HPS High Performance Space Structure Systems GmbH GERMANY

ADEO DE-ORBIT SUBSYSTEM

ADEO-N2

Dragsail Deorbit Mission

Deployable Passive De-Orbit Sail Subsystem Enabling Space Debris Mitigation for CubeSats, SmallSats and Constellations

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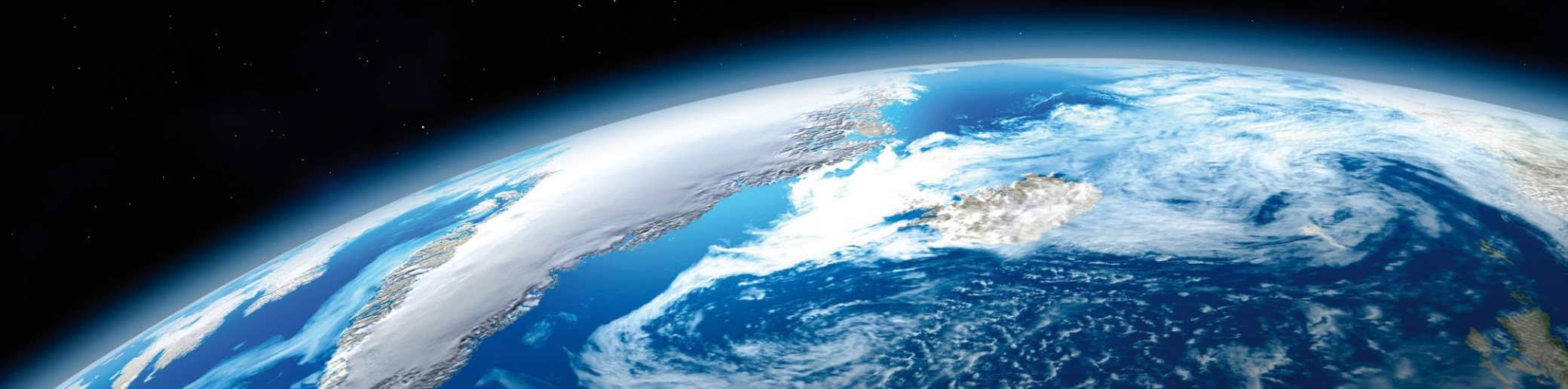
Section Head & System Engineer

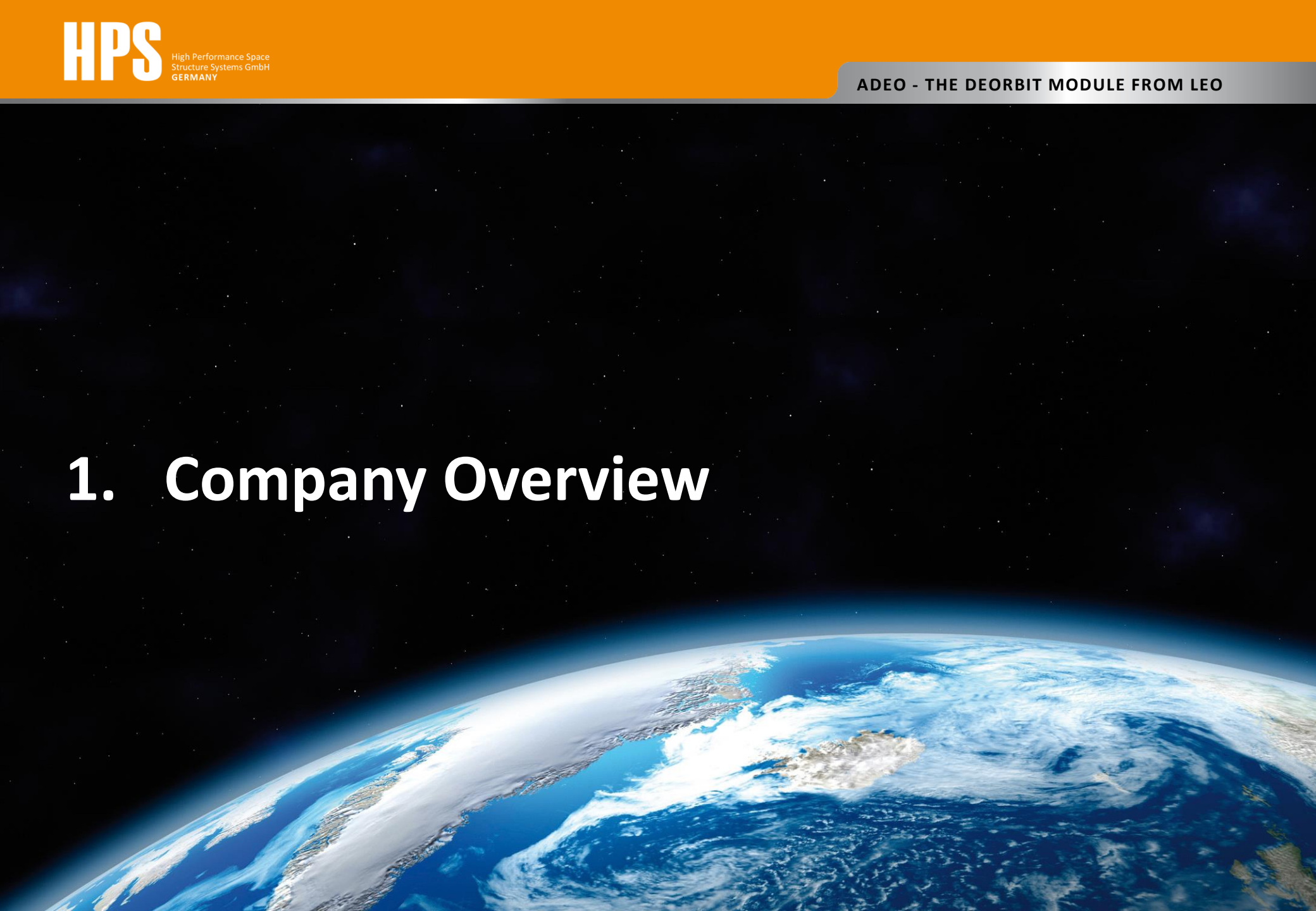
Clean Space Industry Days (CSID) at ESTEC - 19.10.2023

