HPS High Performance Space Structure Systems GmbH GERMANY

ADEO DE-ORBIT SUBSYSTEM

PASSIVE DEORBIT TECHNOLOGIES – ENABLING A CLEAN SPACE BY MEANS OF AUTONOMOUS DEORBITTING CAPABILITY

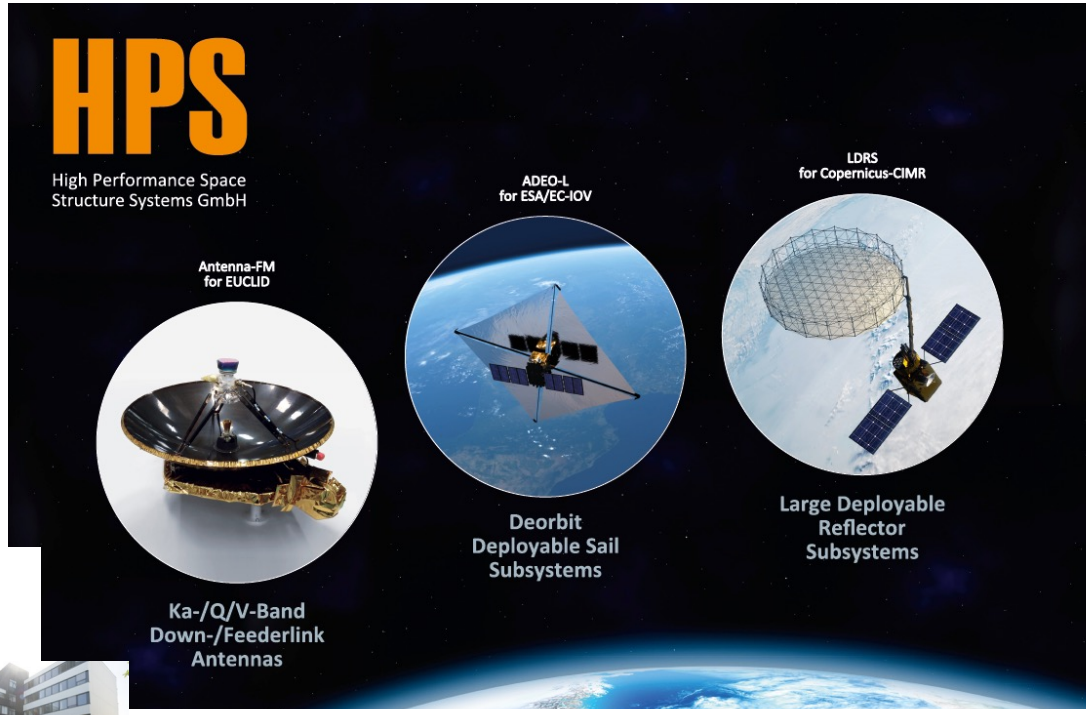
Daniel Stelzl (HPS)

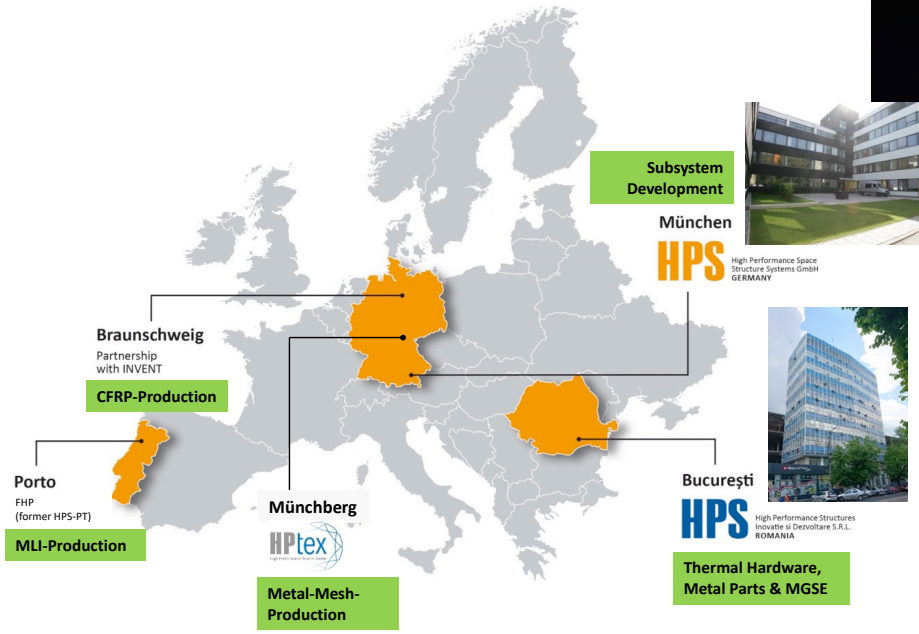
ESTEC | Clean Space Industry Days 2022

Content

1. HPS Group and Main Partners

- German SME
- Founded in year 2000
- 98% private ownership (2% by INVENT)
- 70 employees in the HPS Group





