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TeSeR – Technology for Self-Removal of Spacecraft

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Airbus Defence and Space

Clean Space Industrial Days 2018

25 October 2018, ESTEC

TeSeR – At a Glance

Challenge:

- Mitigate the risk of new space debris from disused spacecraft

Goal of TeSeR (Technology for Self-Removal of Spacecraft):

- Develop concepts for a standardized Post Mission Disposal (PMD) module:
  - Shall be attached to any future spacecraft **on ground** – NO in orbit service
  - Shall perform PMD for any future spacecraft after end of operation in a reliable and cost-efficient manner

Main outcomes: evaluated concepts and on-ground prototypes

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TeSeR – The PMD Gap

Status Quo: only 50% - 60% of spacecraft perform PMD

Goal: 90% PMD success rate

For a few years, PMD is required but:

1. PMD has significant impact on spacecraft design, e.g. MetOp-SG requires several hundreds of kg additional fuel and additional thruster only for PMD

→ PMD becomes a design and cost driver if designed individually for each spacecraft (tailored design)

2. In case of loss of communication and control

→ Conventional (integrated) PMD approach fails

3. PMD not attractive for spacecraft owners/operators

→ Propellant is preferably used for lifetime extension

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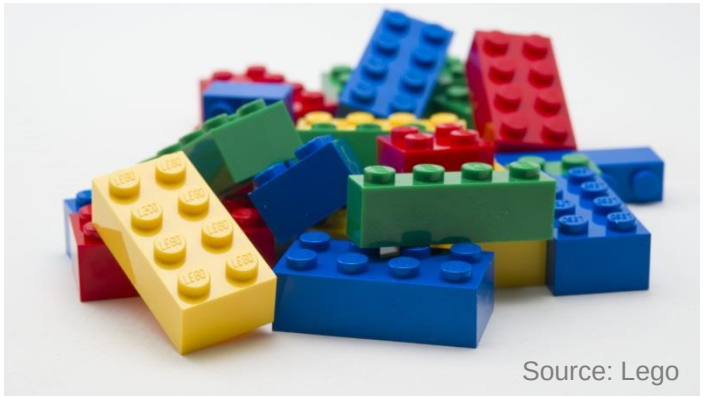
TeSeR – Remove Any Spacecraft

Closing the PMD gap requires a module which can remove **any** future spacecraft.

- Scalability
- Modularity
- Versatility



PMD module shall be cheaper than conventional approaches.

- Simple design
- Standardized
- Suited for industrialization

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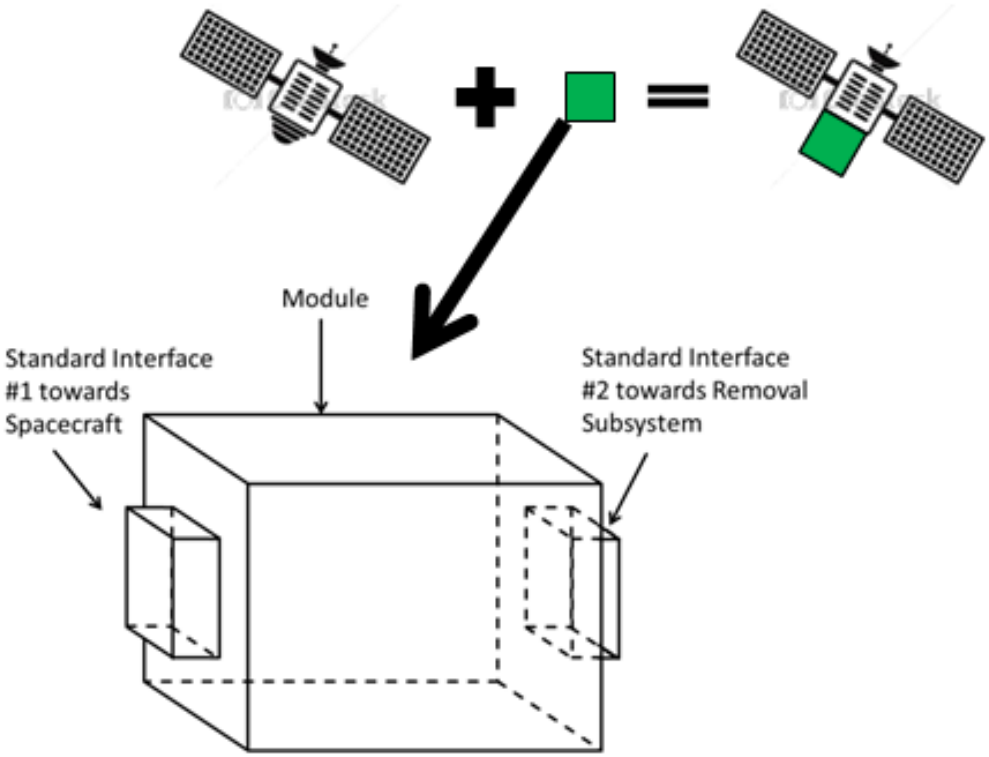
TeSeR – Versatile, Scalable, Modular