AGENDA

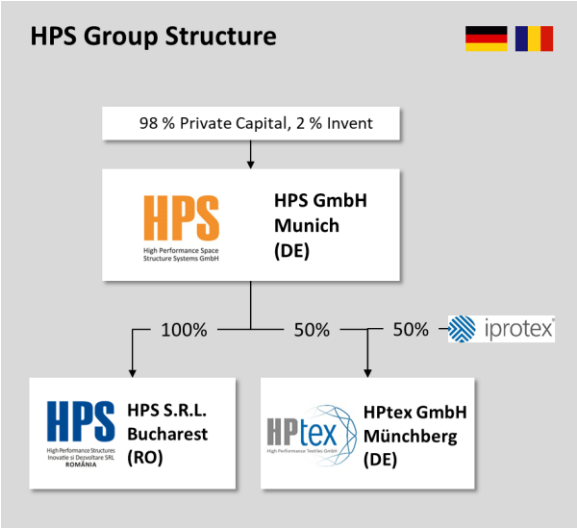
1. Company Overview
2. Space Debris Situation & Regulations
3. ADEO Product Description
4. ADEO-N2 – Mission and Deorbit Facts



1. Company Overview

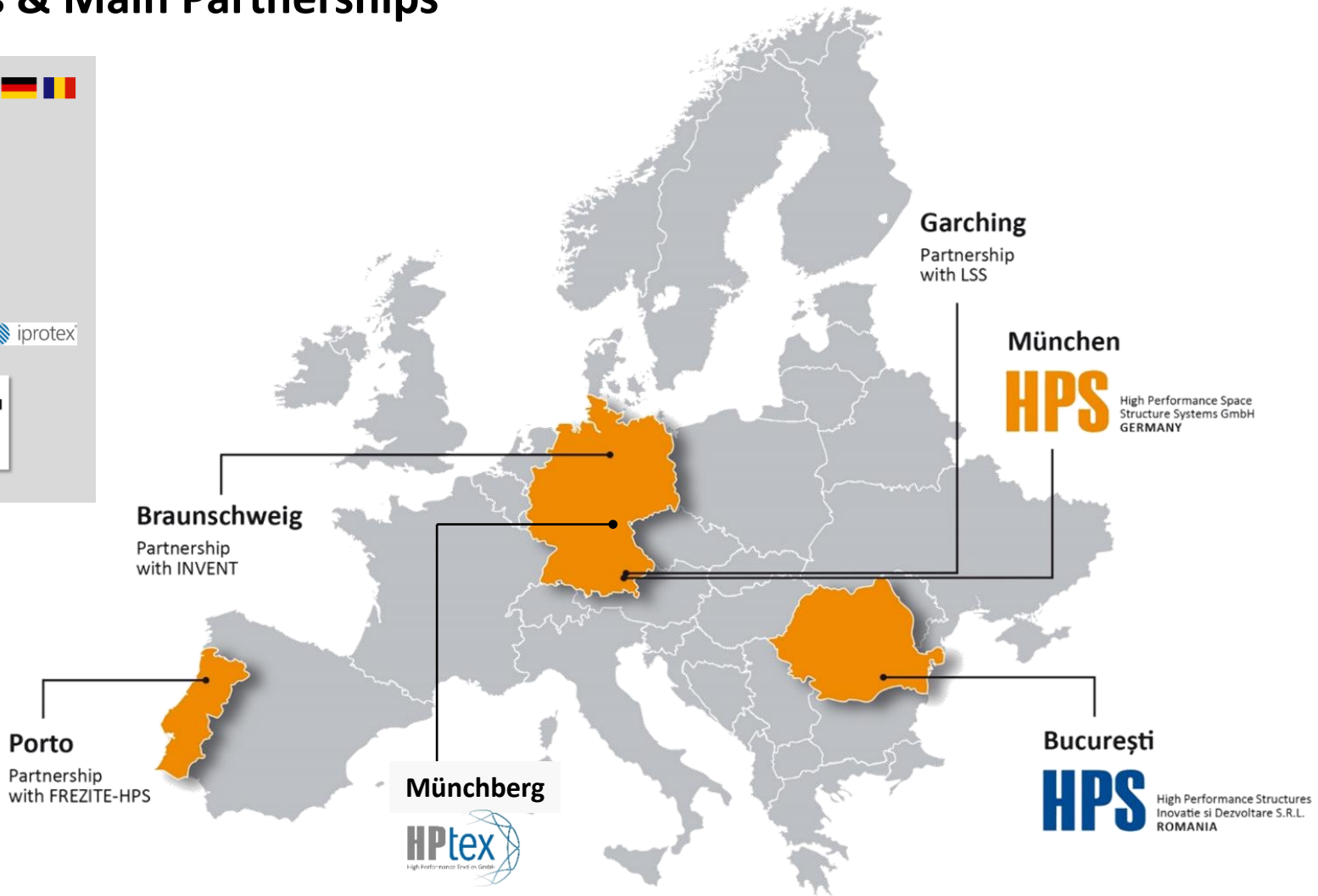


HPS Group Sites & Main Partnerships



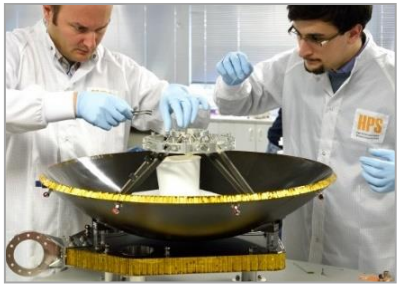
Number of Employees 2023:

- HPS Munich: 65
- HPS Romania: 15
- HPtex: 5



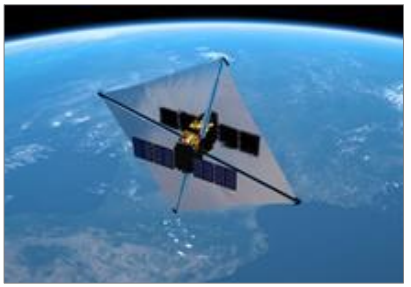
Product Portfolio HPS Group

