HPS High Performance Space Structure Systems GmbH GERMANY

ADEO DE-ORBIT SUBSYSTEM

ADEO-N

The European Commercial Passive De-Orbit Subsystem

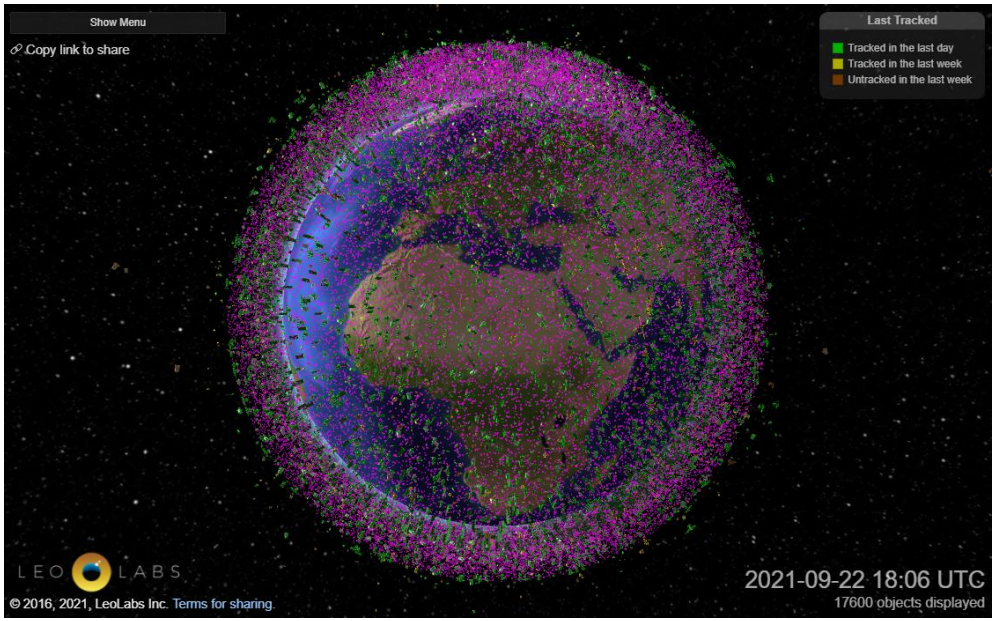
Philipp Laube (HPS)

Clean Space Industrial Days | September 2021

Managing the end of life

Methods to comply with the „25-years“ rule (or less)

- **(Initial) Mission Altitude** (typical 550-650km)
- **Indirect Re-Entry** (with remaining fuel)
- **Direct Re-Entry** (dedicated fuel)
- **Passive** (Solar Sails, Tethers, **Drag Sails**)

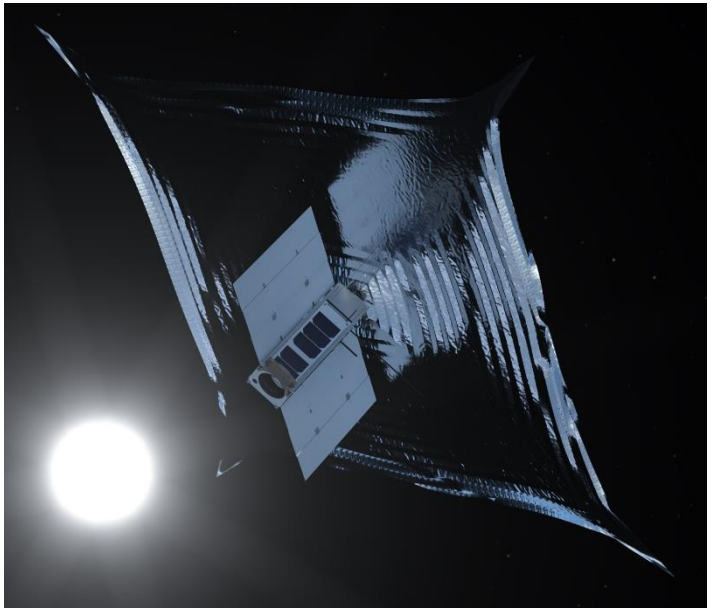


https://platform.leolabs.space/visualizations/leo

This Low Earth Orbit Visualization (LEOV) is the property of LeoLabs, Inc.

The ADEO Drag Sail Family

The ADEO subsystems are passive de-orbit subsystem based on deployable drag sails.



The residual atmosphere in LEO is used by increase of the S/C's effective surface area.