Two Standard Interfaces:

- Standard interface #1 to attach module to any spacecraft **on ground**
- Standard interface #2 to attach different removal technologies to module



- Select the removal technology appropriate for spacecraft and orbit, e.g. solid rocket motor for controlled de-orbit or dragsail for uncontrolled/semi-controlled de-orbit

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TeSeR – Simple, Standardized, Industrialized

Most subsystems for module are readily available

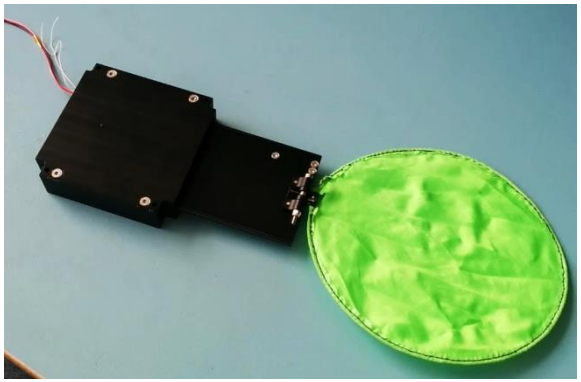
- Structure/Mechanism/Thermal
- Power supply
- Communication
- Attitude control
- Command and data handling

TeSeR development

- Removal technologies

TeSeR development

- Standardized interfaces



Two removal technologies pre-developments
Left: Self-deployable deorbiting space structure from Aalborg University (survived a failed launch in 2014 and is still working)
Right: Decommissioning device, solid propulsion from D-Orbit

