TECHNOLOGIE IST UNSERE LEIDENSCHAFT

ESA Clean Space Workshop

Design and Development of a Deployable Membrane for Passive Deorbiting Systems

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Agenda

- Background, Motivation and Objectives
- Project Team
- Deployable Membrane Development Plan
- Current Status and Outlook

Background

- Number of controlled and un-controlled objects in the Earth orbits increases rapidly
- Debris origins from various sources (ranges from microns up to meters and due to the velocity of several kilometres per hour impacts and hence collisions are highly energetic)
- Increasing danger for manned and un-manned spacecraft
- Goal: reducing and preventing space debris in particular in Low Earth Orbits by de-orbiting un-operational satellites
- Space Debris Mitigation rule: < 25 years

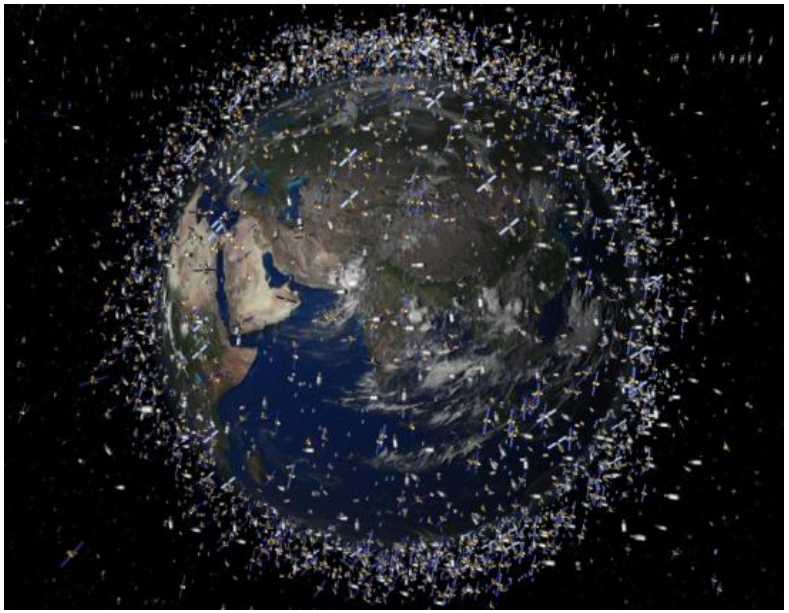

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Illustration of orbit population in Low Earth Orbit

Project Objectives

- ESA has initiated two activities which shall advance the technology required for such passive means of de-orbiting

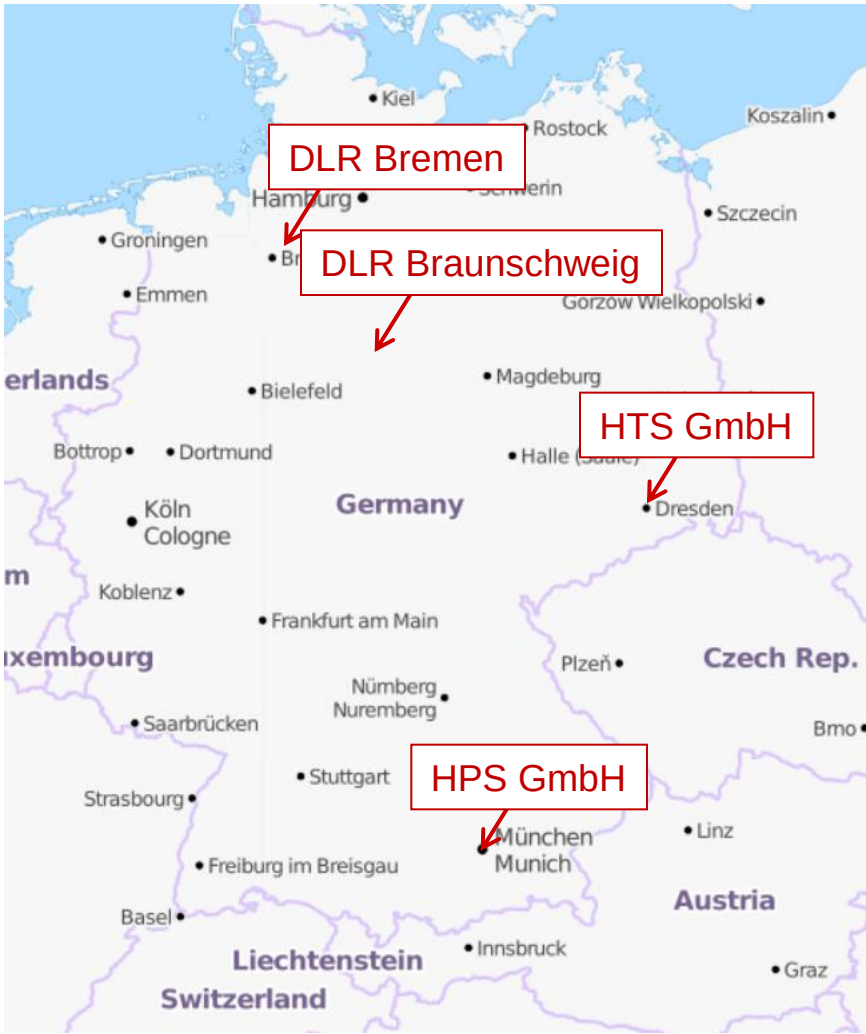
- The ultimate goal: Develop a lightweight, robust and reliable membrane which can be used as a drag sail for passive de-orbiting, along with:

  - Membrane Material selection and coating definition
  - Definition of folding and deployment approach
  - Design of drag sail and interfaces
  - Material tests (impact tests, ageing tests)
  - Full scale Breadboard (deployment tests)

Note: The activity is carried out under ESA contract No. 4000112241 within the Clean Space Programme (GSTP 6-1 CS)

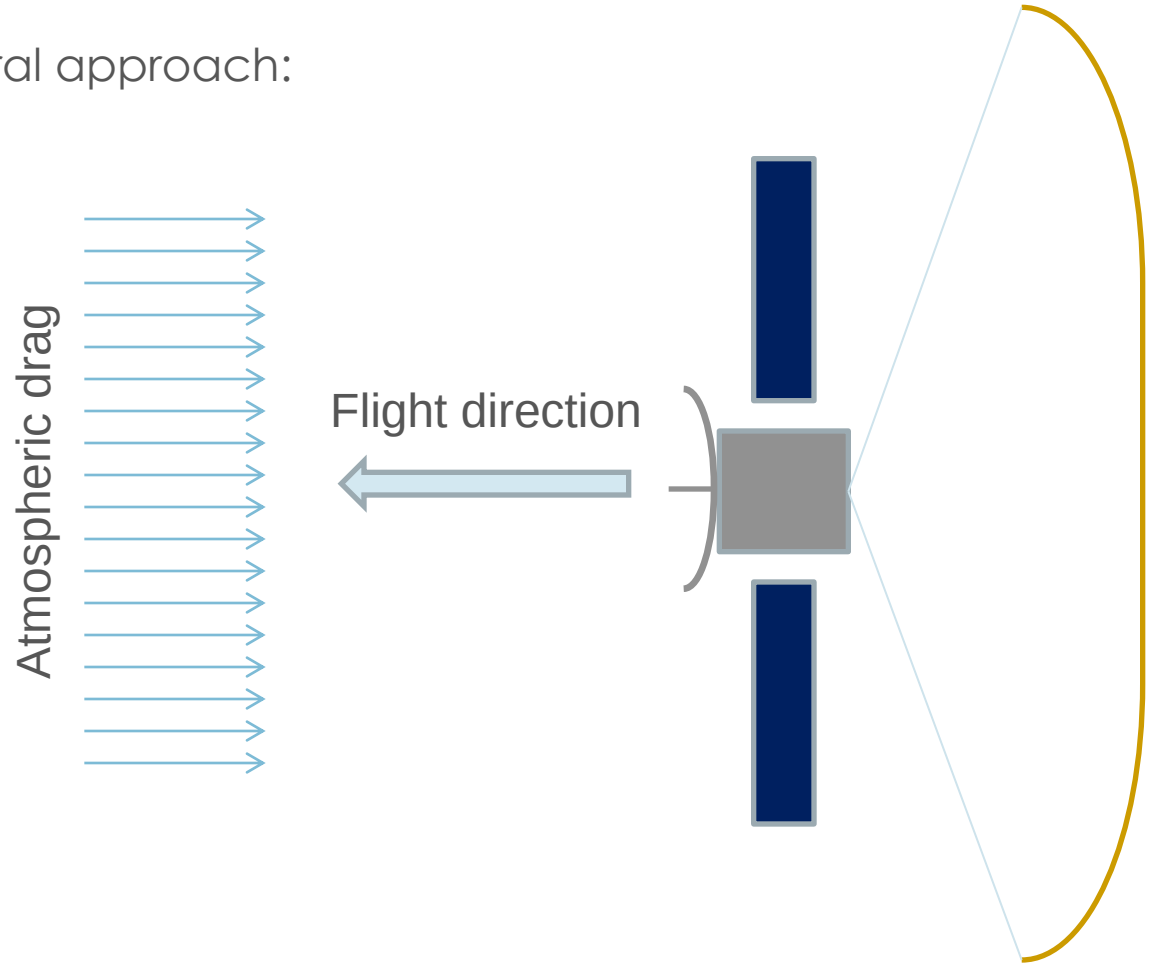
Project Team

- Hoch Technologie Systeme HTS GmbH
  - Prime
- High Performance Space Structures HPS GmbH
  - Detailed Analyses
  - Impact tests and assessments
- DLR Bremen
  - Packaging, deployment, aging
- DLR Braunschweig
  - Deployment concept
  - Interfaces