2. Deorbiting: Current Legal Situation

- **IADC – Inter-Agency Space Debris Coordination Comitte – <u>recommendations only!</u>**

  E.g:

  - „Support to the IADC Space Debris Mitigation Guidelines" – 2019 – Recommendation
  - „Space Debris Mitigation Policy for Agency Projects" - 2014 – Policy
  - „Stability of the Future LEO Environment" - 2013 – Recommendation

- **European Code of Conduct**
- **France Net Zero Space Charter (Law!)…….etc.**

2. Deorbiting: Current Legal Situation

- IADC – Inter-Agency Space Debris Coordination Comitte – recommendations only!

  E.g:

  - „Support to the IADC Space Debris Mitigation Guidelines" – 2019 – Recommendation
  - „Space Debris Mitigation Policy for Agency Projects" - 2014 – Policy
  - „Stability of the Future LEO Environment" - 2013 – Recommendation
- European Code of Conduct
- France Space Operation Act (Law!).....etc.

SIMPLIFIED CONTENT:

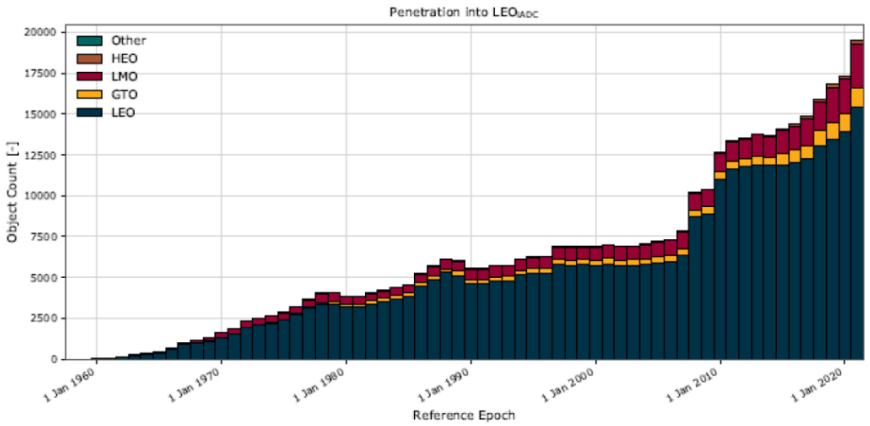
Decommission all LEO satellites orbiting within 2000 km at the end of their operational live

within 25 years

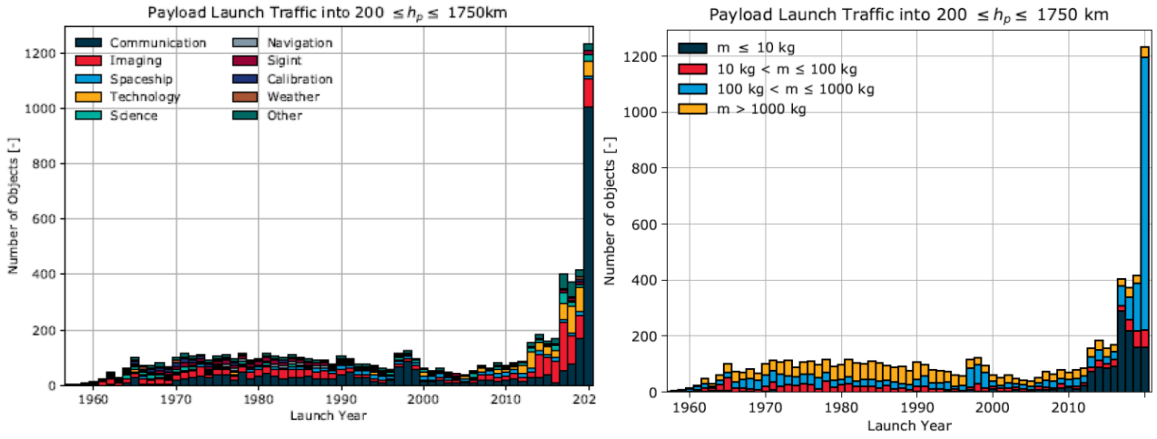
This is NOT binding and is NOT controlled!