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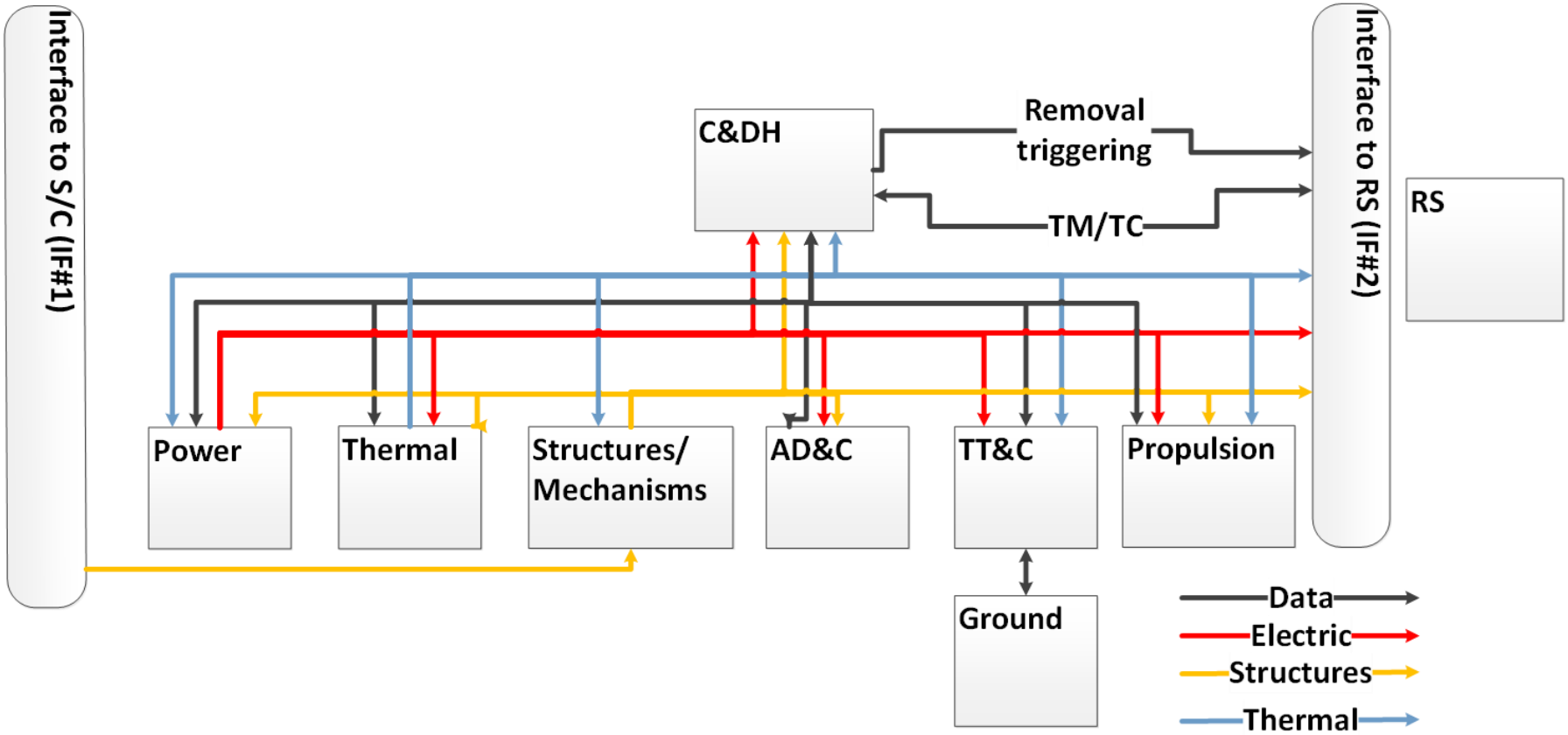
TeSeR – Functional Architecture



Functional block diagram of the PMD module, its subsystems and links, and its two standard interfaces
Bundeswehr University Munich