Unique features of ADEO are:

- **ultra-light weight** (lower mass than additional propellant for indirect or direct re-entry)
- **scalable sail size** (1.5 m^2 to > 100 m^2) tailored to each spacecraft/mission
- **generic** (standard interfaces with adjustable interface brackets for spacecraft)
- **completely passive** (no need for active control)

ADEO Family

ADEO-L (Large for sail >25m²)

ADEO-M (Medium: overlapping L- and N-class, i.e. 10-25m²)

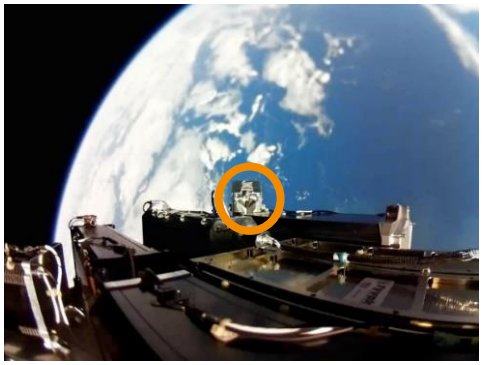
ADEO-N (Nano for sail 2.5-5.0m²)

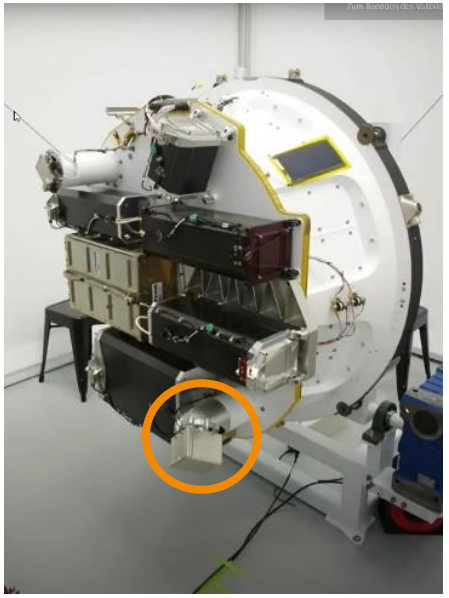
Selection of the class is dependent on initial orbit, S/C mass and time constraints for deorbiting.

Use of multiple ADEO-N, for example, on one S/C or upper stage is an option where accommodation of a bigger system might be unfeasible.

ADEO Family Heritage

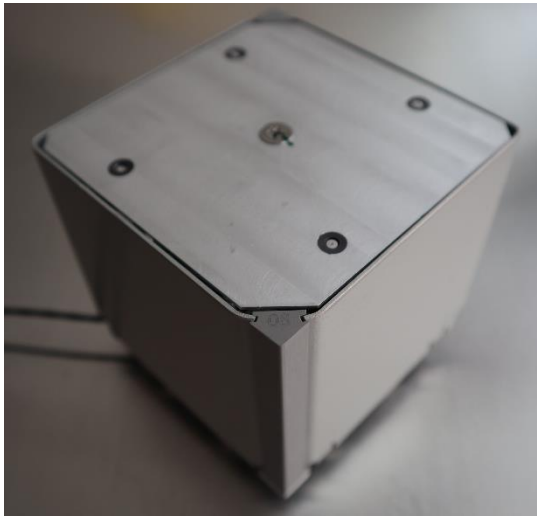
- ADEO-1 (2014 - 2017, in contract to ESA): Engineering Model; extensive test program
- ADDA (2017, in contract to ESA): Study
- ADEO-N1 (NABEO, 2018 - 2019): First Mission “Pride of Bavaria” (2.5 m² sail) launched in November 2018
- ADEO-N Parabolic Flight (2019 - 2020)
- ADEO-2 (2018 - 2022, in contract to ESA): first PFM (ADEO-L class), launch in 2024.
- **ADEO-N2** (2021): IOD flight in June 2021 on ION platform by D-Orbit (Italy)