Solid Reflector Antennas



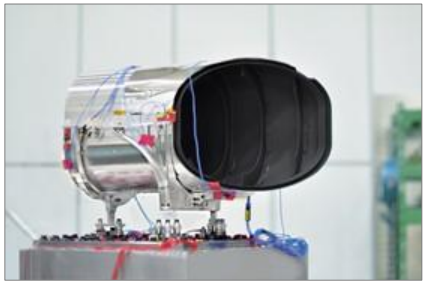
Large Deployable Reflector Subsystems

Deployable Deorbit Sail Subsystems



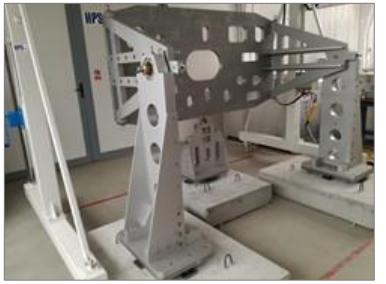
Thermal H/W (Radiators, Thermal Straps, MLI, etc)

Secondary Structures



Antenna Components

Mechanical Ground Support Equipment



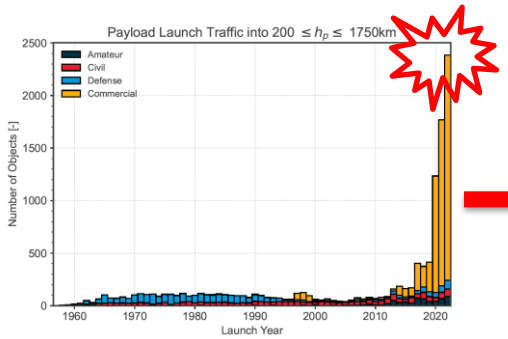
Other Products and Services: radiation protection caps, composite structures, engineering & integration service