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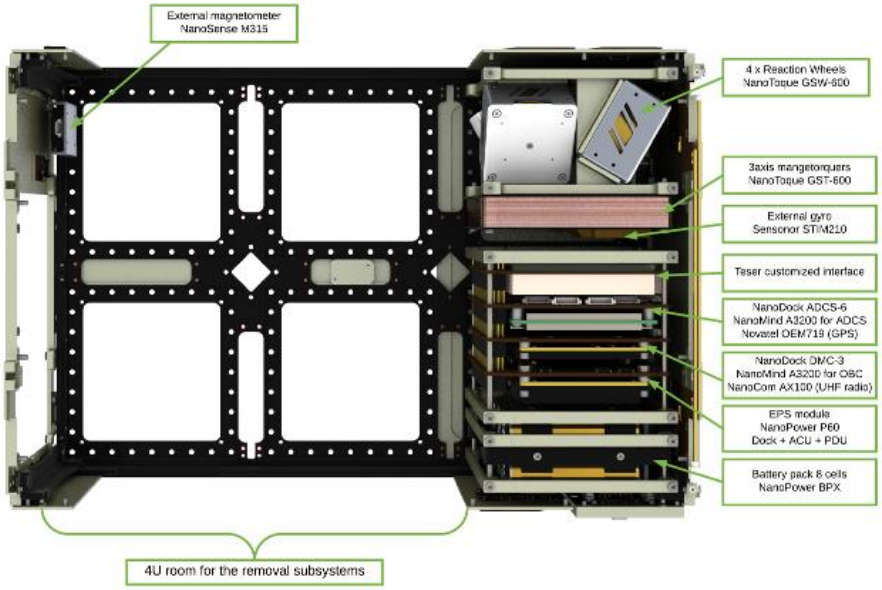
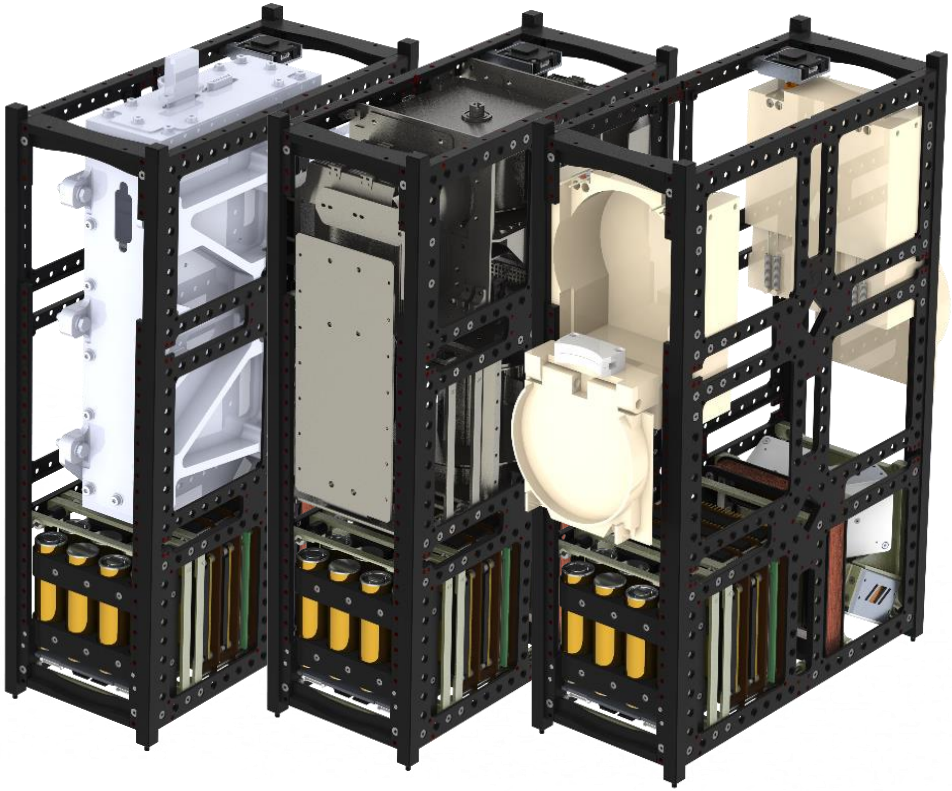
TeSeR – PMD Module



Prototype: 6U structure with platform avionics



PMD module prototype with three different removal subsystems: solid rocket motor, electro-dynamic system, dragsail