The idea of passive deorbiting :

- General approach:



Use drag by residual atmosphere to slow down and descent satellite

The idea of passive deorbiting:

- Advantages
  - No energy or propellant required
  - Simple plug-and-play system (no major implications to satellite design)

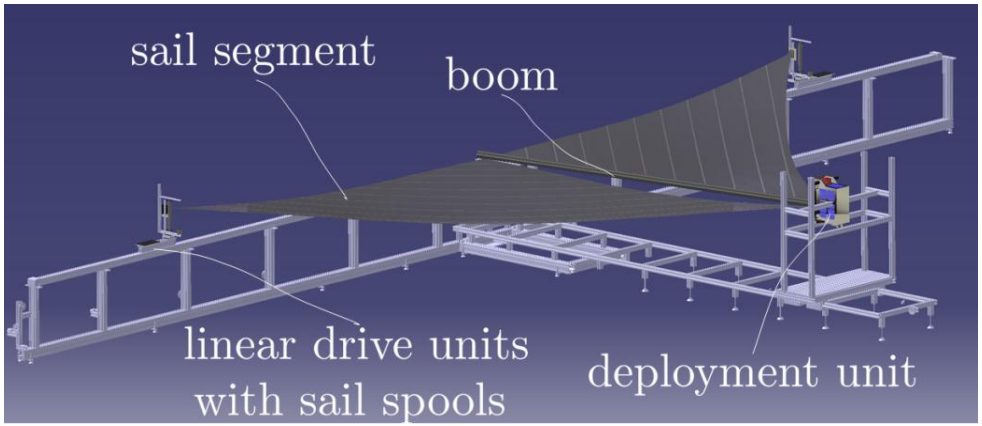
- Drawbacks
  - Long descent time
  - Only applicable for LEO spacecraft

Major Requirements

- Ultra low specific weight to allow for sufficiently large, yet lightweight sails
- Low storage volume
- Long lifetime (resistance to solar and cosmic radiation, particle radiation, etc.)
- Tolerance to long storage time under difficult environmental conditions
- Resistance to wide temperature range during storage and operation
- Mechanical robustness and damage tolerance

Development and Test Plan

- State-of-the-art review of materials, sails technologies, packaging concepts and deployment concepts
- Requirements consolidation
- Material trade-off (including material testing)
- Definition of joining techniques, interfaces to booms, packaging and deployment technique
- Breadboard design, manufacturing and thorough testing
  - Joint and interface tests
  - Ageing tests (thermal cycling, VUV, Atox)
  - Impact tests
  - Deployment tests (full scale)
- Synthesis



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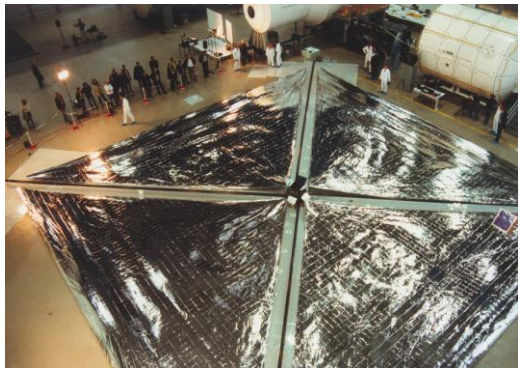
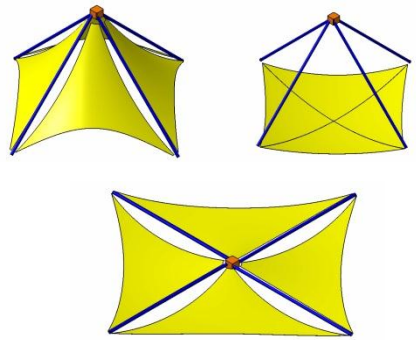
Current status



- State-of-the art assessment on deployable membranes and sail finished
- Requirement specification consolidated
- Concurrent Engineering Work shop (with ADEO parallel study)
  - Baseline system design selected
  - Baseline membrane design parameters allocated



- Preliminary material selection:
  - Dupont Kapton 7.6 µm, VDA
  - Joining by bonding (first temperature stress tests show promising results)

Next steps and milestones

- Finalisation of material trade-off
- Finalisation of packaging and deployment approach
- Design of I/F to booms
- Breadboard design, GSE design
- Impact analysis (MASTER2000)
- Next milestone: PDR, May 2015

Thank you very much!

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