A Passive Altimetry and Dosimetry Nanosatellite Mission

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Introduction

- TU Graz is developing an advanced CubeSat for ESA, called OPS-SAT
- RUAG Space Austria and TU Graz: study of passive reflectometry (ASAP project)
- Proposal for an Austrian CubeSat to GSTP: PRETTY (Passive REflectometry and DosimeTrY)
- 3U CubeSat with powerful processor and SDR front-end
Passive Reflectometry

Altimetry:
determine relative Delays between direct/reflected signal
PRETTY

Triple CubeSat (10 x 10 x 30 cm) with deployable solar arrays
Power: 24 W
PRETTY

Satellite Bus: flight-proven subsystems
OBC, EPS, UHF transceiver
structure, deployable solar arrays
GNSS Antenna

- 8 L-band patches antennas
  - Gain: 15 dBi
  - Beamwidth: 25.5°
  - Bandwidth ~ 70 MHz
Main Payload: Satellite Experiment Processing Platform (SEPP)

- 2 x System on Module Altera Cyclone V SoC in cold redundancy
- Memory
  - 1 GB DDR3 RAM (ECC)
- Mass Memory
  - external 8 GB Industrial SD-Cards (SLC)

developed by TU Graz

Radiation-tested at ESTEC up to 20 krad
Software-defined Radio Receiver

- RF front-end based on commercial SDR chip
- Interfacing with processing platform
- Frequency range: 300 MHz – 6 GHz
Dosimeter

- Measuring radiation environment inspacecraft
- Using small, low-power payload with a RADFET
- Payload developed by Seibersdorf Laboratories
Grazing Altimetry

- Ice area/height analysis
- Sea height analysis
- Measurements at incident angles > 70 degrees
- Moderate requirements on the attitude control system
- Pointing accuracy: 1 degree
Reflection Coefficients
Cross-Correlation

• Cross-correlation approach does not require any knowledge of GNSS spreading codes:
  – encrypted GPS P(Y)-codes,
  – the classified GPS M-code
  – Galileo E1-A signals can be utilised.

• Increases the total signal energy

• Grazing reflections: significantly longer coherence times than reflections at small incidence angles.

• Coherent integration times up to 50 ms expected

• L-Band data down link of geostationary satellites
Data Rate Requirement

- S-Band downlink
- Data rate: 1 Mbit/s
- Data volume/day download: 1.8 Gbit
- Data volume generated: 55 Gbit (max.)
- Reduced duty cycle
- Data compression
Summary

• PRETTY: Passive Reflectometry mission
• Using 3U CubeSat (heritage from OPS-SAT)
• Powerful processor & SDR front-end
• Altimeter realised
  – Sea height
  – Ice cover
• Contribution to climate monitoring
• Measuring of radiation effects
• Phase B running under ESA‘s GSTP program
• Flight in about 2 years expected
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