ESA DRAGLINER – COULOMB DRAG BASED TELECOMMUNICATION SATELLITE DEORBITING DEVICE

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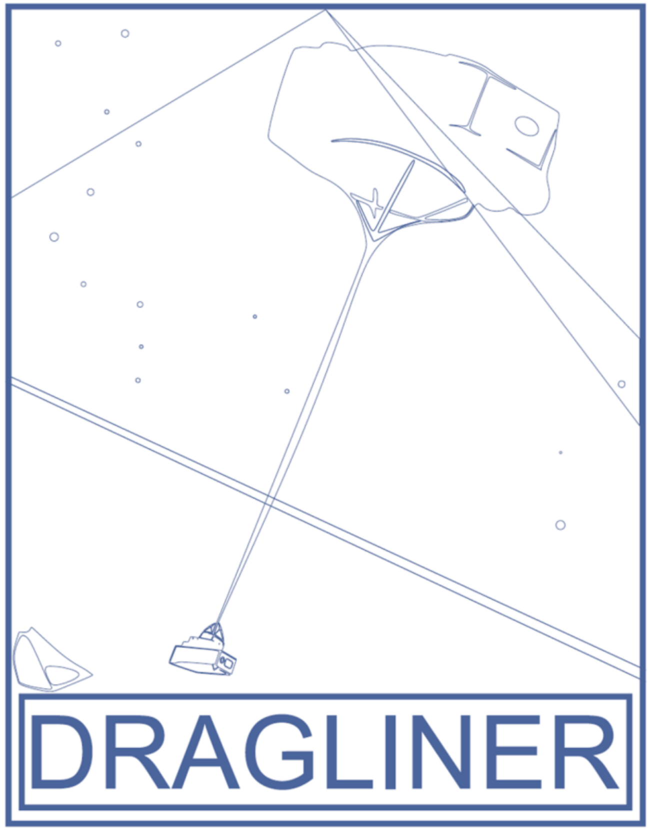
Overview of the talk

- Introduction of the speaker and Aurora Propulsion Technologies
- Coulomb drag introduction
- Dragliner overview
- Concept of operations
- Simulations
- Upcoming testing



Introduction of the speaker – Pyry Peitso

Versatile space technology professional with over 10 years of experience from university, research institute and private corporations, interested in space project planning, FMECA analysis, space instrument design and testing, plasma brake and deorbiting analysis.

Master of Science (Tech) in Space Technology from Aalto University

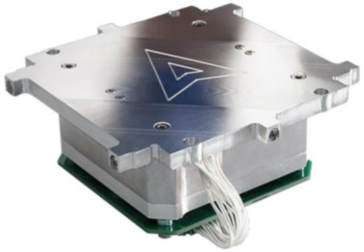
In Dragliner, Project Manager for Aurora Propulsion Technologies contributions, WP lead in several WPs

Company Confidential – Aurora Propulsion Technologies

Aurora Propulsion Technologies

Aurora Propulsion Technologies

We are a space technology company focused on making space activities sustainable. Our products are based on our two core technologies: the miniature resistojet thrusters and the Plasma Brake, a tether-based deorbiting technology. We were founded in 2018 here in Espoo.



Aurora Resistojet Module (ARM)

Miniaturized resistojet system for attitude and orbit control

Aurora Plasma Brake (APB)

Tether-based propellantless deorbiting system for up to 500 kg satellites

Collision Avoidance System (ARM-C)

Extremely compact collision avoidance thruster at < 100 g total mass

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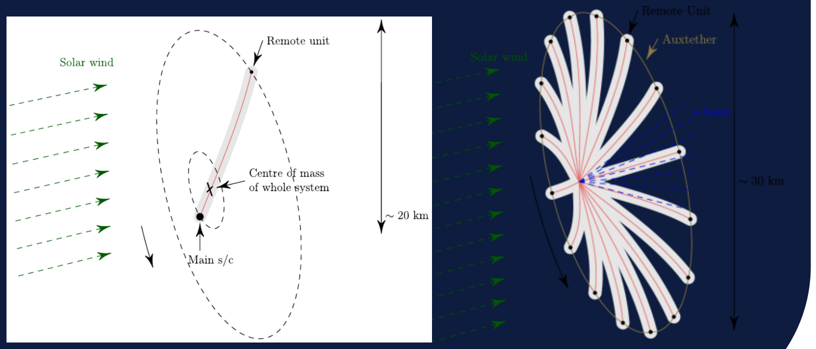
Coulomb drag introduction