3. Launch and Space Objects Situation (LEO Orbits)

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



Evolution of absolute number of objects in LEO from 1960 till 2020
Source: ESA – Annual Space Environment Report 2021

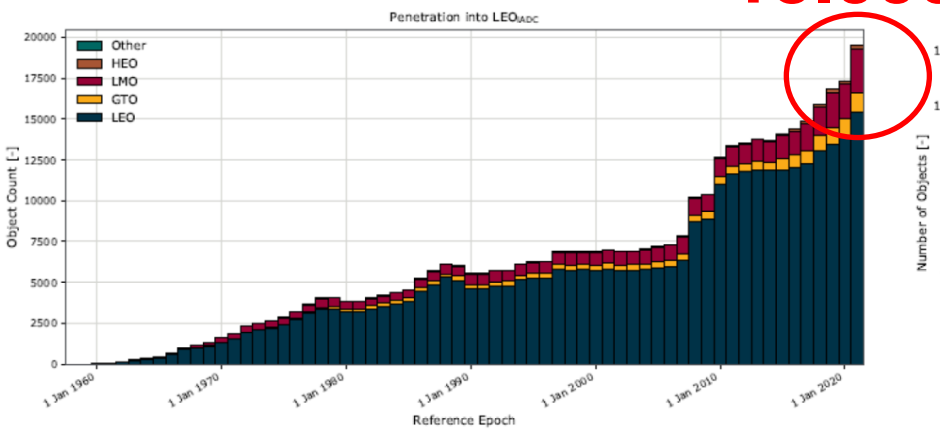


Evolution of the launch traffic near LEO per mission type (left) and mass category (right) from 1960 till 2020
Source: ESA – Annual Space Environment Report 2021

3. Launch and Space Objects Situation (LEO Orbits)

25 year rule/recommendation was derived before the „NewSpace“ and „Space Privatisation“ age and does not reflect the current situation of launches and S/Cc

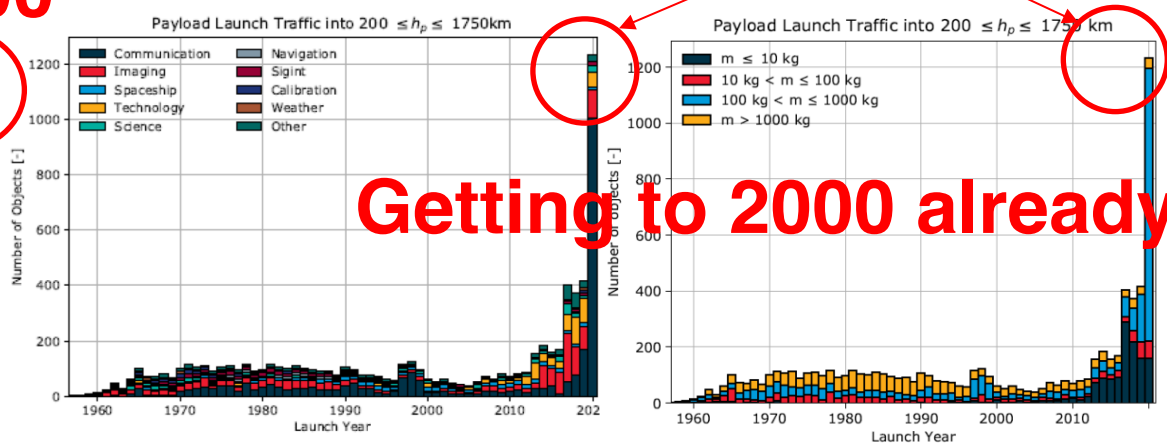
15.000



Evolution of absolute number of objects in LEO from 1960 till 2020
Source: ESA – Annual Space Environment Report 2021

