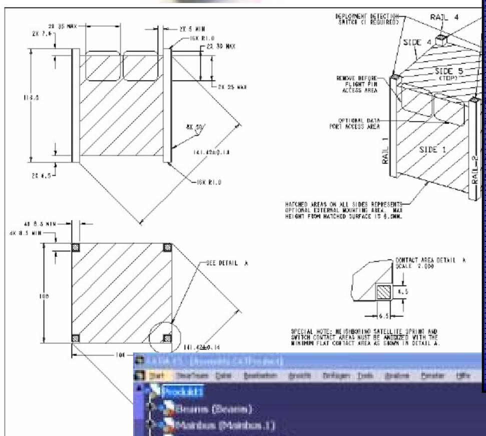
presented by Jakob Schab
1st Hellenic-European Student Space Science & Technology Symposium
11.10.2006 Patras

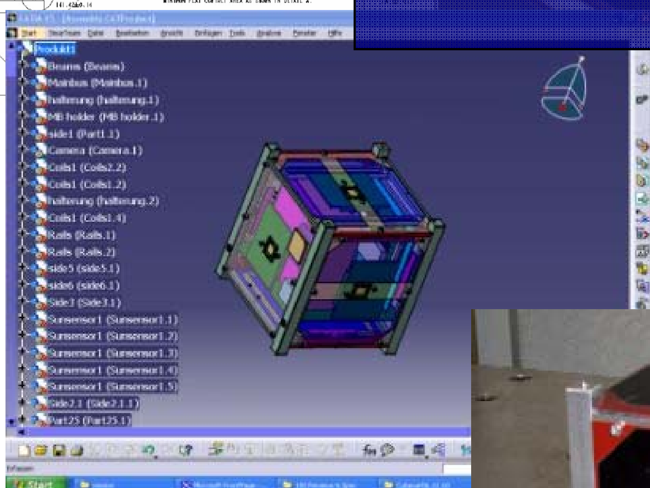
Hochschule Aachen
University of Applied Sciences

Contents

What is COMPASS-1

- First Picosatellite build at ACUAS
- Managed and developed by students
- The name refers to the Attitude System and the Project Motivation





Mission Overview

Project Objectives

- Insight into the system engineering process and team dynamics
- Better understanding of subjects (technical and management)
- Collaboration and contacts with industry, universities and other Cubesat groups

Mission Objectives

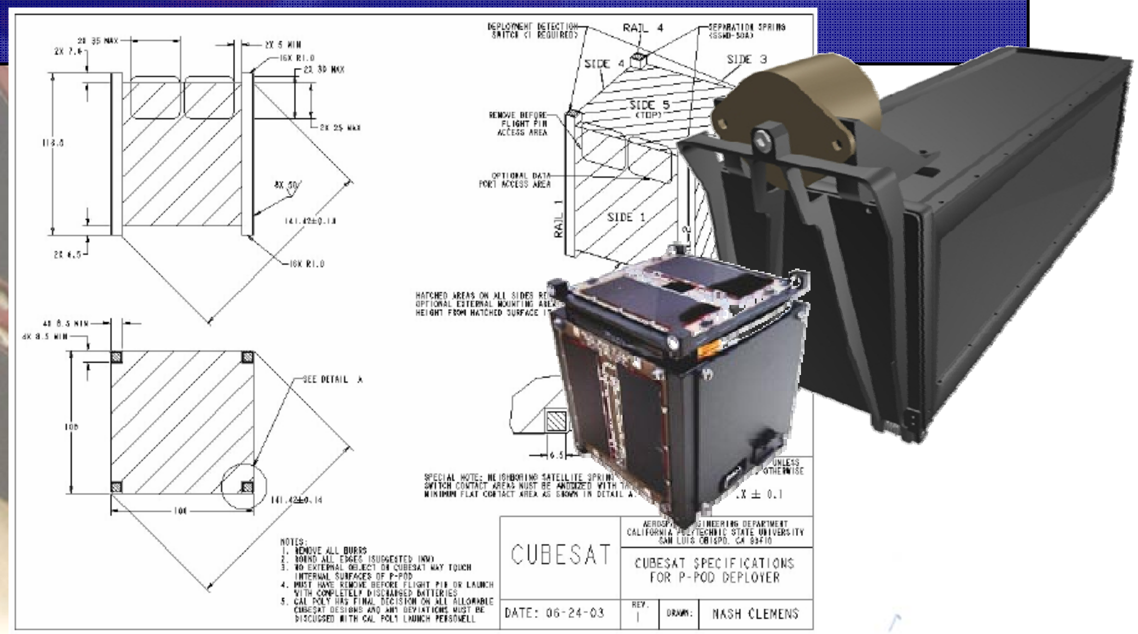
- Remote Sensing with color camera
- GPS receiver validation
- Technology demonstration:
  - Extensive use of COTS components
  - Fast UHF communication downlink
  - Active magnetic attitude control
  - Lithium-Polymer batteries for power storage