2. Space Debris Situation & Regulations

Space Debris – Deorbiting – Current & New Regulations

ADEO DE-ORBIT SUBSYSTEM

Past: 25 year rule/recommendation from IADC was derived before the „NewSpace“ age and does NOT reflect the current situation of launches and S/C in orbit



Evolution of the launch traffic near LEO per mission from 1960 till 2022
Source: ESA – Annual Space Environment Report 2023

Source: https://usradioguy.com/satellites/the-kessler-syndrome/

Current: New FCC-Regulation (USA), Zero Debris Policy (ESA), Space Traffic Management (EC) and ISO Standard:

Decommission all **LEO S/C** out of at the end of their operational live

within **≤ 5 YEARS**

with **DEORBIT RELIABLITY → ≥ 90% and ≥ 95% for constellations**

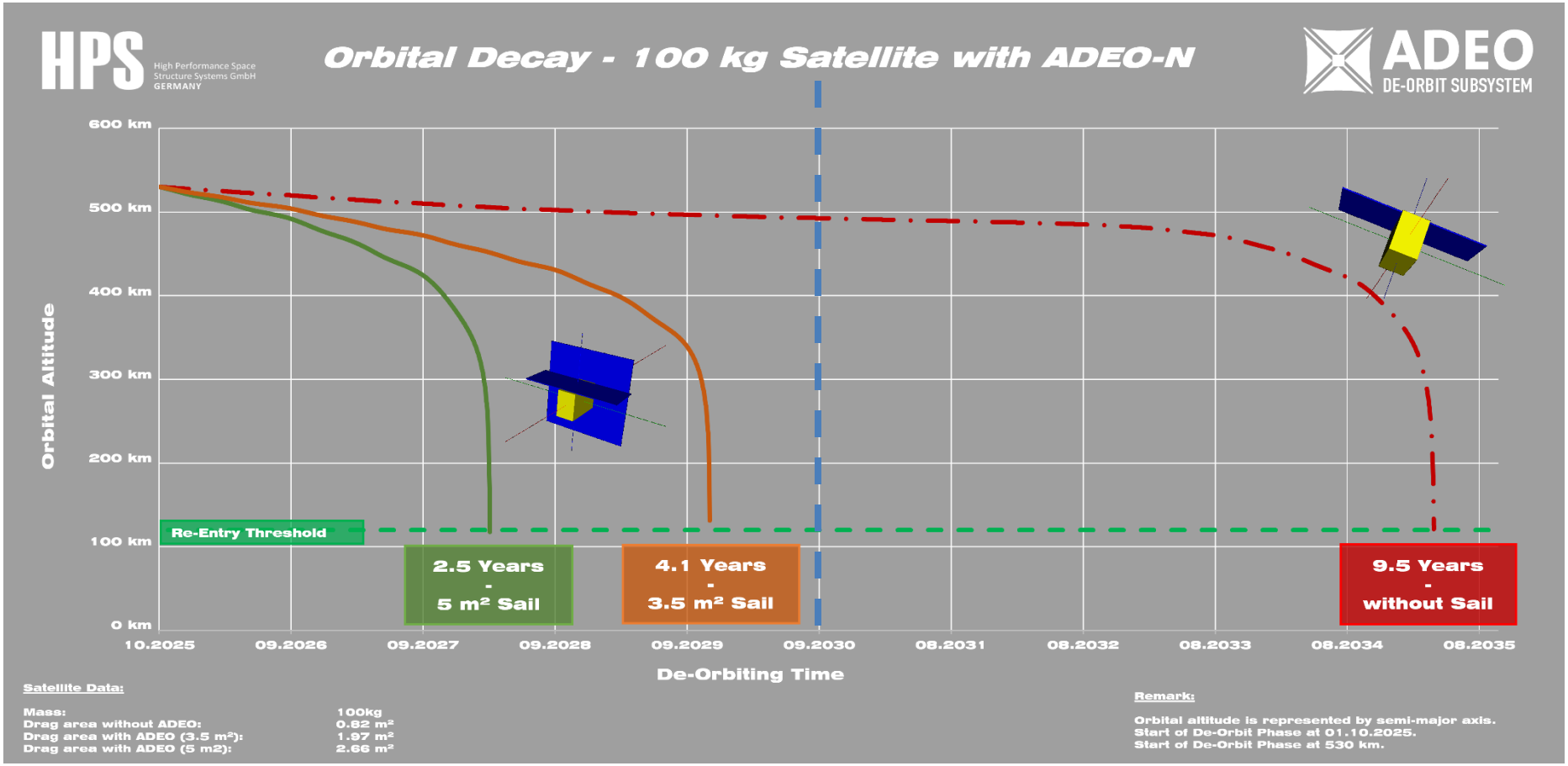
3. ADEO Product Description

How does ADEO help to be Compliant to New Regulations?

