ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

eSpace
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Pico- and Nanosatellites at EPFL

Lessons learnt

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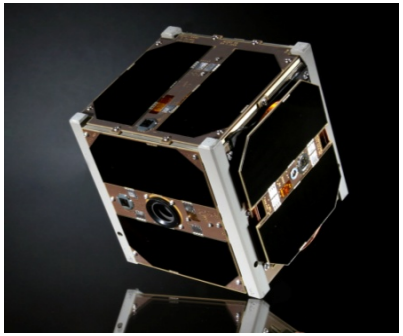
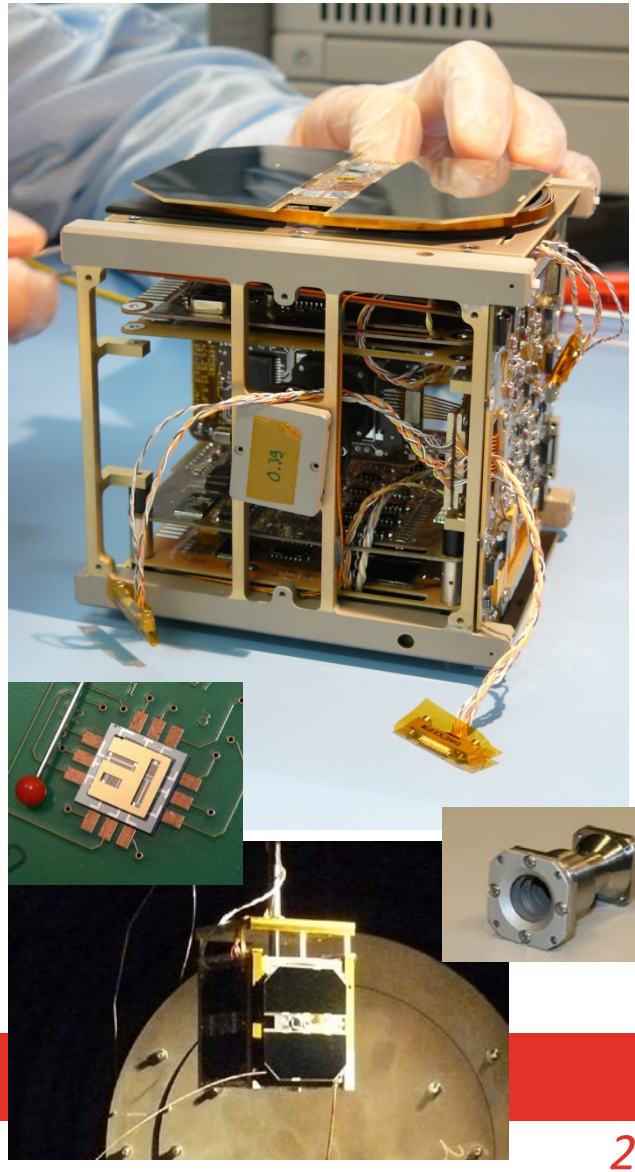


LIFT to Space Conference 2015
Geneva, Switzerland
February 4th 2015

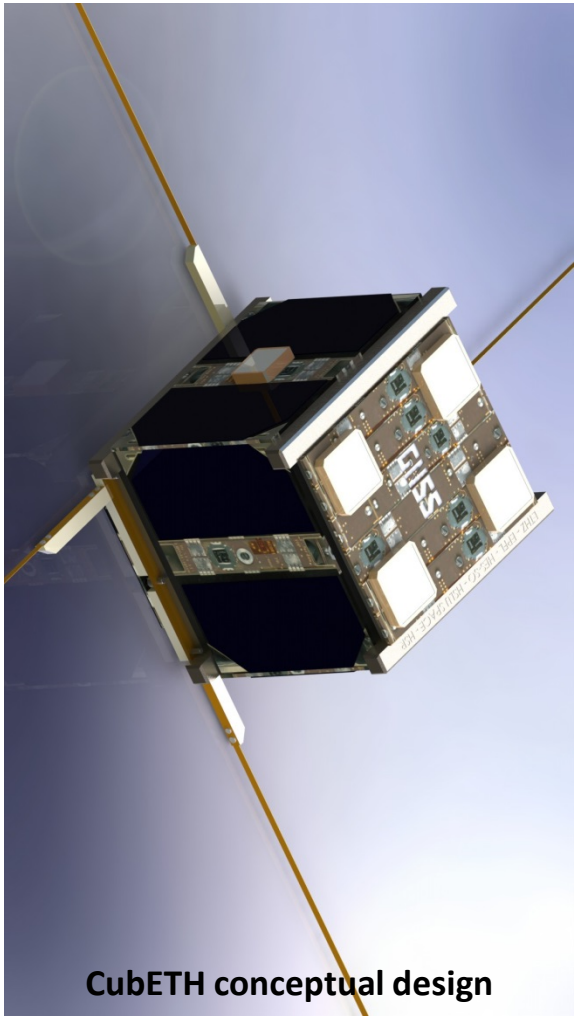
PicoSats: SwissCube

- Objectives: Educational project
  - ~ 200 students involved over 5 institutions (HES-SO, Uni Neuchatel, NWFH, Uni-Bern, EPFL)
  - 3-yr development
  - Launched in Sept. 2009, still operational after 5 years in space (LEO 700 km)
- Size, mass: 1U CubeSat, 820 g
- Labour context: project represents ~135'000 hours of work (supervising + student labour)
- Architecture:
  - Simple functionalities
  - Functional (degraded) redundancy
  - Distributed processing