Cubesat Overview

The CubeSat standard has been defined in 1999 by Prof. Twiggs of Stanford University in collaboration with CalPoly University.

The concept was chosen for COMPASS-1 in order to:

- **reduce the launch costs**
- **simplify the design process**



Mass: 1kg

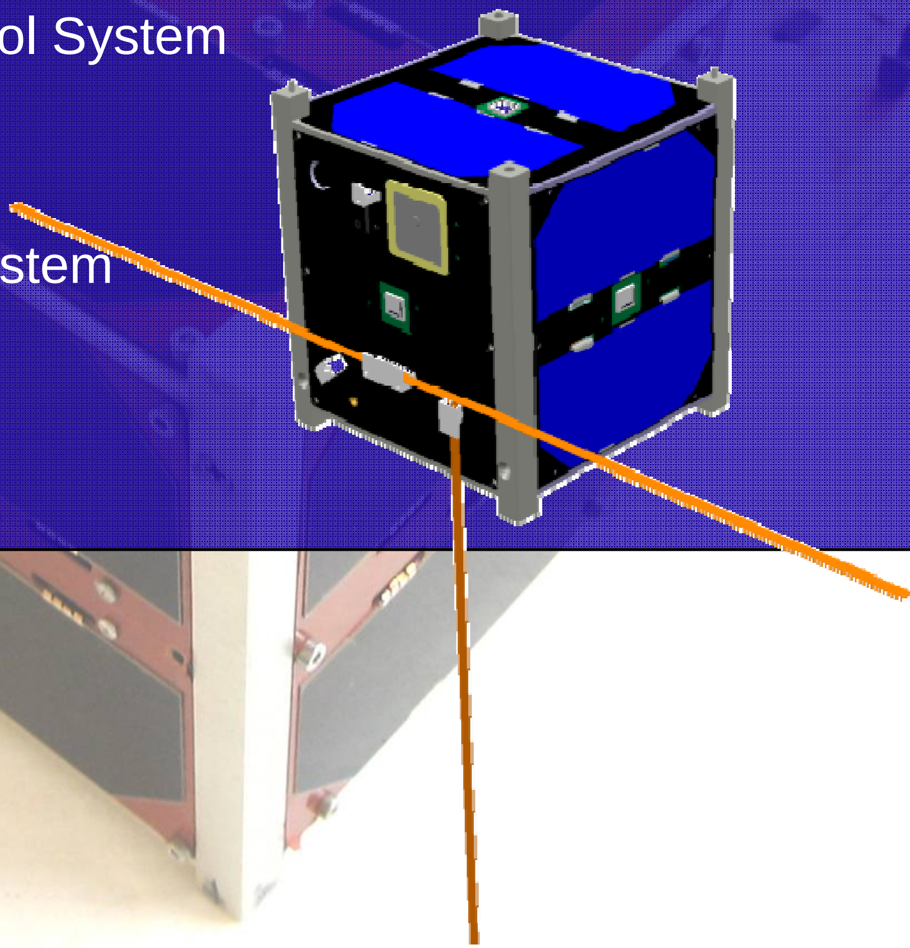
Size: 10cm x 10cm x 10cm

Mission: your choice!