 Reduce deorbit time ≤ 5 years	ADEO increases the natural drag and reduces the deorbit time to under 5 years!
 Guarantee successfull disposal	ADEO works independent from S/C functionality!
 Improve on-ground casualty risk assessment	ADEO is fully demisable!
 Avoid in-orbit collisions	1) ADEO dragsail MEMBRANE does NOT increase collision risk – should be implemented in DRAMA 2) Precise tracking of S/C with DeCAS system from Aviosonic 3) Collision Preventation Simulation with Okapi:Orbits Service
 Avoid internal break-ups	ADEO does NOT increase the risk!
 Guarantee dark and quiet skies	ADEO offers a non-reflective sail membrane!
 Prevent intentional release of space debris	ADEO does not cause additional debris!

Deorbit Example – S/C = 50 kg, Orbital Altitude = 600 km

ADEO DE-ORBIT SUBSYSTEM



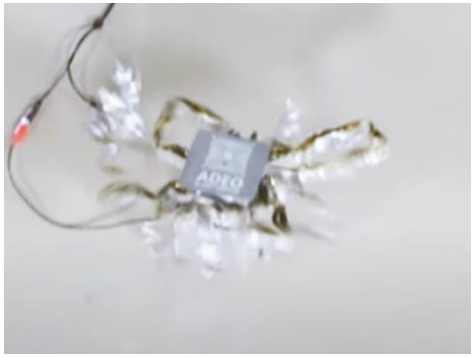
ADEO Product-Family with Availability Dates

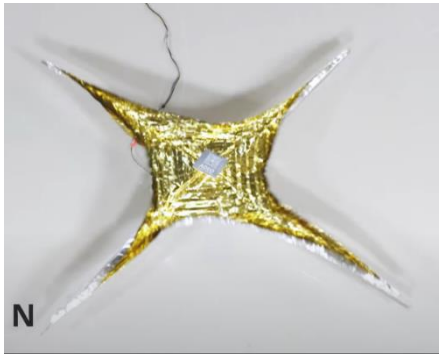
ADEO DE-ORBIT SUBSYSTEM

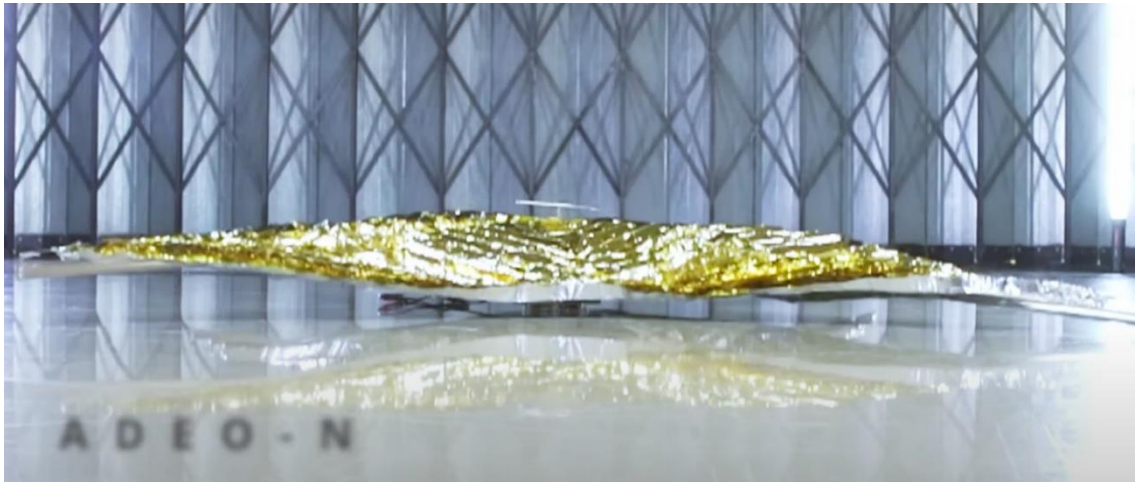
	ADEO-P (ico)	ADEO-C (ube)	ADEO-N (ano)	ADEO-M (edium)	ADEO-L (arge)
Status	In Development *(available Q1/2024)*	In Development *(available Q1/2024)*	In Production (available since 2018)	In Development *(available Q1/2024)*	PFM at MAIT *(available Q2/2024)*
Satellite Masses	1 - 20 kg (1U – 16U)	5 - 50 kg	20 - 250 kg	100 - 700 kg	500 - 1.500 kg
ADEO Module Mass	0.35 kg	0.75 kg	0.8 kg	4.0 kg	9.5 kg
ADEO Module Size (stowed)	9.8 x 9.8 x 3.5 cm^3	9.0 x 9.0 x 7.2 cm^3	10 x 10 x 10 cm^3 (12 cm height for 7m^2 sail)	diameter 29 cm height 13 cm	40 x 40 x 10 cm^3
Sail Area	1.0 m^2	3.4 m^2	5.0 ± 2 m^2	15 ± 5 m^2	20 - 100 m^2
Deployment Mechanism	Spring-based	Spring-based	Spring-based	Controlled continuous deploym. with spring	Motor
Activation System	Pyro Cutter	Pyro Cutter	Pyro Cutter	Pyro Cutter	Release Nut
Mechanical Interface	4 x M5 thread (8.6 cm x 8.6 cm)	CubeSat Standard	4 x M5 thread (diam. 8.2 cm)	8 x M6 thread (diam. 27.5 cm)	8 x 7.0 mm hole (diam. 28/29 cm)
Electrical Interface	2 Wires (free ends)	4 Wires (free ends)	2 Wires (free ends)	4 Wires (free ends)	3 Connectors D-Sub HD15, RS-422
Electrical Power	12V @1A – 10 msec	>1V @3A - 25 msec	12V @1A – 10 msec	>1V @3A - 25 msec	24-38 V *(<280 mW in Standby)*