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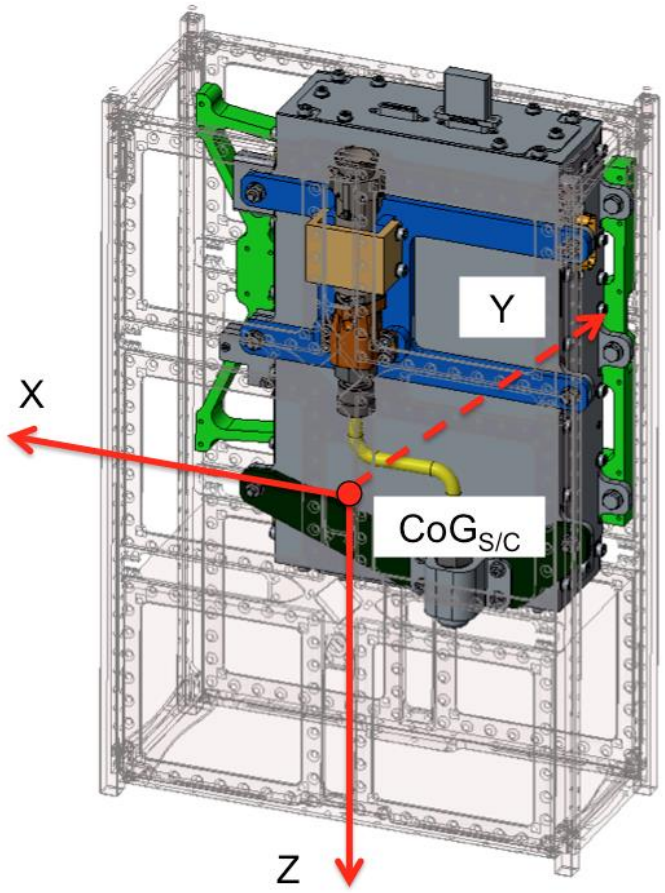
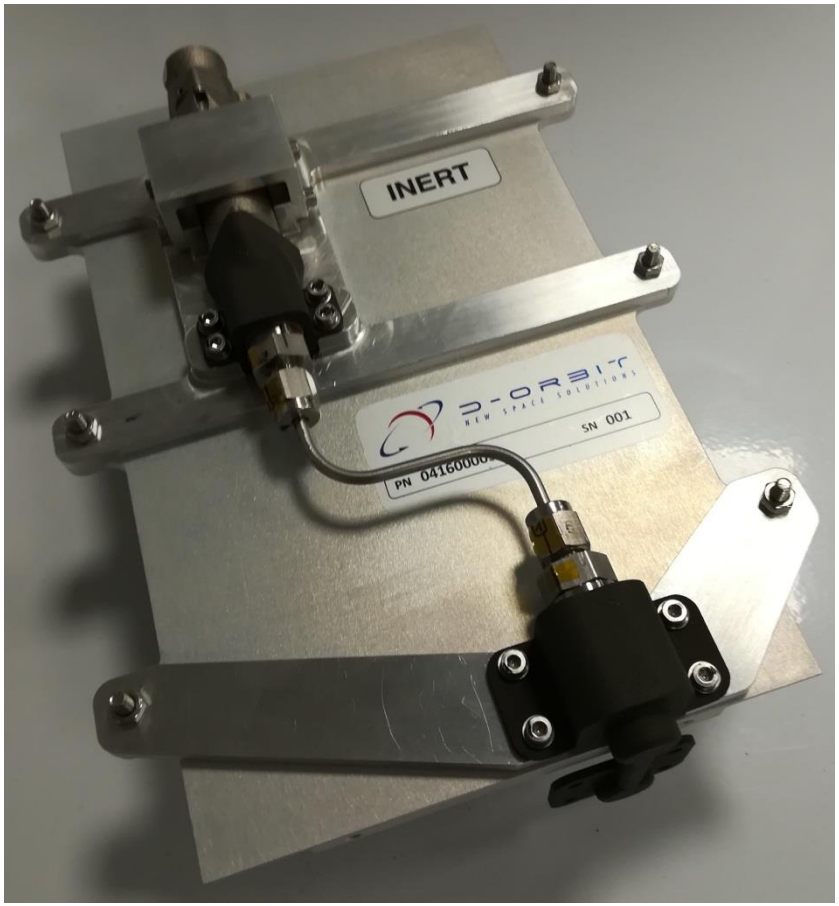
TeSeR – Solid Rocket Motor



Integration of solid rocket motor in 6U structure



Close-up of solid rocket motor

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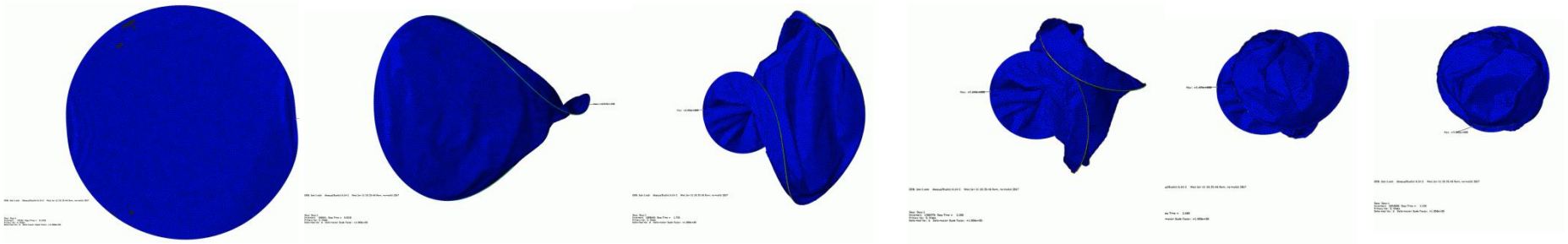
TeSeR – Dragsail