PicoSats: CubETH

- Objectives: Educational, technology demonstration & science
  - 5 institutions involved (ETHZ, HES Luzern, HES Rapperswil, HES-SO, EPFL)
  - Test of a GNSS receiver tracking GPS, Glonass, Galileo and Compas
  - Precise Orbit Determination based on Single Frequency GNSS, Attitude determination
  - Experimental measurements: radio occulattions, reflectometry, air density estimation
- Size, mass: 1U CubeSat, ~1kg
- Labour context: Student labour + supervisors
- Architecture: Payload is multiple redundant



CubETH conceptual design

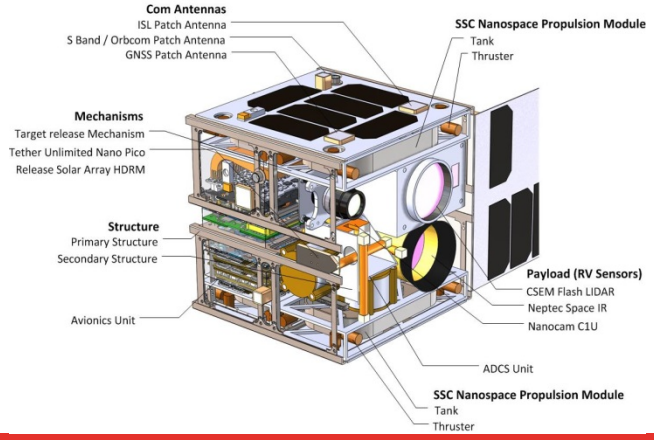
Lessons learnt from these PicoSat developments

- "New Age" of education:
  - Learning by doing
  - Condensed System Engineering and flight experience (Phase A-E in 2-3 years)
  - Very dynamic environment for master students and young engineers
  - Asks for taking responsibilities early on (what students creates, flies…)
- New mindset in satellite design:
  - nanosats are a very open and free environment to test new technologies and implementations
  - rapid insertion of high tech from other domains into the satellite designs
- Flight system:
  - Small and focused functionalities (or measurement objective)…
  - Redundancy handled differently … good testing…
  - Simple on-board autonomy … all of this brings robustness…
- New applications: constellations (QB50)…