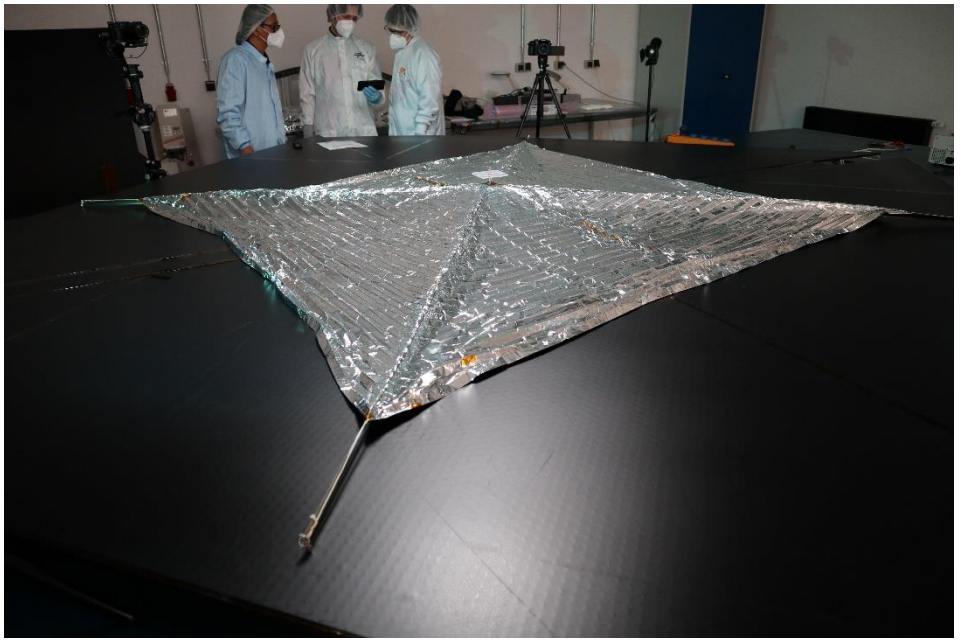




ADEO-N

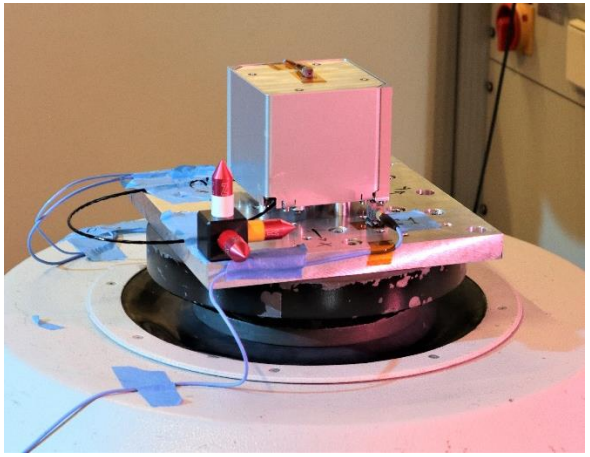
- **Stowed Size: 1 U**
- **Mass: < 0.9 kg**
- **Drag Sail Area: 1.5 - 5.0 m²**
- **„Jack In The Box“ deployment in two steps, allowing accommodation within S/C structure or next to other payloads:**
  1) Sail and Booms move upwards
  2) Booms deploy and unfold Sail