Status: 01.09.2023

ADEO-N deployment in less than 3 sec.



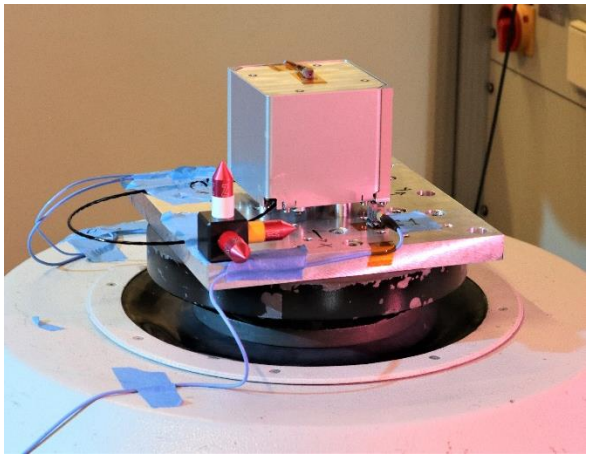


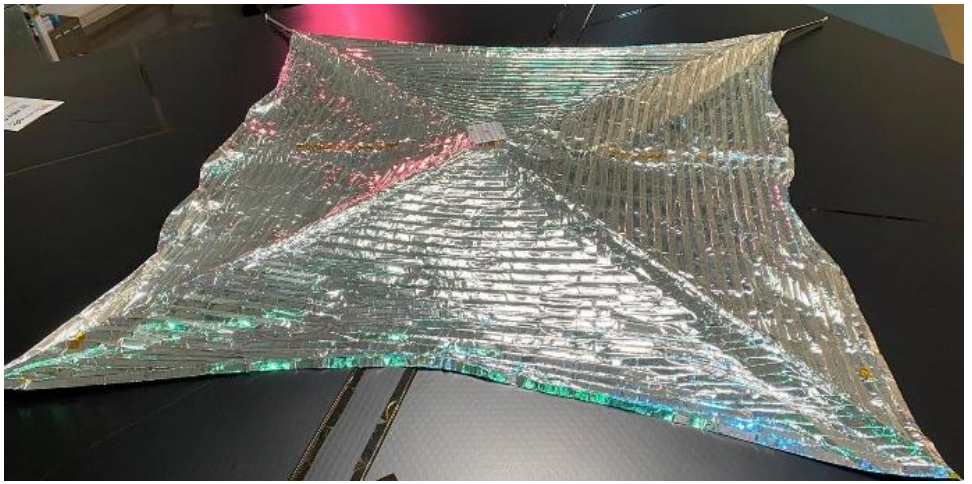


4. ADEO-N2 – Mission and Deorbit Facts

ADEO-N2 – Test Campaign at DLR Bremen

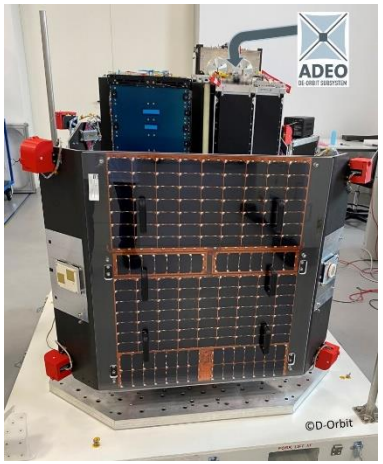
- Development & Design beginning in 2020
- Manufacturing and Assembly in Q1/2021
  - Stowed Size: 1U
  - Mass: 800 g
  - Drag Sail Area: 3.6 m²
- Qualification („Test as you fly“) in Q2/2021
- Integration on D-Orbit‘s ION in May/June 2021
- Launched on 30th June of 2022





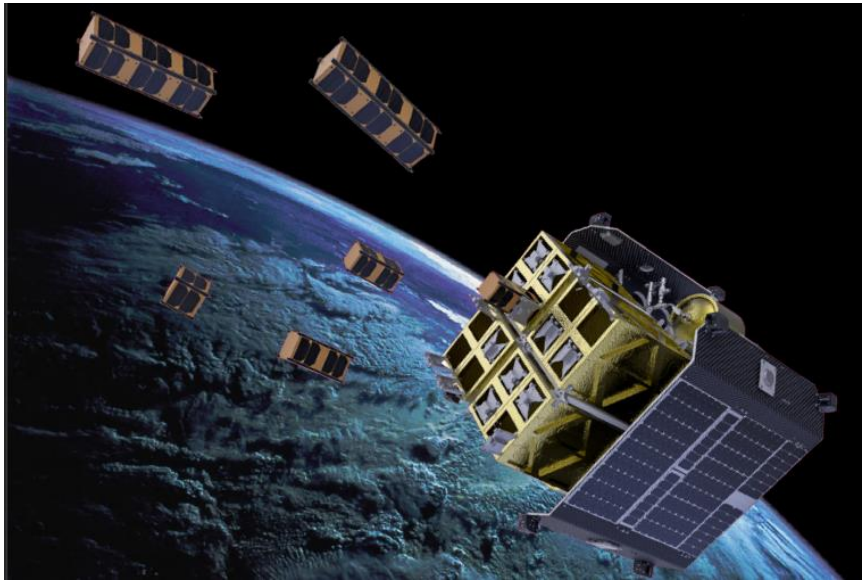
ADEO-N2 PFM during vibration test at DLR [top], after ambient deployment test in DLR‘s Integration Laboratory (ISO8) [bottom], deployment in hot TVAC chamber [left]