Shown here: Process of three times non-linear folding of the dragsail
Final achievement: nine times folding of the dragsail

Dragsail subsystem with the unfolded/deployed sail

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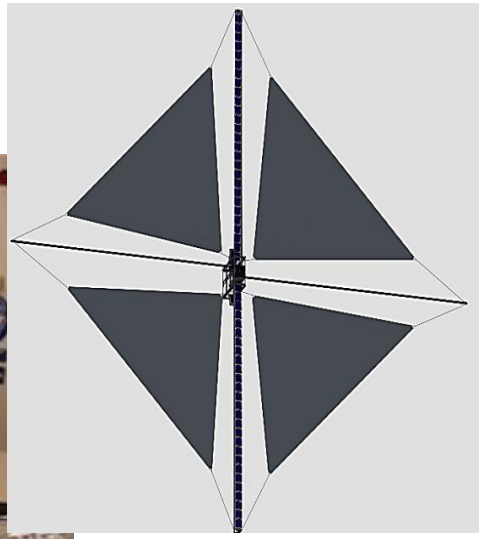
TeSeR – Electro-Dynamic Hybrid System



Unfolded Rigid Boom Electro-Dynamic Drag Sail (RBEDDS)

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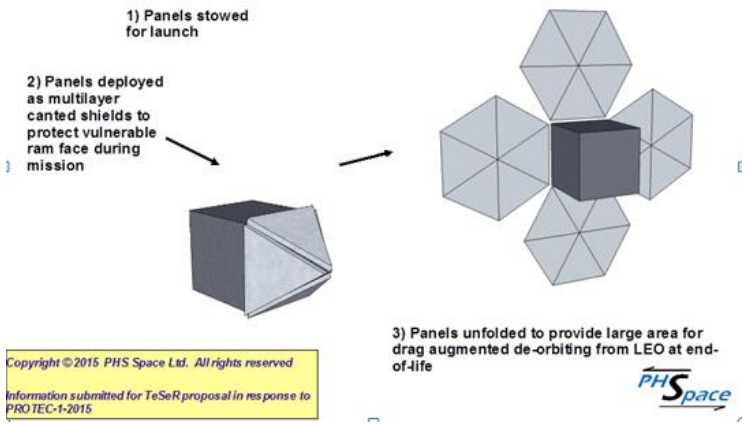
TeSeR – Additional Results

Technical:

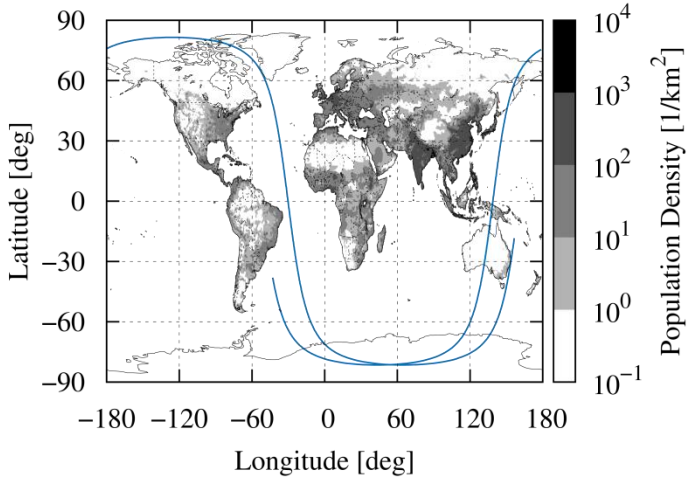
- Innovative passive AOCS concepts for long-time stabilization
- Re-entry simulations (semi-controlled)
- Multi-purpose concepts (shielding, impact detection…)

Non-technical:

- Norm evolution (ISO)
- Legal aspects (negligence, liability…)
- Insurance aspects (risks, insurability…)



Multi-purpose concepts



Semi-controlled re-entry

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Project

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TeSeR – Basics

TeSeR (Technology for Self-Removal of Spacecraft)

- Output: Evaluated concepts and on-ground prototype
- R&D project funded by the EC in H2020 framework (grant agreement number 687295)
- Kick-off: 02/16
- Completion: 01/19