1.200

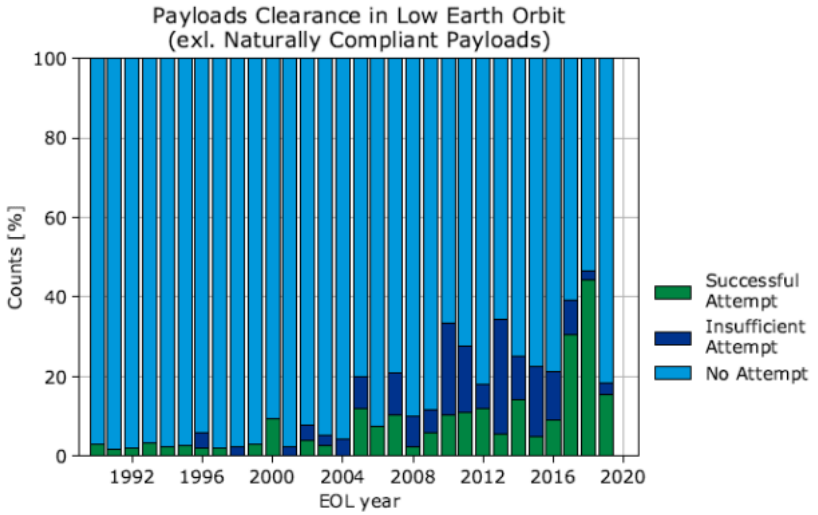
Getting to 2000 already



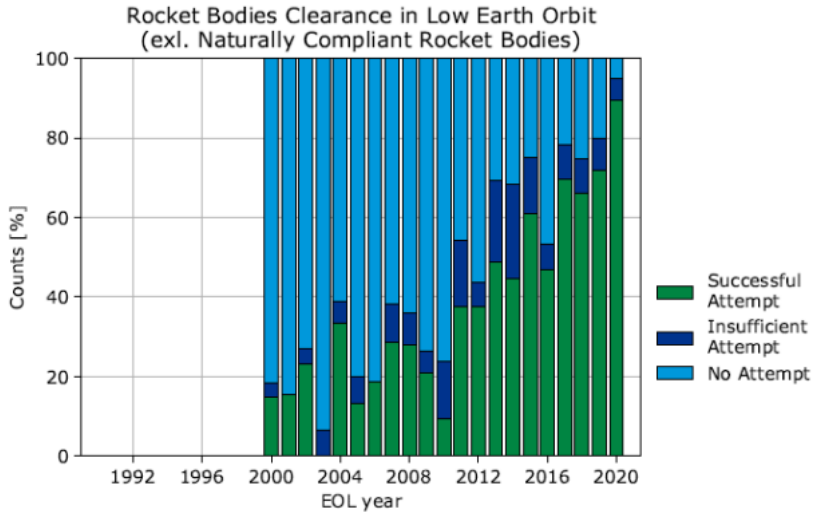
Evolution of the launch traffic near LEO per mission type (left) and mass category (right) from 1960 till 2020
Source: ESA – Annual Space Environment Report 2021

3. Launch and Space Objects Situation (LEO Orbits)

- **Deorbit Reliablity**



(a) Relative clearance of LEO_{IADC} by payloads.



(b) Relative clearance of LEO_{IADC} by rocket bodies.

DEORBIT reliablity less than 50% !!

3. Launch and Space Objects Situation (LEO Orbits)

Summarizing some facts from the ESA – Annual Space Environment Report 2021, a clear discrepancy is notable:

15.000 objects in LEO in 2020

1.200 launches to LEO in 2020

2.000 newly added objects to LEO in 2020

only 400 objects re-entered from LEO in 2020

……..AND THE TENDENCY OF OBJECTS IN LOW EARTH ORBIT IS RAISING

3. Launch and Space Objects Situation (LEO Orbits)

Summarizing some facts from the ESA – Annual Space Environment Report 2021, a clear discrepancy is notable:

15.000 objects in LEO in 2020

1.200 launches to LEO in 2020

2.000 newly added objects to LEO in 2020

only 400 objects re-entered from LEO in 2020

.....AND THE TENDENCY OF OBJECTS IN ORBIT IS RAISING

COLLISION RISK INCREASED TREMENDOUSLY

3. Launch and Space Objects Situation (LEO Orbits)

Summarizing some facts from the [illegible] report 2021, a clear discrepancy is notable:

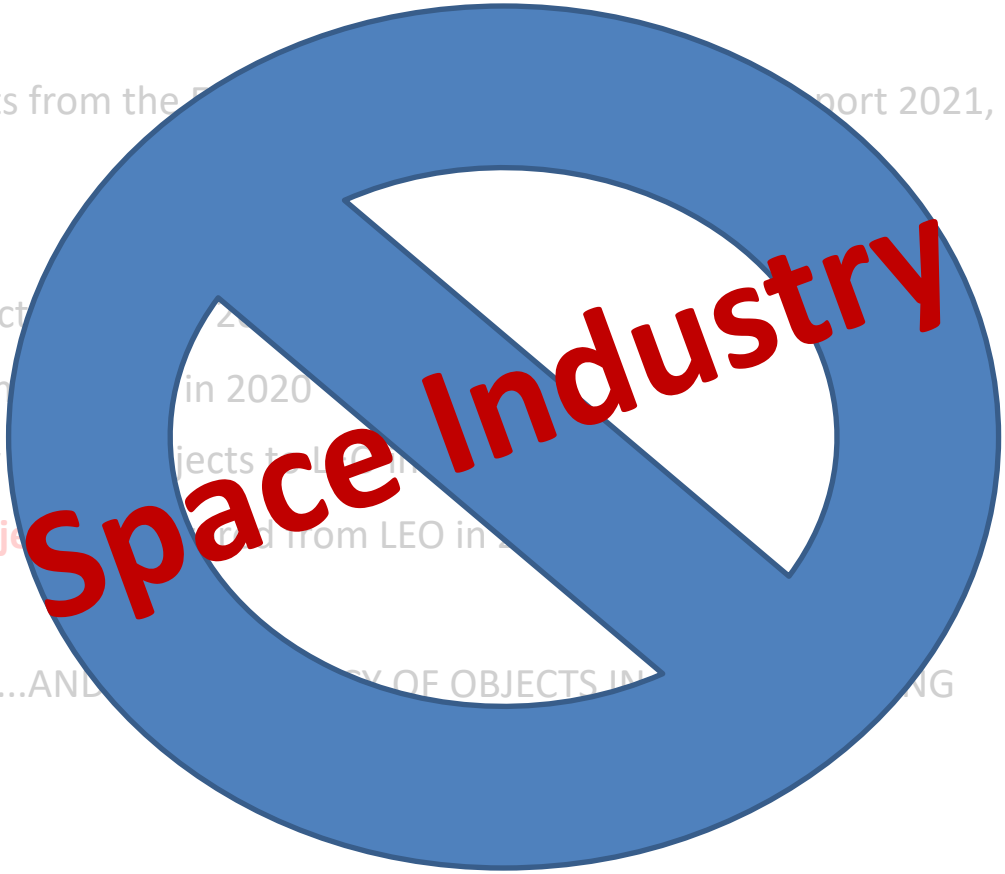
15.000 object[illegible]

1.200 launch[illegible] in 2020

2.000 newly [illegible]jects to LEO in [illegible]

only 400 obje[illegible]d from LEO in [illegible]

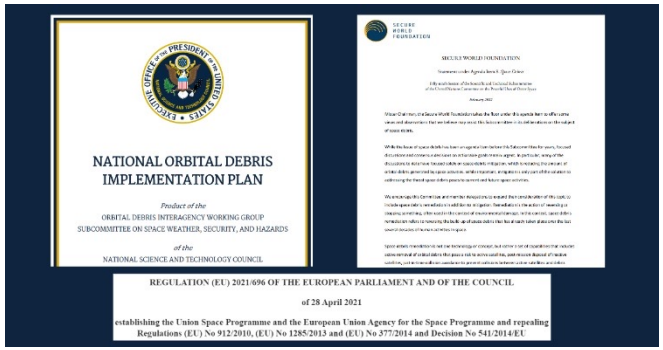
.....AND [illegible]Y OF OBJECTS IN [illegible]NG



2.1 Deorbiting: Current Legal Situation → UPDATE 2022

UPCOMING

- **FCC Adopts 5-Year Rule for Deorbiting Satellites**
- **European Commsion – Space Traffic Management**
- **European Green Deal…….**
- **ESA Zero Debris Approach**



CONTENT:

Decommission all LEO S/C (satellites and rocket bodies) in the secured orbits (e.g. LEO) at the end of their operational live

within

YEARS → ≤ 5 YEARS ?

with

DEORBIT RELIABLITY → ≥ 90% ?