D-Orbit‘s ION SCV “Dauntless David“



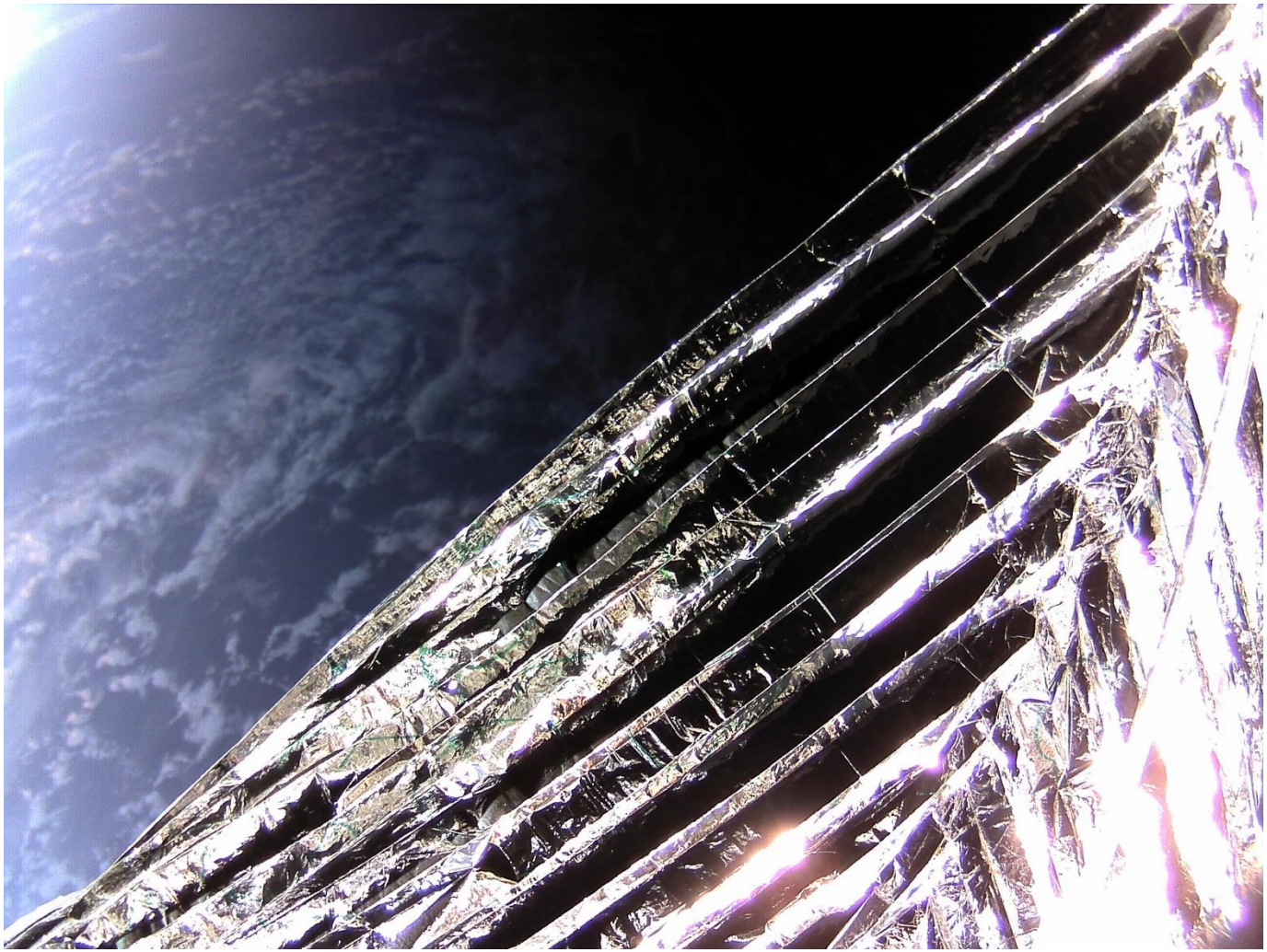
“Wild Ride”

- Launch Date: June 30th 2021, 9:31 pm CEST
- 500 km 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 were launched by D-Orbit with the end of “Wild Ride“



During the final phase, decommissioning, ADEO-N2 demonstrates the deployment. The accelerated deorbiting is verified over the first 100 km, from 500 to 400 km.

ADEO-N2 Deployment Verification in Orbit



Picture was captured on the **15th of December 2022** from ION the D-Orbit´s Satellite Carrier

ADEO-N Deployment Verification in Orbit

ADEO DE-ORBIT SUBSYSTEM

Video was captured on the **15th of December 2022** from ION the D-Orbit´s Satellite Carrier

https://www.hps-gmbh.com/en/category/2023-2/

Deorbit Data

