Self-Inflatable Deployable Structures for Passively De-Orbiting CubeSats

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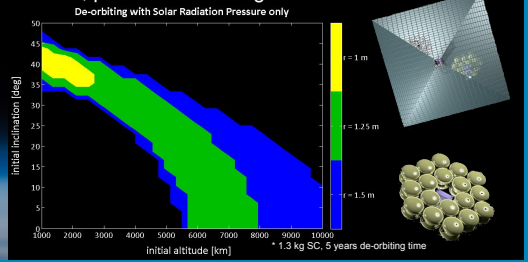
The Concept

The Problem

- ❑ CubeSats are currently launched mostly at altitudes ranging from 200 to 400 km (ISS)
- ❑ They de-orbit naturally within the 25 year recommendation
- ❑ New components + better payloads allow for design of CubeSats operating at higher altitudes
- ❑ More piggy-back launch opportunities are as well available
- ❑ De-orbiting within the timeframe of the space debris guidelines not guaranteed
- ❑ Thrusters require fuel and control at end-of-life

The Solution

- ❑ Higher surface to area mass ratio: SRP, J2 and eventually drag accelerate de-orbiting
- ❑ Deployable structures require less volume: extended panels, satelloons…
- ❑ Residual air self-inflation in vacuum reduces complexity and increases reliability
- ❑ Automatic release at end-of-life even without control, passive de-orbiting



The Experiment

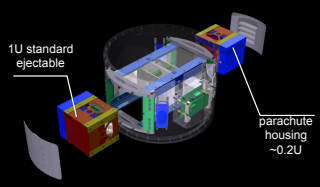
REXUS: Rocket Experiments for University Students

DLR · RYMDSTYRELSEN Swedish National Space Board · esa

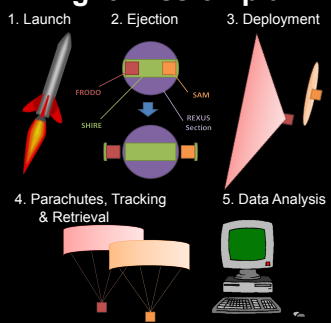
- ❑ Great educational and capacity-building programme
- ❑ Possible model to be reproduced by UNOOSA

- ❑ 2 rocket campaigns/year (+2 BEXUS balloon campaigns)
- ❑ Launch from ESRANGE Kiruna
- ❑ Length of 5.6 m and a diameter of 0.356 m
- ❑ ~3 min µg and ~95 kg payload
- ❑ Altitude between 78-93 km
- ❑ ~4 experiments per rocket (main body and nose cone)
- ❑ Possibility of yo-yo despin and hatches for ejectables

More info at http://rexusbexus.net/



Flight mission plan



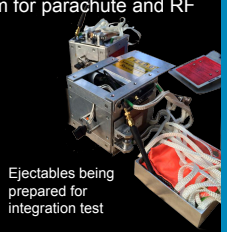
StrathSat-R:

- ❑ Technology demonstrator to deploy two self-inflatable structures in µg and near vacuum: FRODO & SAM
- ❑ Launched onboard REXUS 13 on 8th May, 2013, and REXUS 15 on 29th May, 2014

FRODO

Foldable Reflective Omni-altitude De-Orbiter

- ❑ Novel small-sat de-orbiting concept
- ❑ Thin film reflective material, square pyramidal shape
- ❑ Inflatable struts with residual atmospheric air deploy structure when released
- ❑ 1U CubeSat + 0.2U addendum for parachute and RF antenna for recovery



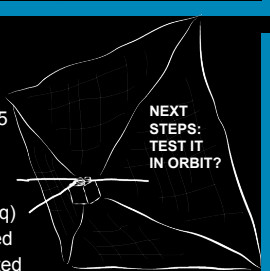
The Results

REXUS 13

- ☒ Ejection failure (pyrocutter not activated)
- ☑ External causes → second chance: REXUS15

REXUS 15

- ☑ Successful ejection
- ☑ Recording, telemetry stored (recovery req)
- ☑ Residual air inflation tested and validated
- ☑ Deployment of pyramidal shape validated
- ☒ Shape perturbed by drag (not intended for <90km)
- ☒ Not possible to test SRP de-orbit (not foreseen as not in orbit)



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