The plasma brake providing the Coulomb drag utilized in Dragliner is a spin-off from the electric solar wind sail technology

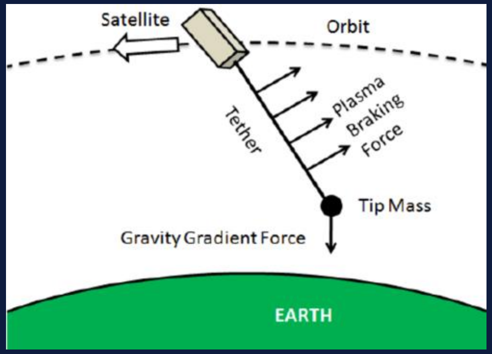
Electric Solar Wind Sail (E-sail)

- Utilizes solar wind momentum for producing thrust
- Uses positive polarity and electron guns



Plasma Brake for deorbiting LEO satellites

- Uses negative polarity
- Interacts with upper atmospheric plasma to produce thrust for deorbiting
- Does not need electron guns, but requires an electron gathering surface area



Project Dragliner overview

- The purpose of DragLiner: to reduce deorbit time from LEO to an order of magnitude shorter compared to 25-year deorbiting policy, while using passive deorbiting method (Coulomb drag) that uses significanly less spacecraft resources than traditional deorbiting methods
- In practise this means increasing the telecommunication satellite plasma brake TRL to 4.
- The outcomes of the the project are tested breadboard models of most critical components of the system, as well as samples of produced tether

- It should be noted that the goal is to preliminarily design a final deorbiting system product. This means that diagnostics and other subsystems used during demonstration phases are not included
- Project started at late 2022, expected to be finished by late 2024
- Consortium consisting of prime contractor Finnish Meteorological Institute, subcontractors Aurora Propulsion Technologies, GRADEL, University of Luxembourg