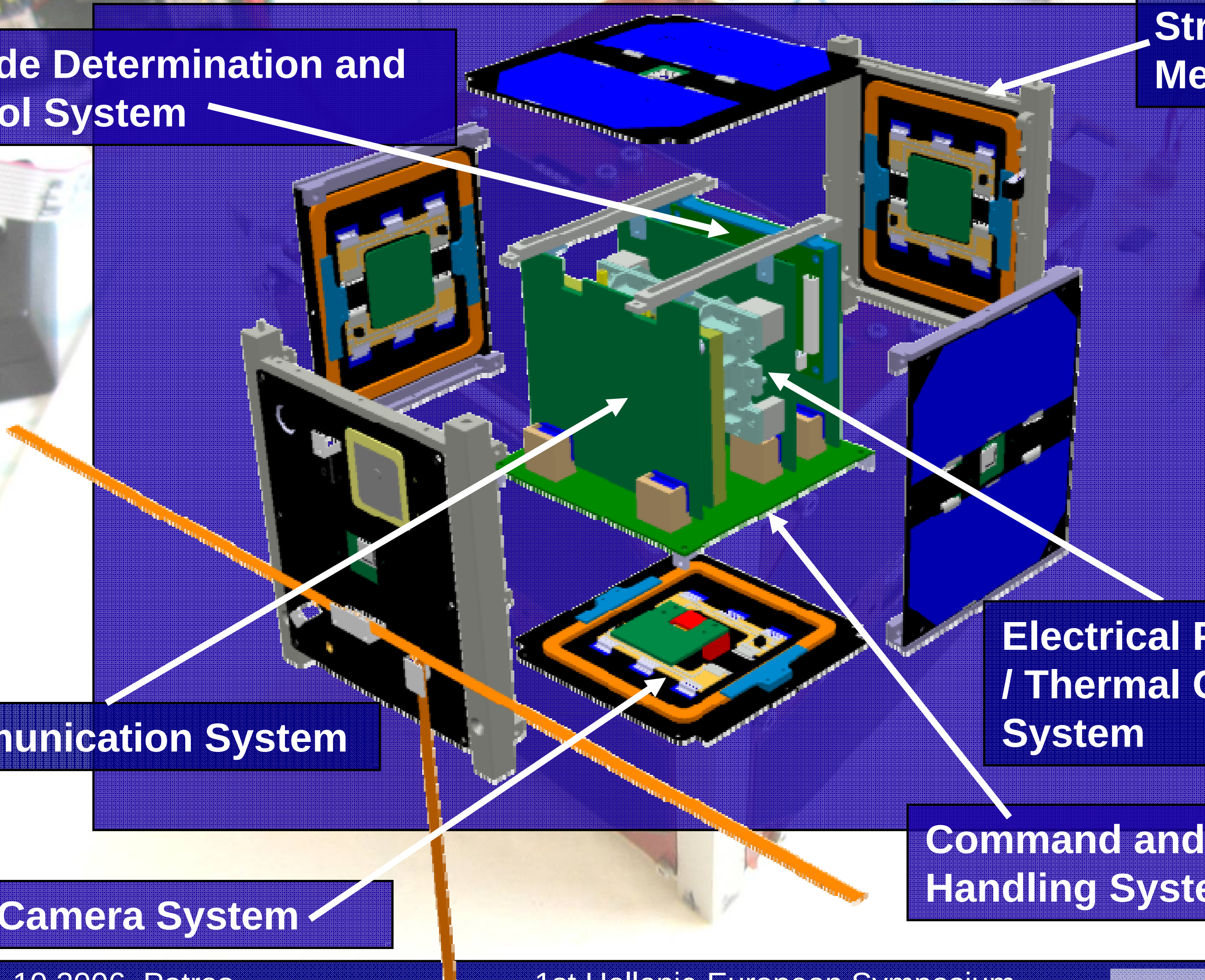
Subsystems

COMPASS-1 has all Systems a standard Satellite has except of Propulsion

- Attitude Determination & Control System
- Electrical Power System
- Communication System
- Command & Data Handling System
- Structure & Mechanisms
- Paylod
- Thermal System