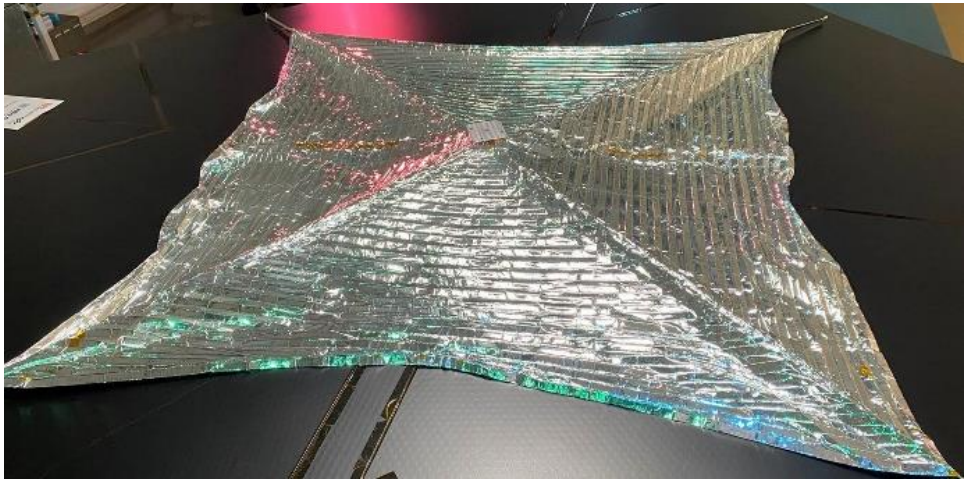




ADEO-N2

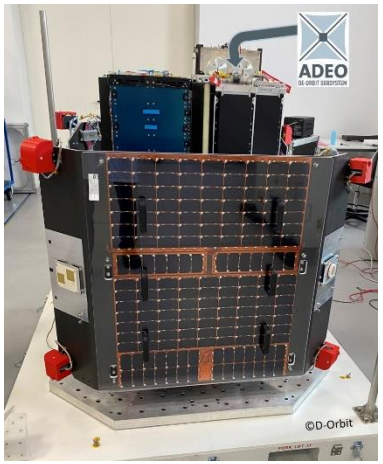
- Development & Design beginning in 2020
- Manufacturing and Assembly in 1st Q 2021
- Qualification („Test as you fly“) in 2nd Q 2021
- Integration on D-Orbit‘s ION in May/June 2021
- Launched on 30th June of 2021
- Currently in Orbit on ION SCV-003 (2021-059AK)
- Deployment planned for end of 2021, beginning 2022





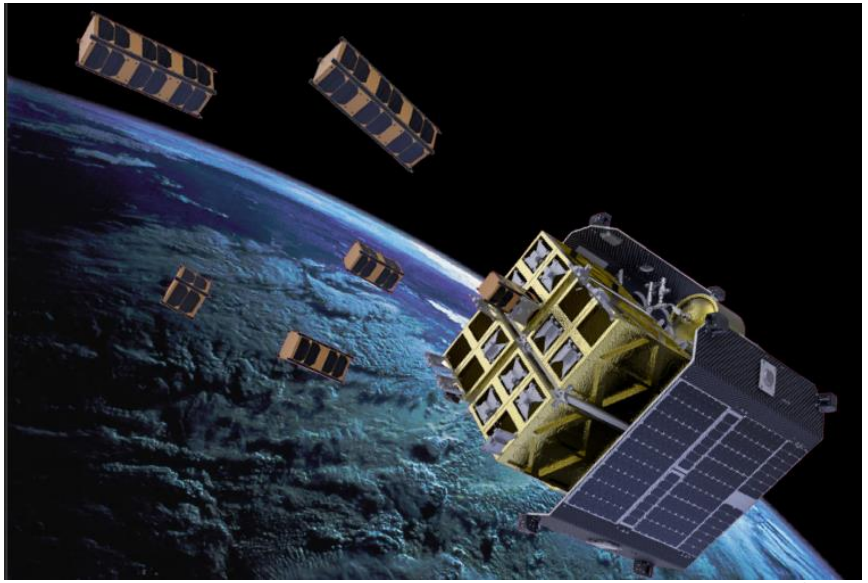
ADEO-N2 PFM during vibration test at DLR [top], after ambient deployment test in DLR‘s Integration Laboratory (ISO8) [bottom], deployment in hot TVAC chamber [left]