Target mission description

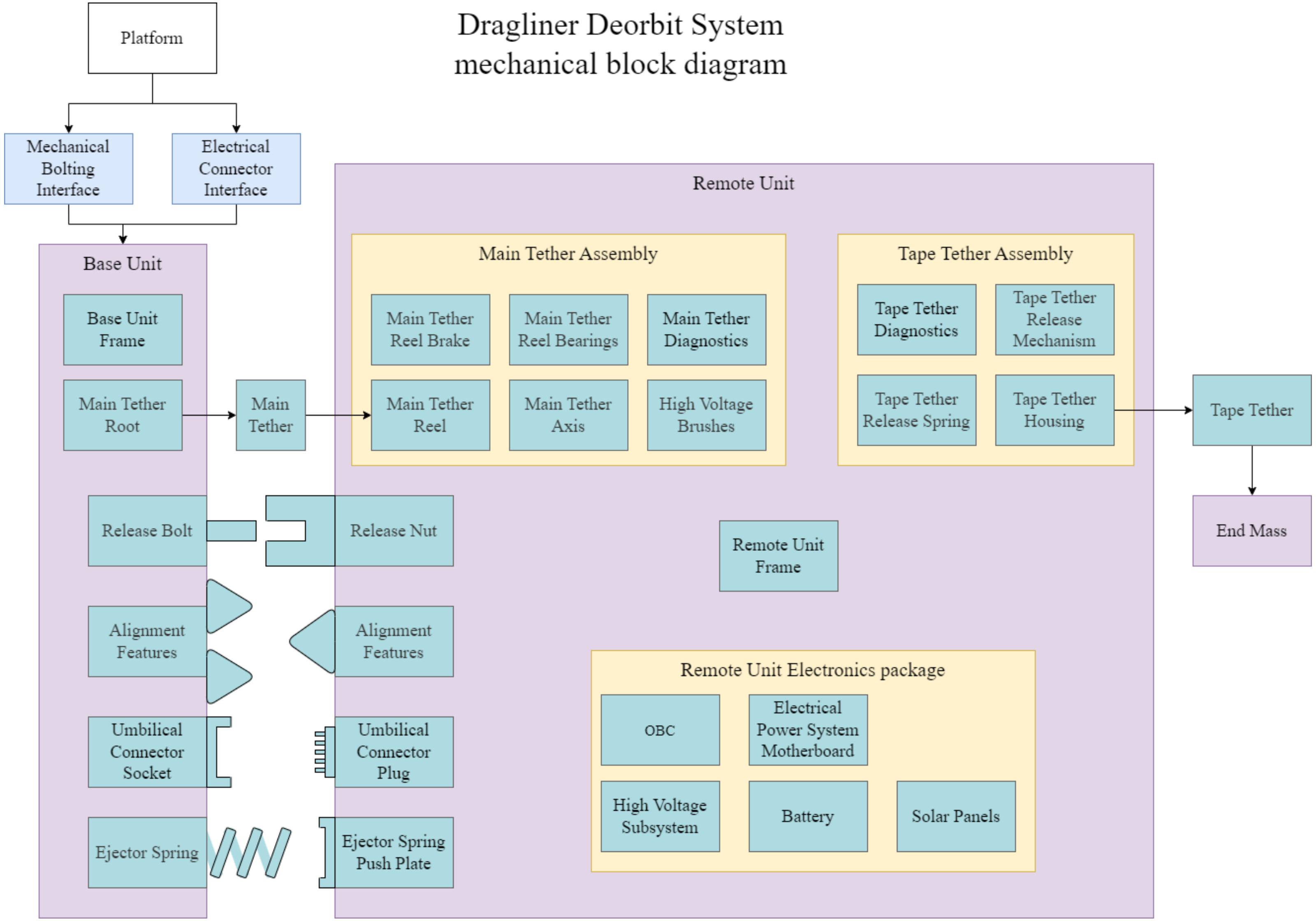
- Main mission requirements:
  - Deorbit time of a 250 kg satellite down to 400 km shorter than 2 years, with 100 days as a goal
    - *Practical upper limit for satellite mass/starting altitude combination for 2-year requirement is 250 kg and 850 km*
  - Low mass, mass fraction for 250 kg satellite and 800 km starting altitude is < 5% (with <2% as a goal).
  - The Deorbit System shall not require the platform to spin during its deployment
  - The platform does not need to be active during deorbiting, which is considered part of satellite decommissioning

Deorbit System concept

The system consists of:

- Base Unit attached to the side of the telecommunication to be deorbited (the Platform)
- Remote Unit containing most of the electronics and other subsystems
- The size of the Remote Unit is approximately a 3U Cubesat
- Two tether systems, the actual Main Tether producing the Coulomb Drag as well as a Tape Tether, for electron gathering surface area

