Four years (almost) of SwissCube operations

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Small Sat pre-Conference Workshop.
• Cubesat projects have been extremely popular in the last 10 years in many universities. These projects have a great reputation for educational and technological goals.

• Question for this presentation:

  - Is it possible to implement scientific experiments with Cubesats?

• Outline
  - Introduction for the Swiss Space Center
  - Definitions
  - Statistics for the last decade
  - Zoom into SwissCube
  - Wrap up and discussion
SwissCube collaboration

About 200 BS and MS students over 3 years (6 semesters)...
supported by laboratory staff and a good systems engineering team...
about 15 laboratories from 7 CH engineering schools and universities were involved...
SwissCube: short presentation
SwissCube: short presentation
SwissCube results: AOCS

Angular norm speed 2009-->2012

- BDOT On
- Gyro 2009
- Gyro post 2011
- Rate from audio

- Gyro saturation rate

September 23, 2009: Launch: Day 0
January 24, 2011: Cold reset
December 29, 2012

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SwissCube results: AOCS

Angular norm speed 2009-->2012

Angular Speed 2012--2013

Gyro saturation rate

September 23, 2009: Launch: Day 0
January 24, 2011: Cold reset
December 29, 2012

nominal ops

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SwissCube results: EPS temperature control

Battery Temperature: MIN and MAX during 2011 and 2012

Motherboard: high temperatures

Motherboard: low temperatures
In the night, and the Sun that is coming is on the opposite face of the camera. We were able to determine pointing accuracy of the cube to 5 degrees using the Moon.
SwissCube: Magnetometer results

Reasons for magnetometer oscillations:
1) Magnetotorquers influences
2) Currents accumulated on the solar panels or on the wires generated magnetic fields.

Lesson learned: need another magnetometer to determine oscillation.
SwissCube results: what worked

• EPS: worked perfectly, satellite is still running
• COM:
  - COM: works fine, some issues with the I²C bus, beacon is great
  - antenna deployment: probably source of many problems
    ‣ initial rotation
    ‣ poor uplink
• AOCS:
  - capable of bringing S/C rotation down
  - sun sensors: 2 out 12 failed after 3 years
  - magnetometers: calibration is off on one of the axes.
  - gyros: work fine, but were in saturation for the first two years.
• Payload
  - works, but optical model is not defined, considerable reflections on the telescope structure
• Ground Segment
  - works perfectly, now baseline for QB50 project constellation project
  - satellite is now operated by a radio amateur
Outlook and conclusions

• Swiss Space Center plans
  - CubETH
    ‣ GNSS high precision measurement satellite
    ‣ PRR scheduled for April 04, 2013
  - Object 3
    ‣ 3U, 3 axis satellite for solar flare observations
  - CleanSpace One

• Although to date Cubesats were not great on science, the future looks quite promising
  - technology has matured to allow more complex payloads and more complex missions
  - there are great ideas for science with Cubesats (ExoplanetSat, MicroMas)

• Keys to a successful CubeSat science mission
  - 3U Cubesat
  - early start with the payload
  - testing, testing, testing
  - flight heritage: 3rd generation satellite (#3 in series)
Discussion?
SwissCube results: AOCS effects

Panel Temperatures

Panel Temperatures

YN side has the antenna attached

Angular norm speed 2009—>2012

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