D-Orbit‘s ION SCV “Dauntless David“



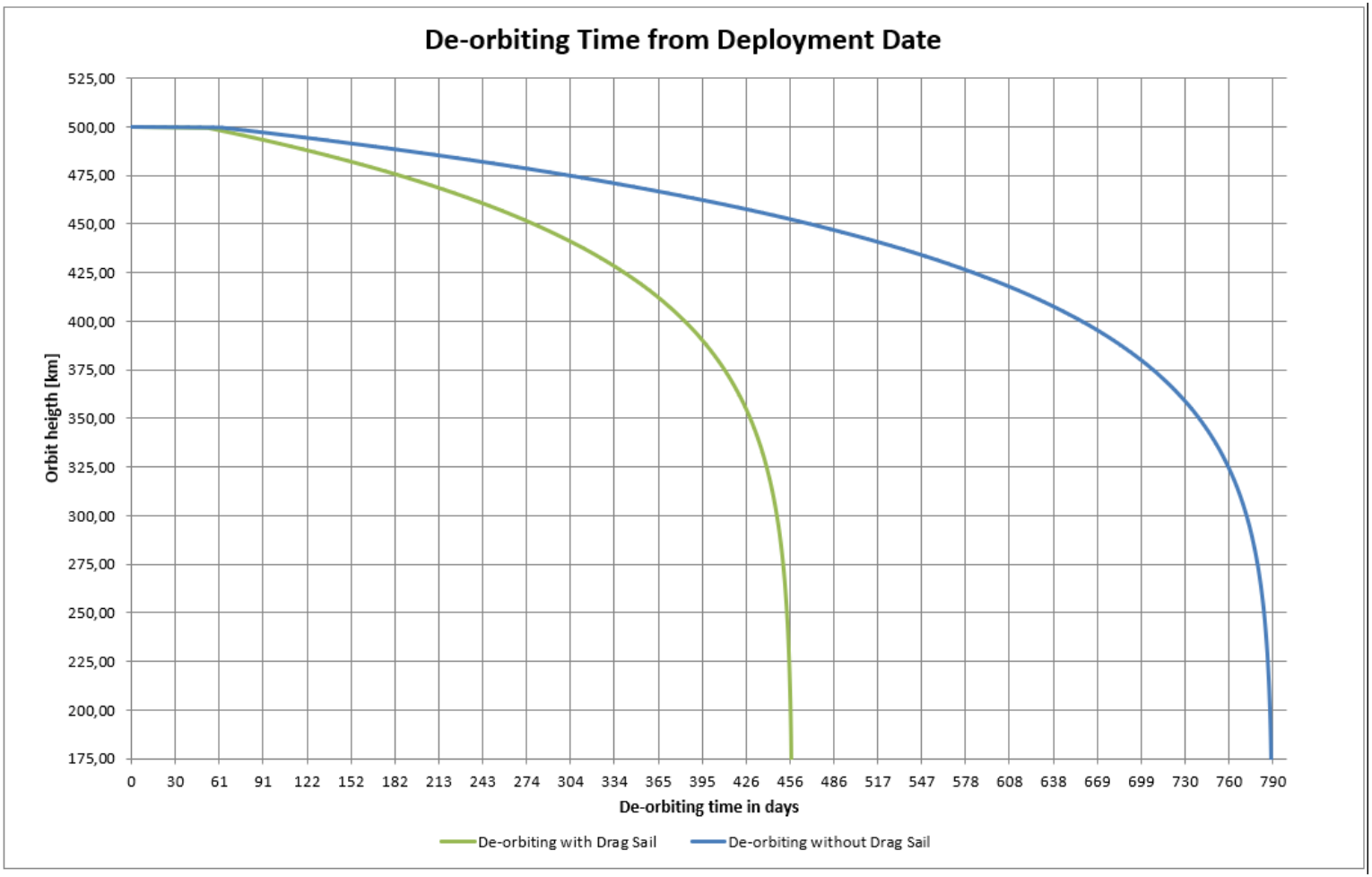
“Wild Ride”

- **Launch Date: June 30th 2021, 9:31 pm CEST**
- **500km sun synchronous orbit**
- **Deployment of six satellites into distinct orbits and IOD of 12 hosted payloads**
- **Customers from 14 countries onboard**
- **In total 63 payloads will be launched by D-Orbit with the end of “Wild Ride“**