Subsystem Overview



Attitude Determination and Control System:

ADCS Mainboard:

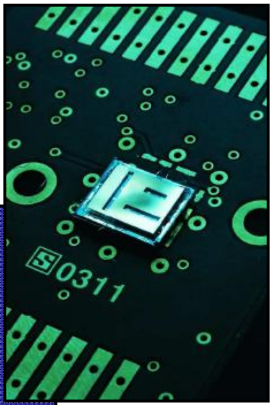
- 16-bit µController
- 3-channel current driver
- 8Mbit Flash ROM, 16kbyte EEPROM
- 3-axis AMR magnetometer
- GPS interface

Magnetorquers:

- 400 copper wire turns
- 20g mass per coil
- appr. 2µNm torque capacity
- feedback current-control
- high quality winding geometry

Three Axis Magnetometer:

- sensor based on AMR effect
- 16bit resolution digital interface
- ± 0.64mT measurement range
- reduced linearity error (~30nT)



Sun Sensors:

- MOEMS 2-axis analog slit sensors
- digital front-end electronics
- data transfer via serial bus

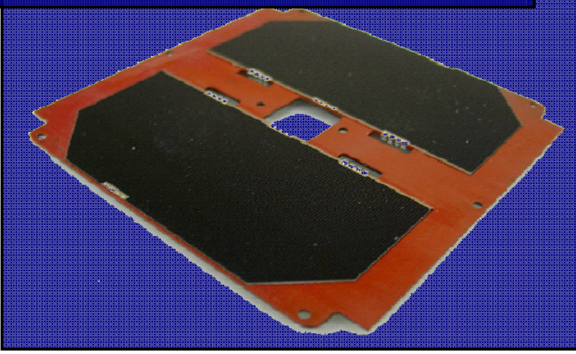
Electrical Power System

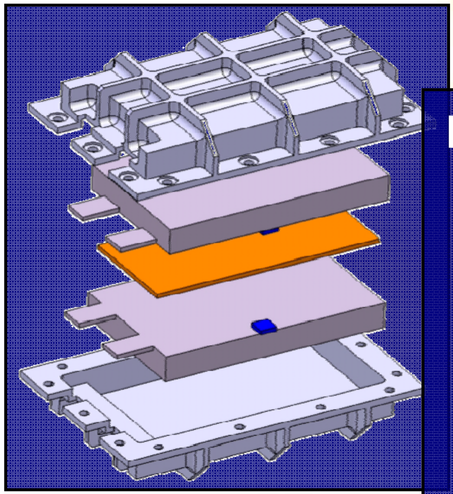
EPS/TCS Mainboard:

- 8-bit Microcontroller 8051 architecture
- I2C, UART and SPI bus
- Peak Power Tracking (PPT)
- 5V boost converter, 3V3 buck regulator
- Lithium-Polymer charger chip

Solar Cells:

- 5 solar panels (the sides of the cube)
- Each panel with 2 cells in series (max. 2,5W per side panel)
- Triple-Junction Space Solar Cells
- Schottky diodes protect against shadowing effects