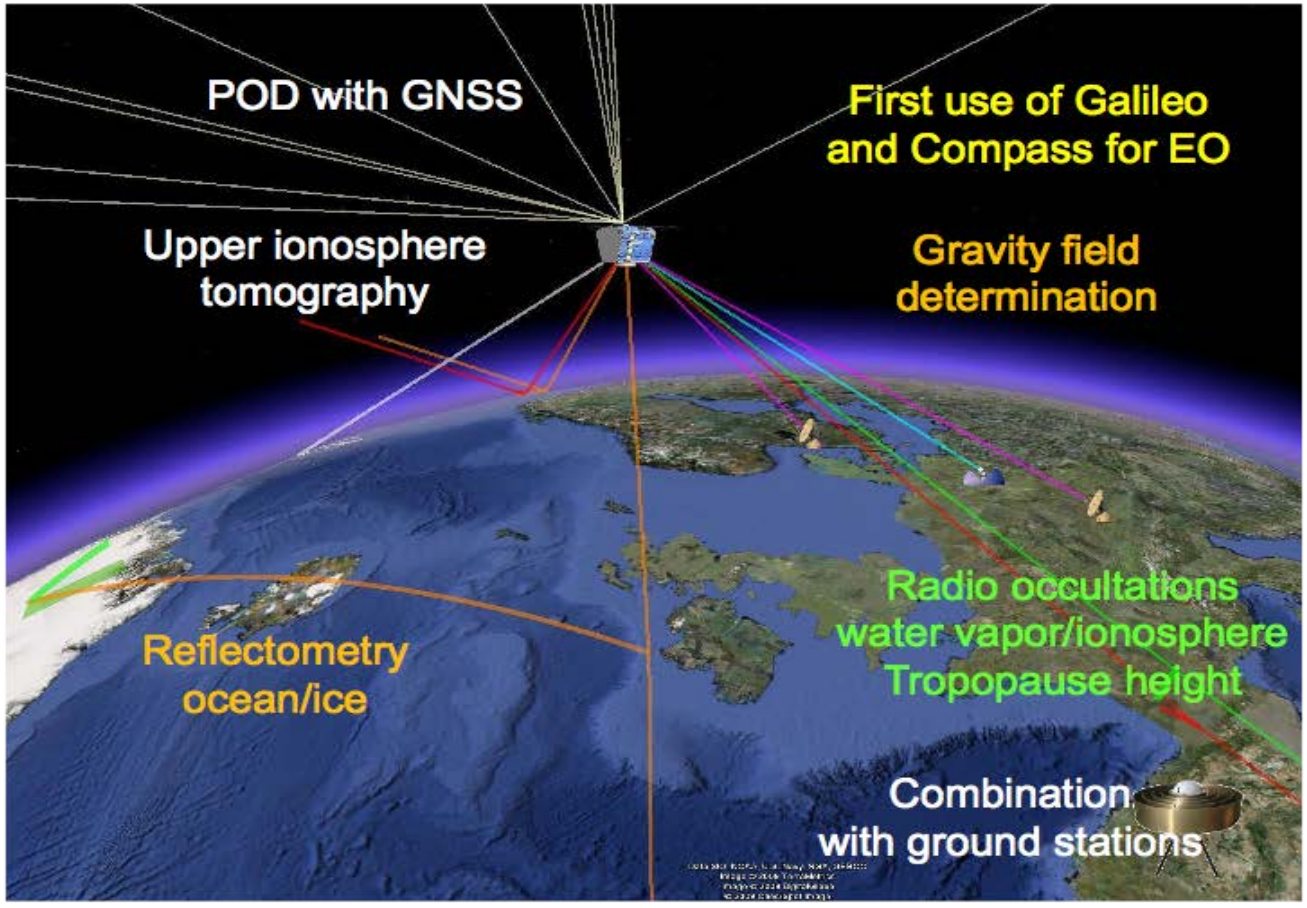
Next? CADRE NanoSats mission

- CADRE: CubeSat Active Debris Removal Experiment, ESA GSTP activity
- Objectives: Technology demonstration
  - Test of ADR critical technologies
  - De-risking of large ADR mission
- Size, mass: Chaser 8U, 16 kg – Target 4U, 4 kg
- Labor context: Semi-professional environment (engineers + PhDs)
- Architecture:
  - Complex functionalities
  - Functional redundancy
  - High power processing

CADRE conceptual design (6 DoF NanoSat)

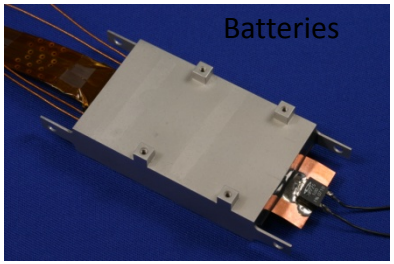


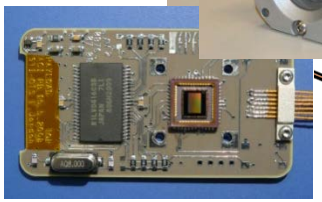
CubETH back-up

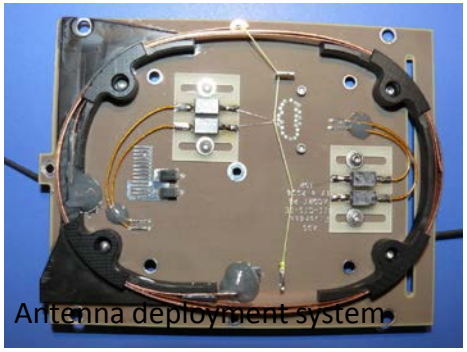


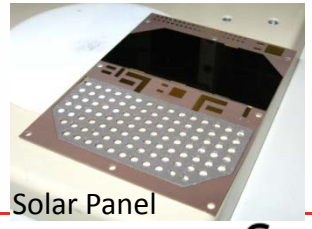
GFZ Helmholtz Centre Potsdam

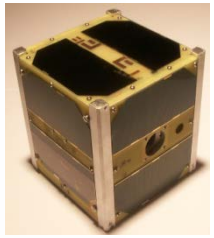
SwissCube Flight System

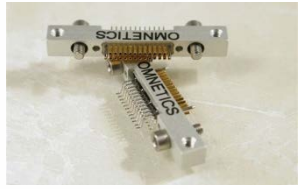









STM Model



SwissCube Electronic system

- 7 subsystems
  - Spread over 16 boards
- In total…
  - 357 wires…
  - More than 1000 components
    - Soldered by hand by the team
- Other considerations
  - EMC problems, I2C bus
  - Thermal dissipation of PA
  - Integration difficulties
  - Solutions : creative ideas, and solutions seaked early in the design