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TeSeR – Team

- Airbus Defence and Space (Coordinator)
- Aalborg University
- Beazley Group
- D-Orbit SpA
- GomSpace A/S
- HTG Hyperschall Technologie Göttingen GmbH
- PHS Space Ltd
- University of Surrey
- Bundeswehr University Munich
- University of Strathclyde
- Weber-Steinhaus & Smith

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Summary

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TeSeR

Challenge:

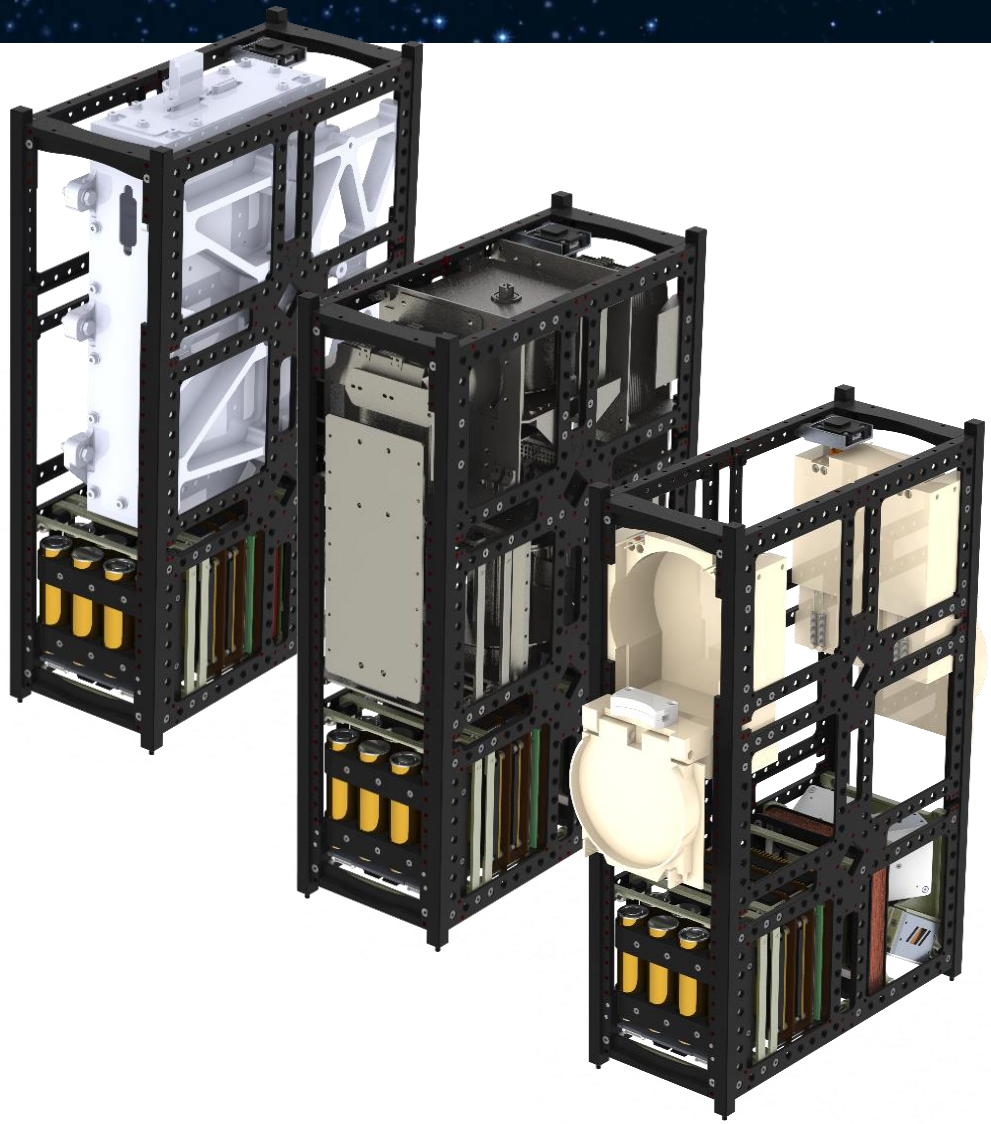
Close the PMD Gap

Solution:

Reliable and cost-efficient

PMD module

- Attachable to any future spacecraft on ground
- Scalable
- Modular
- Versatile
- Simple design
- Standardized
- Suited for industrial production



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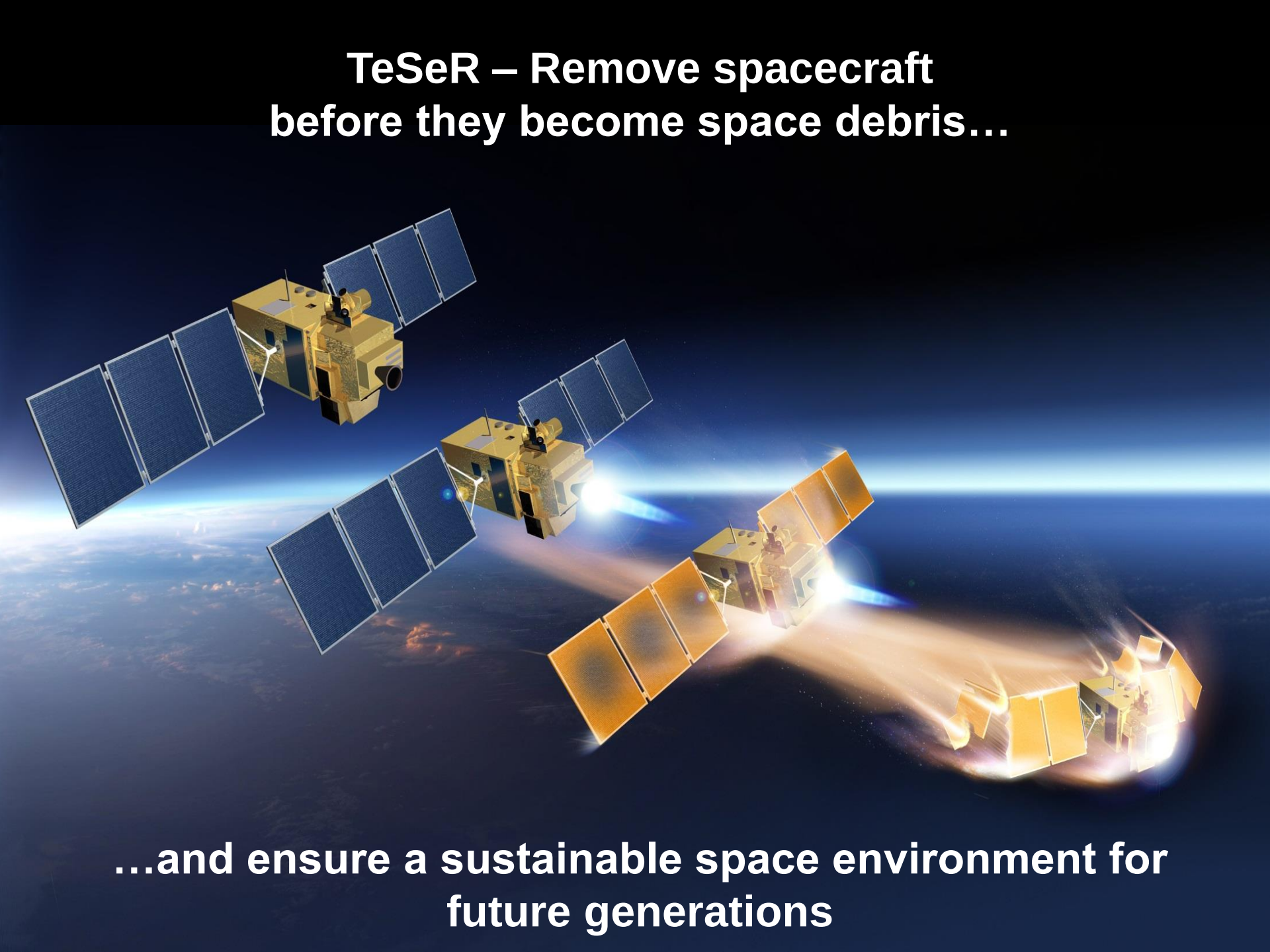
TeSeR – Remove spacecraft before they become space debris…



…and ensure a sustainable space environment for future generations

TeSeR – Point of Contact

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