Dragliner Deorbit System mechanical block diagram



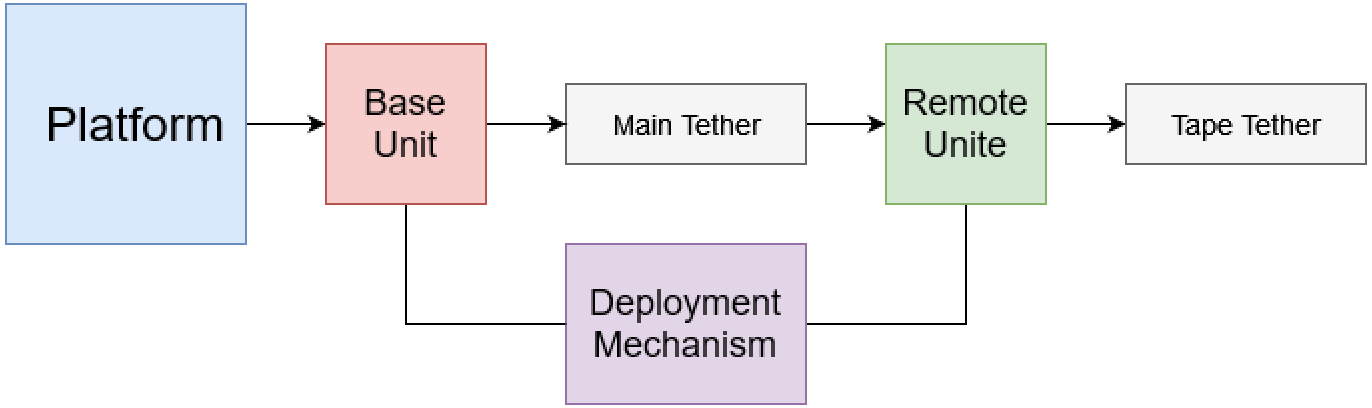
Main Tether

- The Deorbit System consists of two idential modules, each carrying 5km of Main Tether.
- The plasma brake is defined as a microtether, it has a mass of less than 200 ug / m.
- This means that the total mass of the system is very low, and it is safe to other space assets in case of collision (as the impact is comparable to common micrometeoroid impacts in LEO). Though the impact is not safe to the microtether itself.
- The material must be electrically conductive to allow charging, and tolerant to ATOX environment on LEO. Must be tolerant to micrometeoroid or debris impacts, thus it cannot be a single wire, but multiwire configuration (3-4 wires).
- After considering several material options, aluminium has been chosen for the Main Tether wire material.
- Main Tether sample production will be done by FMI.

System deployment

The deployment sequence is as follows:

- The Platform performs one final attitude control maneuver, and gives the deployment signal to the Deorbit System
- The Remote Unit is released from the Platform
- The Main Tether is deployed
- The Tape Tether is deployed
- High voltage is applied and the system can start deorbiting