ADEO DE-ORBIT SUBSYSTEM

4. Active vs. Passive Deorbiting

	ACTIVE DEORBITING	PASSIVE DEORBITING
Disadvantages	Active S/C required → Failure prone	Un-controlled re-entry → Demiseable S/C?
	Operational propulsion system required → Failure prone	Short time increase of collision area → Decreased deorbiting time vs. Increased collision risk?
	Operational expenses required	Tumbling attitude during descent
	ADR – Active Debris Removal very expensive	
Advantages	Controlled re-entry possible	**Prolonging missions** due to autonomous capability → automatic deployment trigger possible
	Collision avoidance manoeuvres possible	**No active** S/C necessary
		Solution for S/C with **no propulsion** system e.g. CubeSats, Rocket Bodies
		Low/No operational **expenses**

ADEO DE-ORBIT SUBSYSTEM

4. Active vs. Passive Deorbiting

	ACTIVE DEORBITING	PASSIVE DEORBITING
Disadvantages	Active S/C required → Failure prone	Un-controlled re-entry → Demiseable S/C?
	Operational propulsion system required → Failure prone	Short time increase of collision area → Decreased deorbiting time vs. Increased collision risk?
	Operational expenses required	Tumbling attitude during descent
	ADR: Active Debris Removal very expensive	
Advantages	Controlled re-entry possible	**Prolonging missions** due to autonomous capability → automatic deployment trigger possible
	Collision avoidance manoeuvre possible	**No active** S/C necessary
		Solution for S/C with **no propulsion system** e.g. CubeSats, Rocket Bodies
		Low/No operational **expenses**

IF POSSIBLE….
I WOULD CHOOSE a PASSIV-AUTONOMOUS SOLUTION

5. Autonomous ADEO Deorbiting Dragsail Family


LOW EARTH ORBIT
END OF ATMOSPHERE
CONSTELLATION SHELL
Thrusters
Tethers
ADEO
DE-ORBIT SUBSYSTEM
700 km
900 km
1000 km
2000 km

5. Autonomous ADEO Deorbiting Dragsail Family

ADEO - N (Nano for Cube- and Small-Satellite)

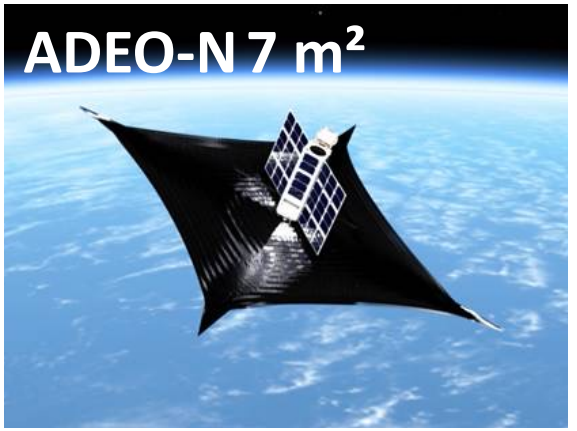
ADEO - M (Medium class: overlapping L- and N-class)

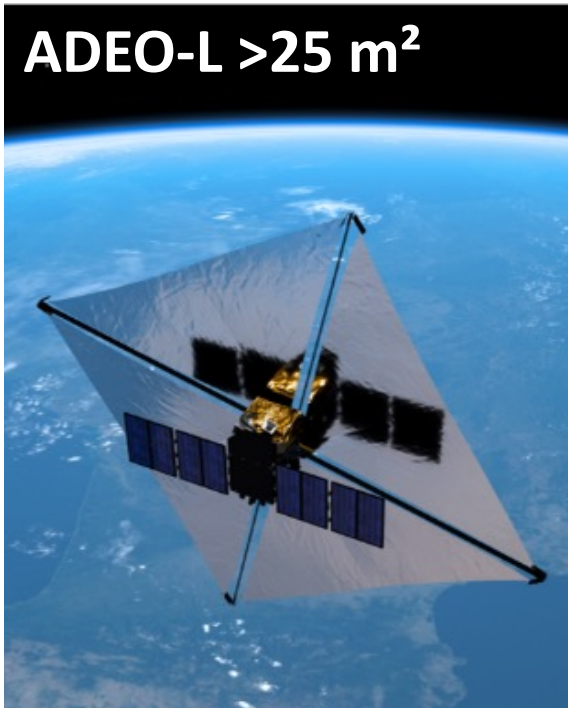
ADEO - L (Large for big satellites)

General Description:

- **ultra-light weight** (lower mass than additional propellant for active de-orbiting)
- **scalable sail size** (2 m² to > 100 m²) tailored to each spacecraft mass
- **generic** (standard interfaces with adjustable interface brackets to spacecraft)
- **autonomous deployment possibility**

	ADEO-N	ADEO-M	ADEO-L
Spacecraft Mass	1 – 250 kg	100 – 700 kg	500 – 1.500 kg
ADEO Mass	< 1 kg	5 – 10 kg	9-14 kg
ADEO Sail Size	2 – 7 m²	7 – 25 m²	25 – 100 m²
Dimensions	10 x 10 x 10 cm³	20 x 20 x 20 cm³	43 x 43 x 18 cm³
TRL	7 (9 very soon ☺)	3/4	6/7 soon ☺





5. Autonomous ADEO Deorbiting Dragsail Family

ACTIVITIES

› Flights:

- ADEO-N1 - 2018 on RocketLab Electron Kickstage (DLR & Bavaria Co-funded)
- ADEO-P - 2019 Parabolic Flight Campaign (DLR Co-funded)
- ADEO-N2 - 2021 1st Flight on ION – Dorbits Orbital Transport Vehicle (OTV) (ESA GSTP Co-funded)
- ADEO-N3 - 2023 2nd Flight on ION – Dorbits Orbital Transport Vehicle (OTV)
- ADEO-L - 2024 1st Flight on P200 – Qinetiq (EC IOD/IOV Programm H2020)

› Projects:

- ADEO-1 - 2014-2018 ADEO-L Development (ESA GSTP Co-funded)
- ADEO-2 - 2018 to now ADEO-L Development (ESA GSTP Co-funded)
- **AFO - 2022 - ADEO Follow On – Industrialisation and Commercialisation (ESA GSTP Co-funded)**

5. Autonomous ADEO Deorbiting Dragsail Family

POSSIBILITIES

› Debris Monitoring:

- Phase 0 Study with OHB (ESA funded)

Thanks to the high modularity of the ADEO deployable mechanism and its internal electronics, different derivates could already been developed and implemented. By using ADEO active debris monitoring, debris avoidance and even debris removal of existing debris is possible.

TIME TO ACT

More than **30,000** **new on-orbit spacecraft** endanger mission sustainability

CleanGreenSpace Missions

Deorbit dead satellites and expended launchers fast and reliably with our deployable dragsail:

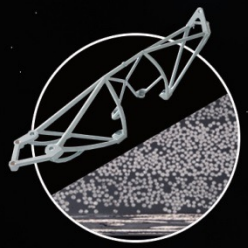
ADEO
DE-ORBIT SUBSYSTEM

ADEO products are suitable for **satellites & launchers** (1-700 kg) de-orbiting from **LEO** (< 800 km)

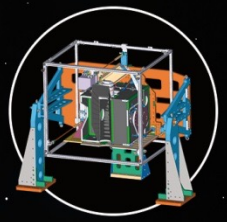
esa

Thank you for your attention!

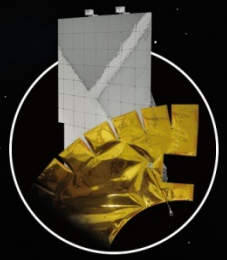
Engineering & Integration Services



New Materials & Processes

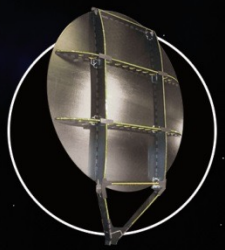


MGSE

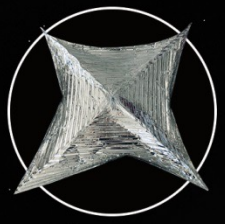


Thermal Hardware

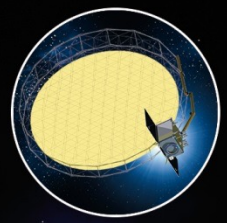
Lightweight Structures



Reflector Antennas



Deployable De-orbit Sails



Large Deploy. Reflector/ Boom Subsystems

HPS GmbH
Hofmannstr. 25-27
81379 München
www.hps-gmbh.com

HPS High Performance Space Structure Systems GmbH GERMANY

HPS S.R.L.
Soseaua Pantelimon nr. 10-12
Bucuresti, sector 2
www.hps-srl.ro

HPS High Performance Structures Inovatie si Dezvoltare S.R.L. ROMANIA