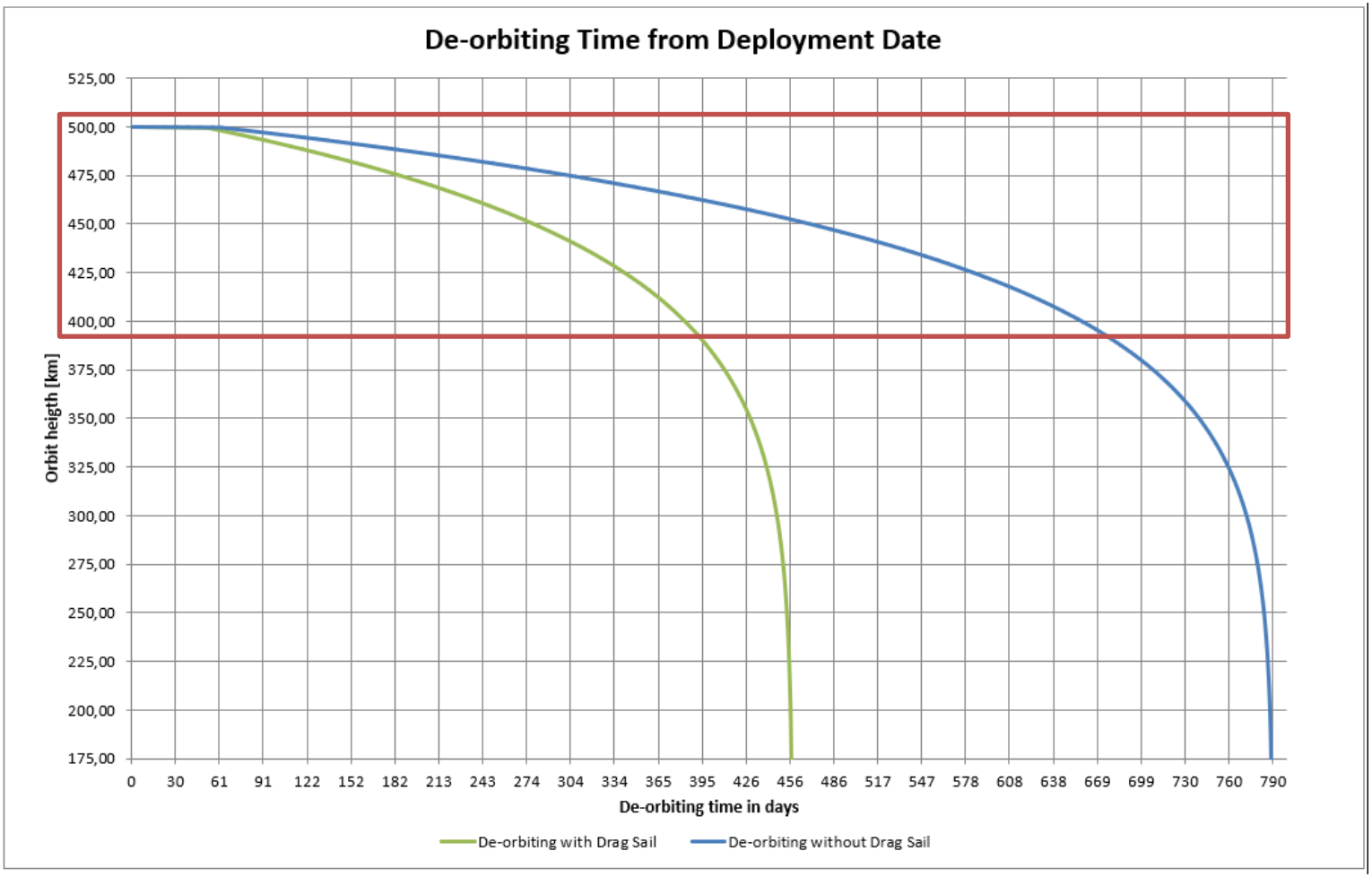


During the final phase, decommissioning, ADEO-N2 will demonstrate the deployment and the accelerated deorbiting will be verified over the first 100km.

De-Orbit Prediction



De-Orbit Prediction



ADEO in short

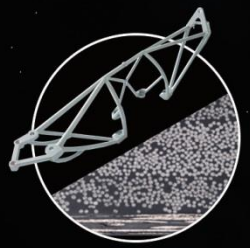
- Extended mission durations (no or less fuel reserves required for deorbiting)
- Enabling uncommon orbits
- Lower complexity, cost and mass than active deorbiting system
- No attitude control required
- Automatic removal of failed S/C realizable
- ADEO-N, TRL-9 after IOD/IOV mission “Show me your wings“ as part of “Wild Ride“
- ADEO-L, TRL-8 after Test Campaign 2nd Quarter 2022

➢ S/C must be cleared for uncontrolled reentry (full demisability)

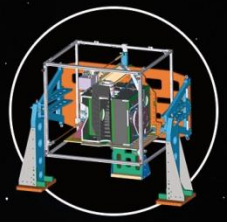
ADEO is ready for business!

Thank you for your attention!

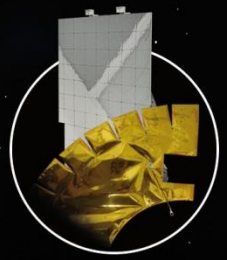
Engineering & Integration Services



New Materials & Processes

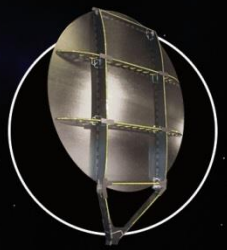


MGSE

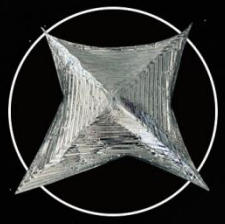


Thermal Hardware

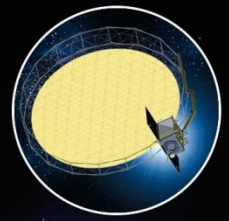
Lightweight Structures



Reflector Antennas



Deployable De-orbit Sails



Large Deploy. Reflector/ Boom Subsystems

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