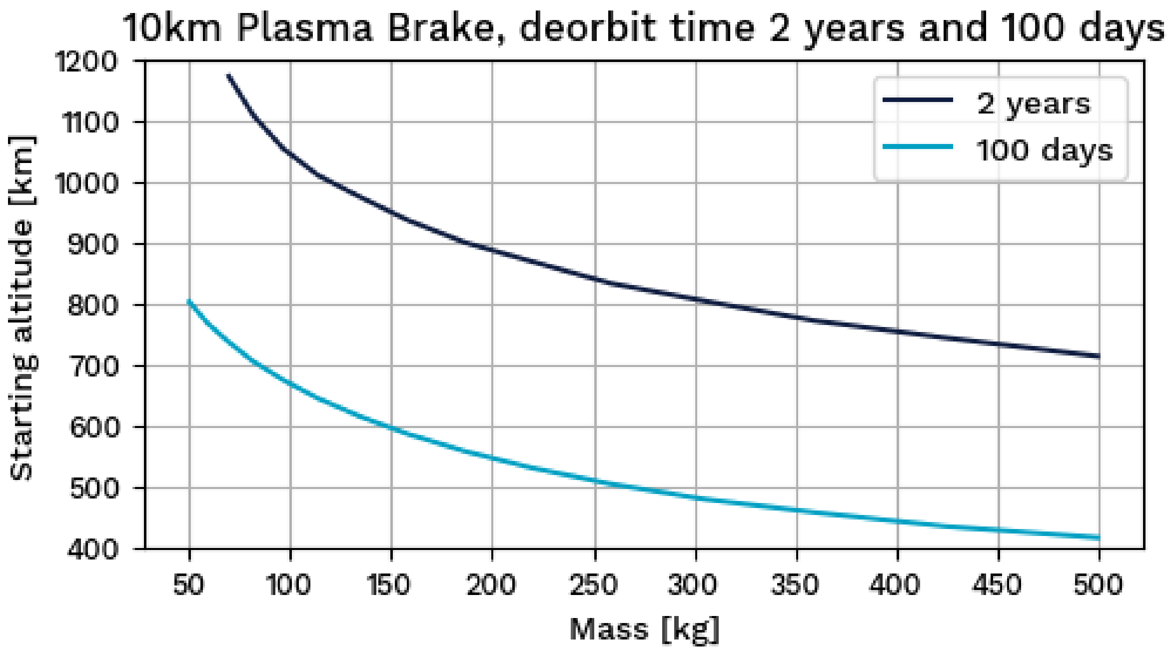


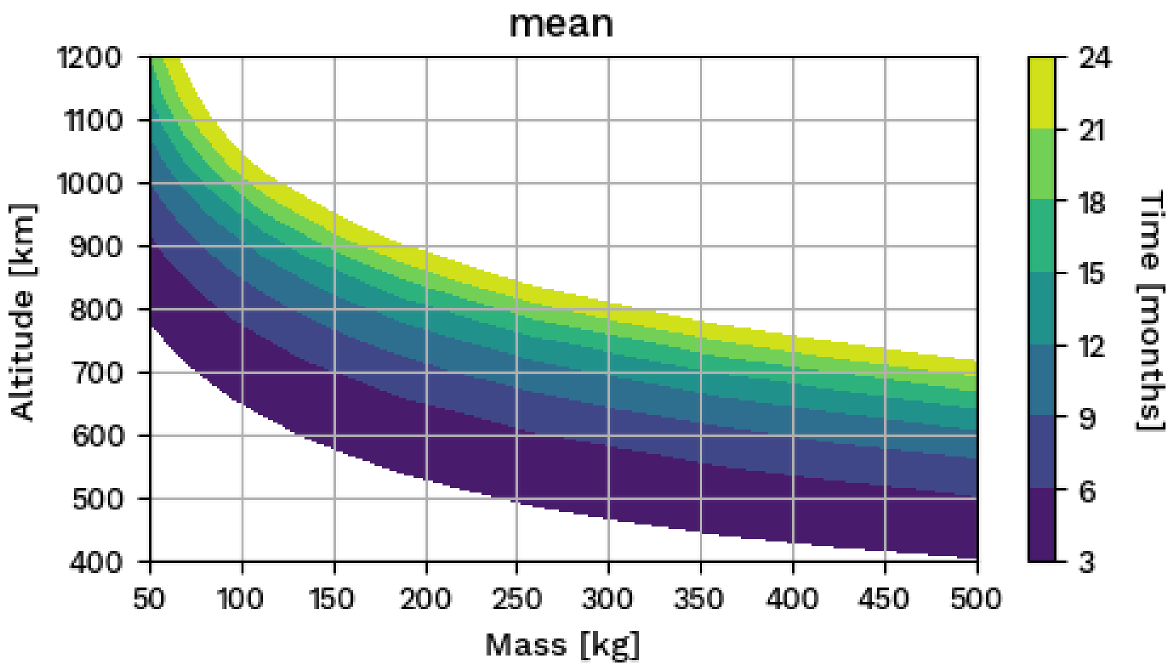
Deorbit simulations

- Performance of the plasma brake has been simulated.
- We utilize in-house developed plasma brake deorbiting simulator (done in Python) to forecast the performance of the system.

For more information, please see:

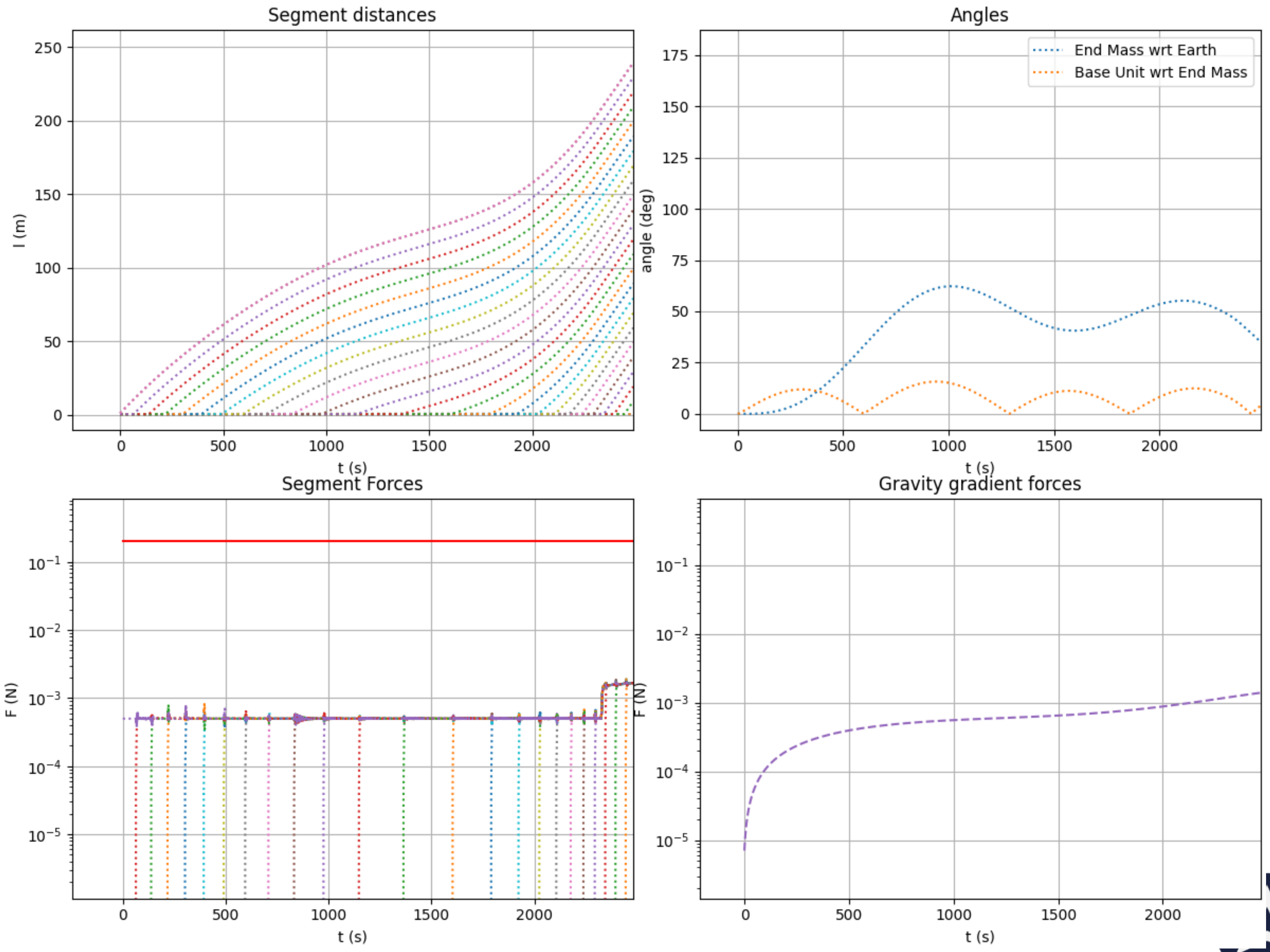
Peitso, P., et al. "Plasma brake deorbiting simulation using dynamic space environment." *7th Space Propulsion 2020+ 1 Conference*. Association Aéronautique et Astronautique de France (3AF), 2021.