Update diagram with telemetry data

Deorbit Data - Tumbling

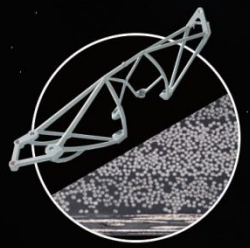
Update diagram with telemetry data

HPS
High Performance Space Structure Systems GmbH
GERMANY

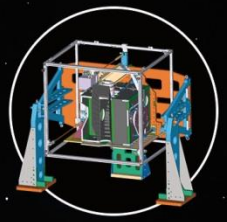
HIGH PERFORMANCE COMPONENTS AND SUBSYSTEMS

Let´s Deorbit European Spacecraft Together!
Thank´s for your time!

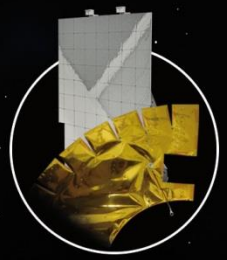
Engineering & Integration Services



New Materials & Processes

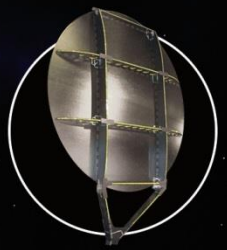


MGSE

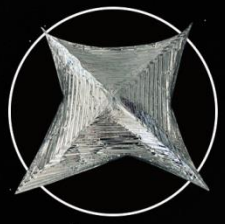


Thermal Hardware

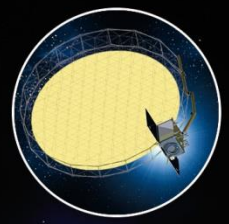
Lightweight Structures



Reflector Antennas



Deployable De-orbit Sails



Large Deploy. Reflector/ Boom Subsystems

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