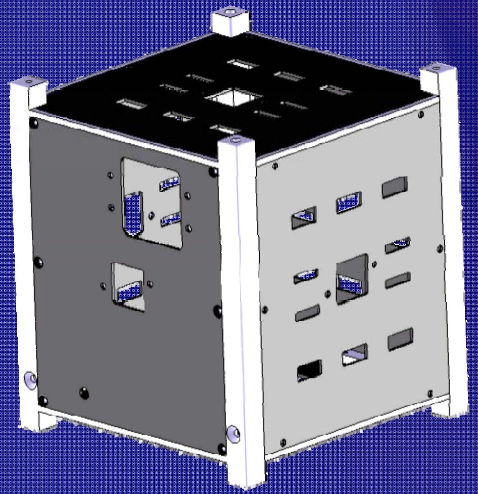


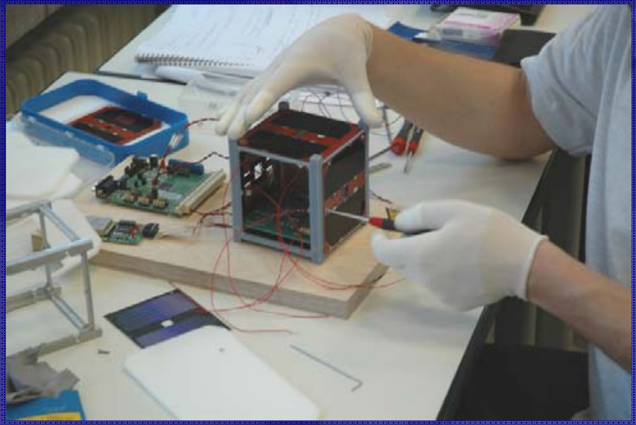
Battery Box:

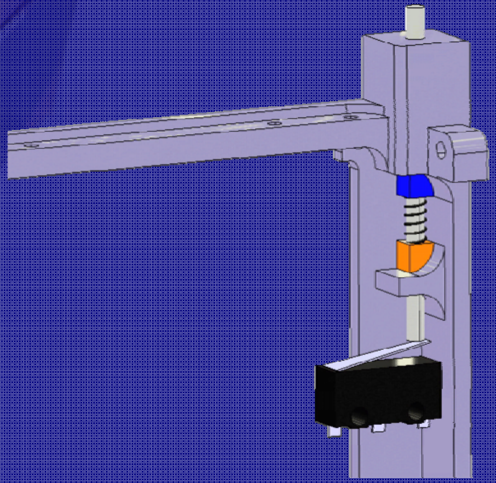
- 2x 1200mAh Lithium-Polymer Cells (parallel, 3.7V nominal)
- 3x temperature sensors
- Heater foil (1W dissipation)
- Protective aluminum housing and epoxy

Structures & Mechnisms

- Protects the electronics and other parts of the satellite against the launch loads.
- Allows thermal control of the inner components a rigid structure with special surface properties is used.
- Highly modular for easy assembly.
- Mechanisms to deploy the UHF/VHF antennas and to close the power circuit of the satellite.







Payload

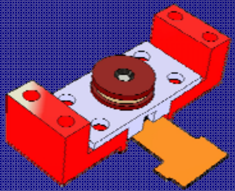
A color camera module, with very small dimensions and power consumption. It delivers images in VGA format (640x480).

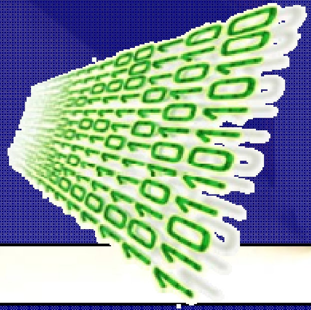
A GPS receiver. DLR modified software for the use in space.

Command and Data Handling System

CDHS Mainboard:

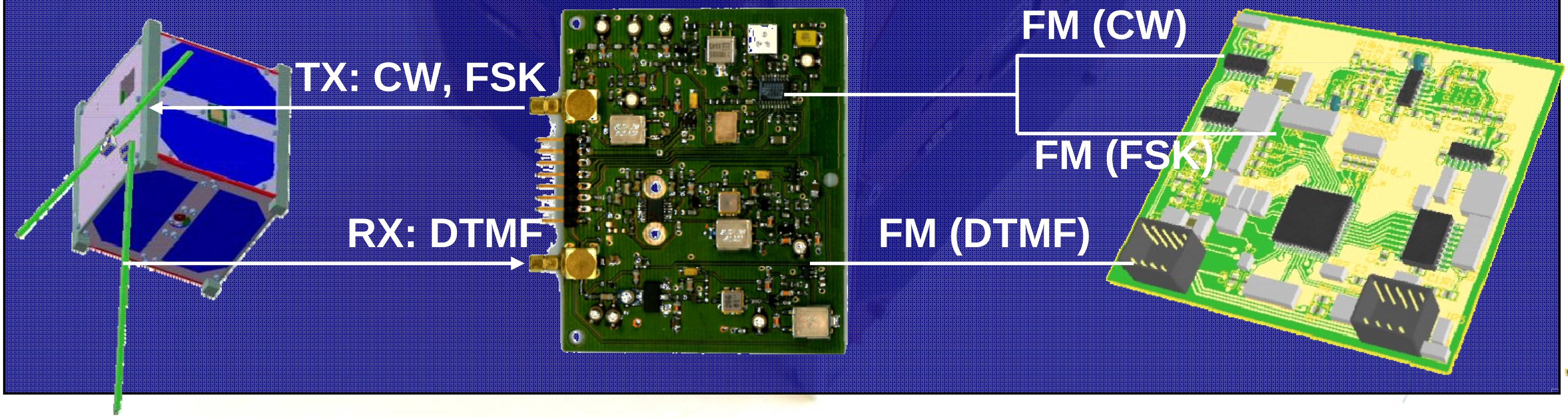
- 8-bit microcontroller 8051 architecture
- I2C Bus
- 16 MByte Flash Memory (for images and *housekeeping* data)
- connector for subsystembords
- payload inteface (control and data recording of the camera modul)
- tast management and activity scheduling
- Software completly written in compact c-modules