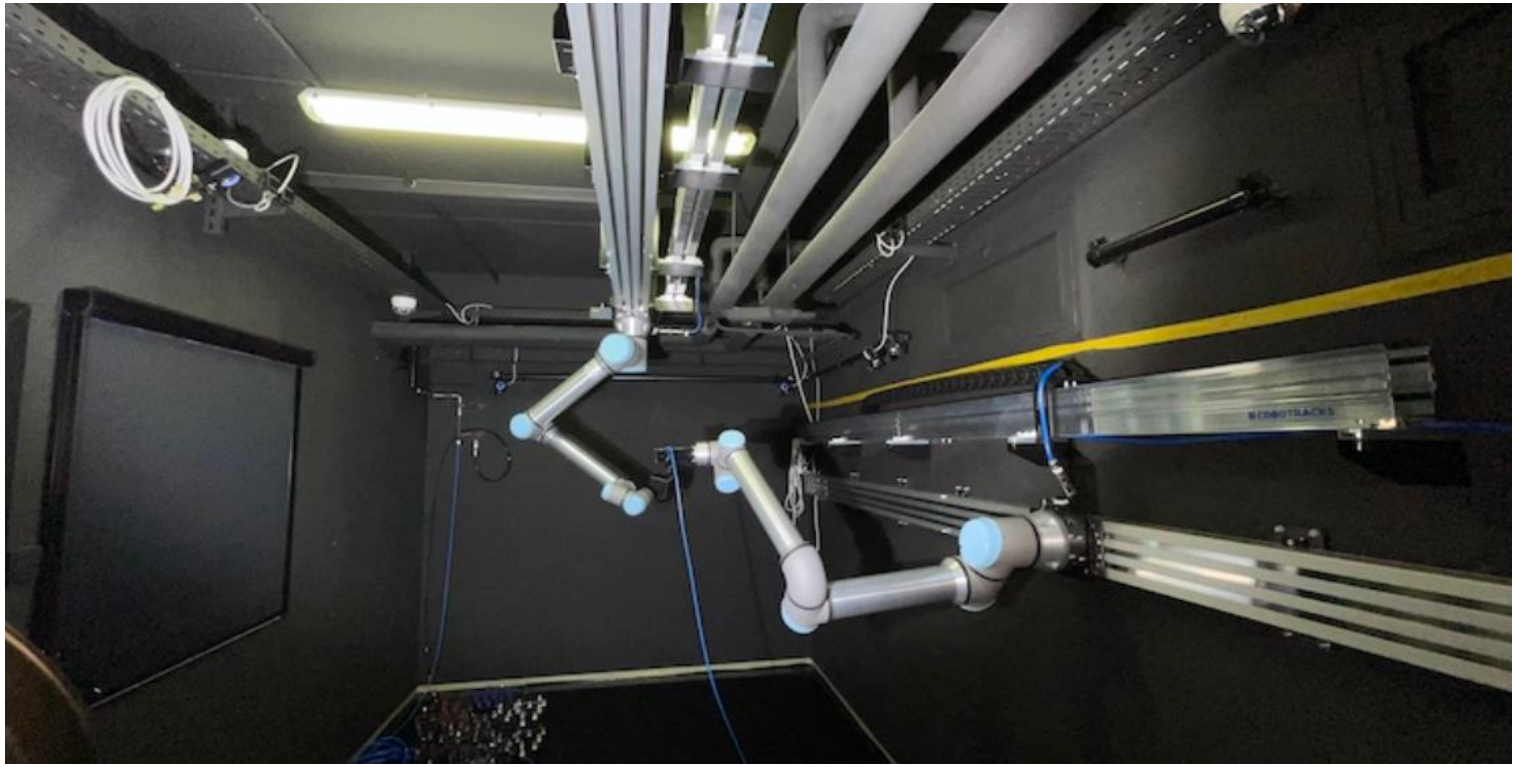
Tether dynamics

- Behaviour of the Main Tether during initial deployment, full deployment as well as the stability of the full tether, have been simulated.
- The simulation was used to verify that the Main Tether opens far enough with the initial velocity for the gravity gradient to overcome the reel friction.
- Simulator done in-house and in Python



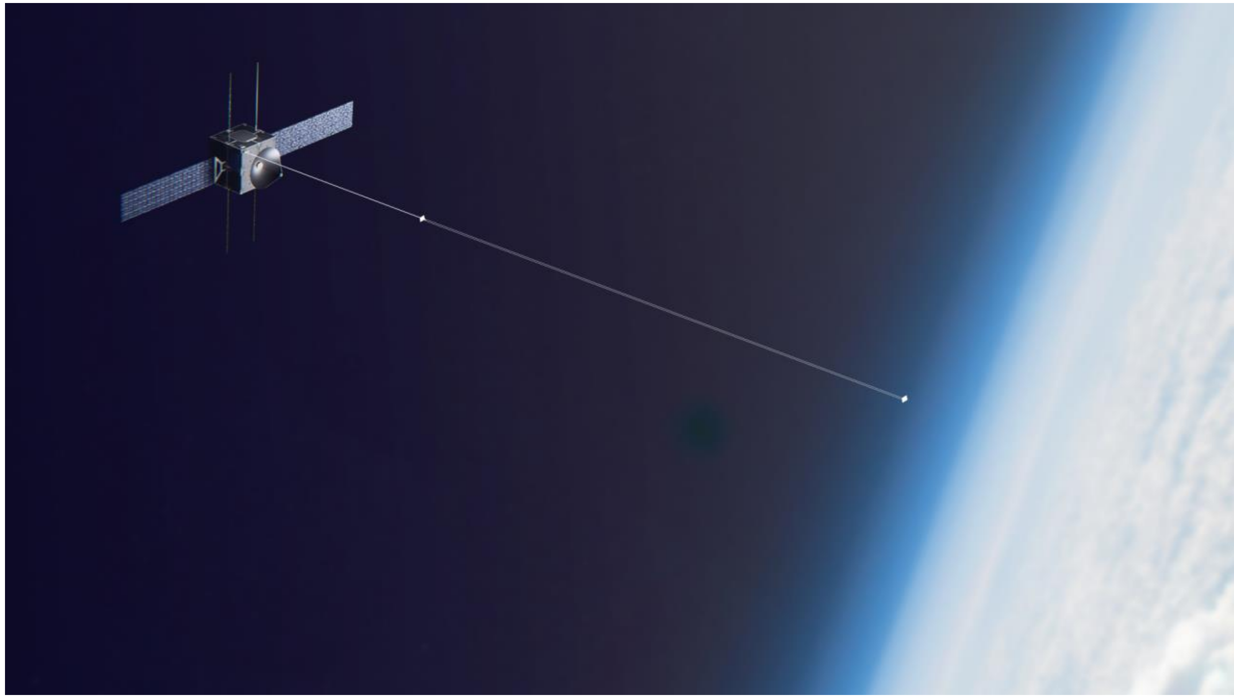
Zero-G lab testing

- Most critical functions of the tether system are to be tested in University of Luxembourg Zero-G laboratory.
- These are mostly opening of the tether systems.
- Test planning currently ongoing thus we unfortunately don't have any results yet.

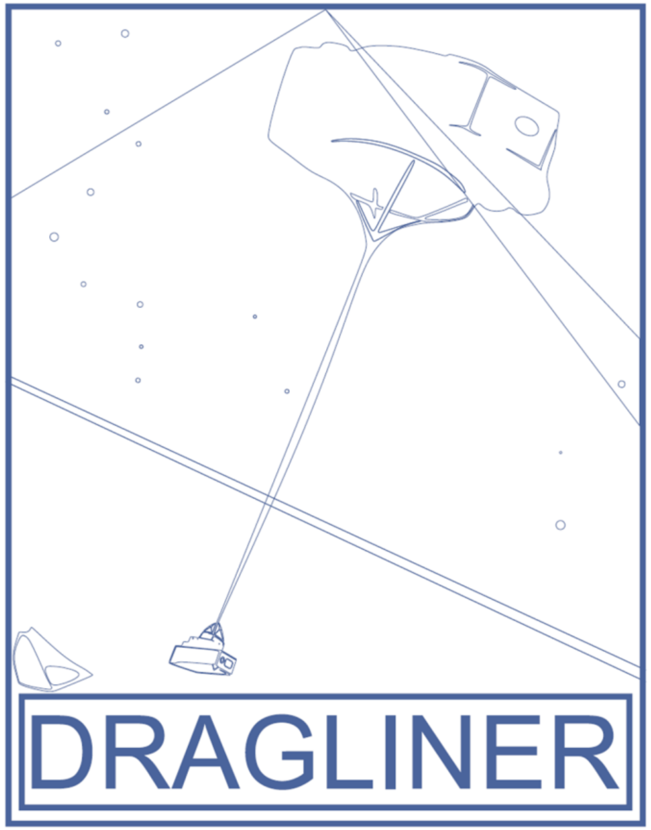


Upcoming developments

- Manufacturing of the breadboard models
- Results from the Zero-G laboratory experiment
- Technology development roadmap
- Complete project by late 2024, increase system TRL



Thank you for listening! Any questions?



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