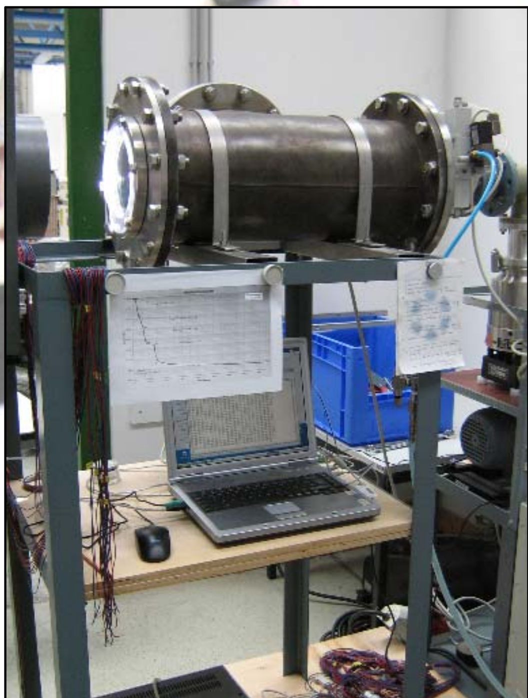


Communication System

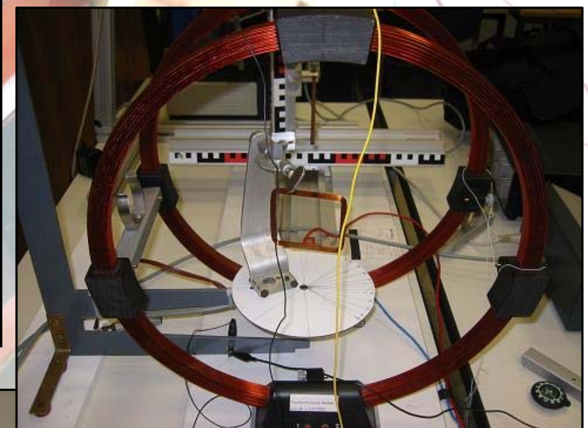
- A monopole antenna is used to receive commands, while data is sent via the dipole antennas.
- The Transceiver amplifies the incoming and outgoing signals.
- The COM board encodes the DTMF commands and sends data in AX.25 format. A beacon signal is sent in CW.

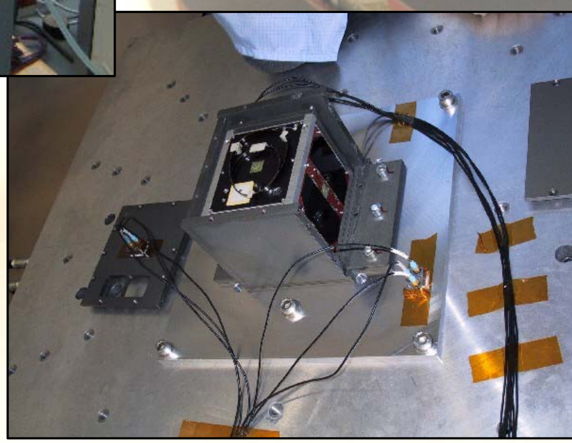


Testing



- Vaccum-Testing
- Thermal-Vacuum Testing
- Vibration Testing
- Functional Testing



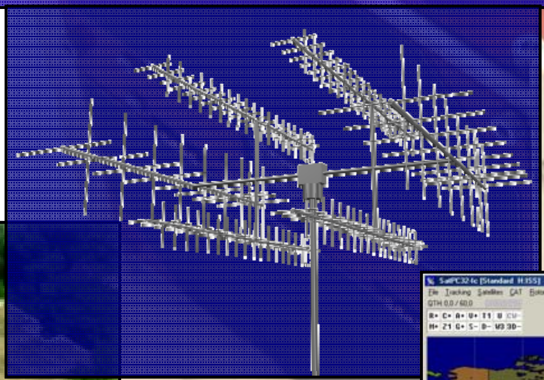


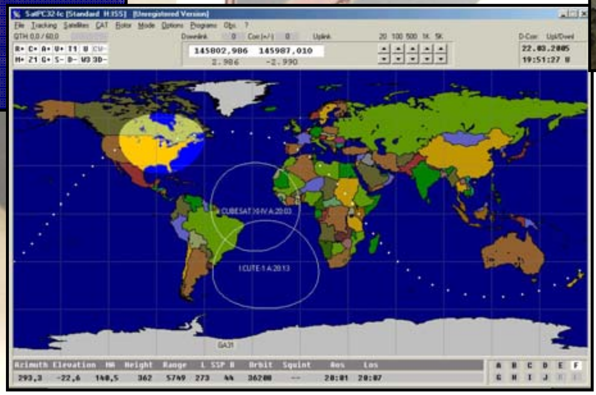
Launch

- Launch negotiations and coordination by UTIAS/SFL
- Lift Off scheduled on 30. June 2007 with India‘s PSLV Rocket as part of the NSL-4
- Sun-synchronous polar orbit:
  - Ascending node of 9:30am
  - Altitude of 635km.
  - Inclination: 97.89 deg

Groundstation Aachen

- Installation of Antenna is at work and will be finished by the end of October
- The groundstation will be part of GS – Network, remote accessable e.g. by DLR Schoollab
- Uplink at 144MHz DTMF, Downlink at 435MHz FSK





Mission Operation

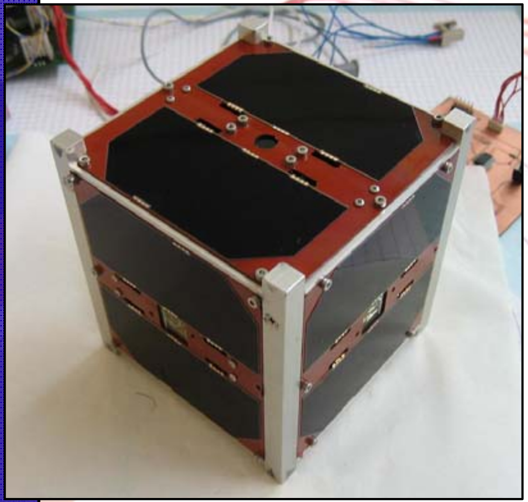
- **LEOP (Launch and first month in Orbit)**
  - First Orbit estimation
  - Uploading critical system datea e.g. system time and TLE
  - Testing proper work of COMPASS-1
- **1st Test Phase**
  - Testing GPS Data Gathering
  - First Image Capturing
  - Extentented Houskeeping Data Download
  - Testing Remote Access of GSA
- **Regular Operation Phase**
  - Data gathering, analysis and publication
  - Releasing the Access Codes to all Radio Amateurs
  - Periodically maintance data Uploads to COMPASS-1

Conclusion

- Flight model and flight spare model integration will be done by the end of november. After acceptance testing the COMPASS-1 satellite will be ready for take off by middle of december

- The project work provides excellent hands-on experience in space engineering subjects and team work.

- More than 30 students have participated in thi project so far.



Thank you!

any Questions?

...and thanks to our sponsors

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