SPACEKEEPERS PHASE A

ESA Clean Days 2026

30/06/2026

Proposed Agenda

1. Consortium and Mission Introduction
2. Technical Challenges → Zero Debris goals
3. Mission architecture and CONOPS
4. System overview
5. Secondary payloads
6. Final considerations

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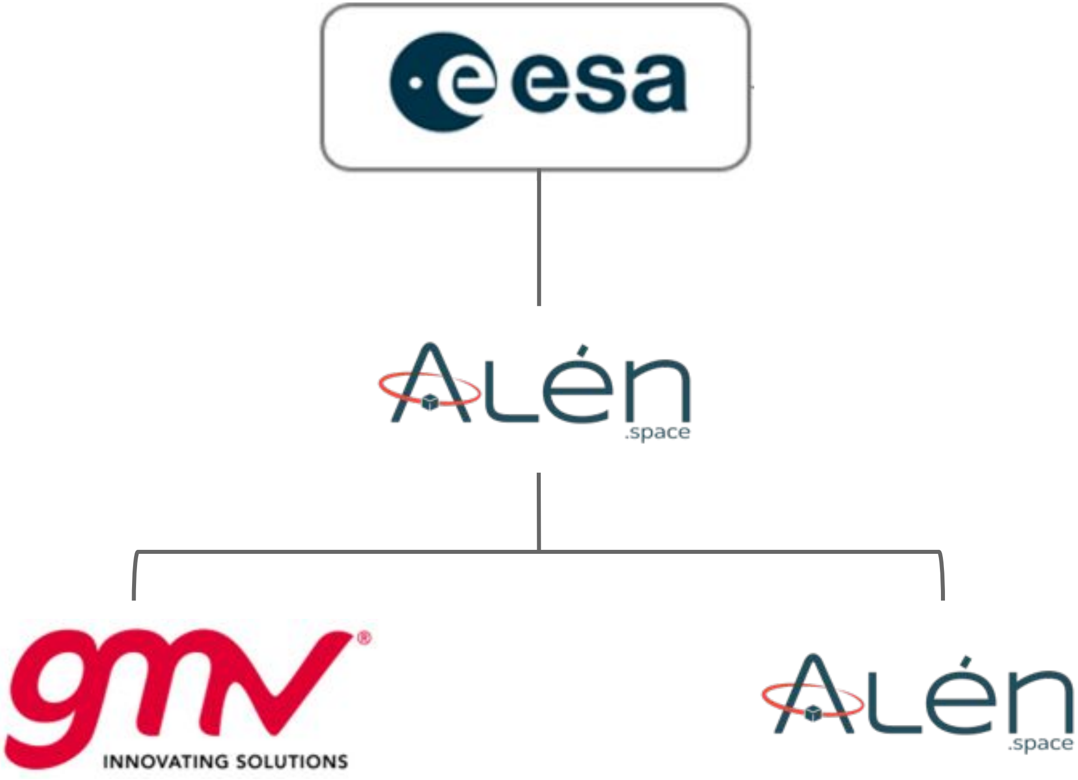
1. Consortium introduction



1. Mission introduction

- **SpaceKeepers** → 16U-equivalent small satellite platform aimed to support evaluating and complying with the ZD 2030 goals, while providing an additional funding scheme, through hosted payloads.

- **Mission proposed hosted payloads:**
  - RF Monitoring Payload
  - Collision Avoidance Automated System

- **Design created to fulfill these goals:**
  - 16U-equivalent configuration, with extended space for RF monitoring antennas
  - Extended surface to enable brightness reduction and attitude-driven drag-augmentation experiments

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2. Technical Challenges

- **TC-1: Reliable disposal at EoL**
  - TRL-9 primary propulsion system → Supports high system reliability
- **TC-2: Reliable passivation**
  - High-TRL components + health monitoring (reduces in-flight unpredicted failures)
  - Independent Space Locator Beacon → Enables satellite tracking
  - Passivation logic proposal (propellant depletion → ADCS energy depletion → EPS energy depletion + cut-off)
- **TC-3: System resilience and monitoring**
  - High-TRL components for critical satellite subsystems (EPS → OBC → TTC → ADCS → Propulsion)
  - OBSW platform on-board health monitoring
  - Autonomous ground anomaly detection system implementation in Mission Control Software
- **TC-4: Collision risk reduction**
  - TRL-9 propulsion system
  - Support: Additional automated collision avoidance maneuvering algorithms
- **TC-5: Dark and Quiet Skies**
  - In-house developed brightness calculation tools → Brightness estimation throughout the orbit
  - Attitude control and mitigation strategies

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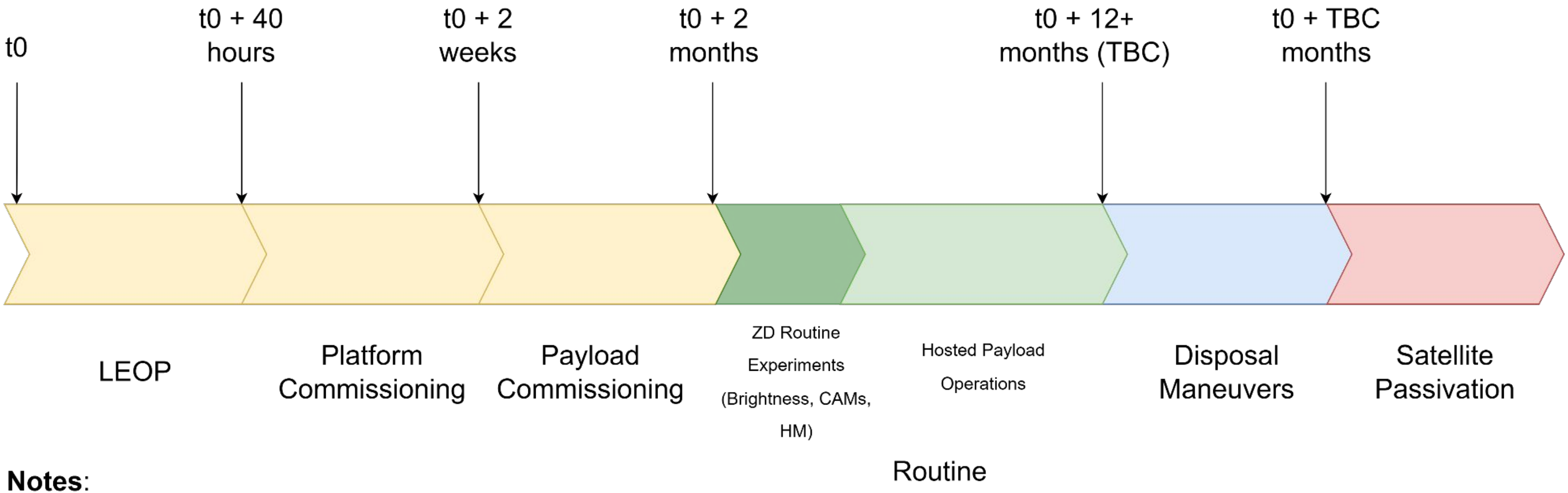
Concept of Operations



Notes:

(1) The primary propulsion system must be operative 48 hours after injection
(2) The disposal maneuver may/may not include altitude lowering to intermediate disposal orbit (natural reentry will occur in <5 years since injection)

Concept of Operations

LEOP & Commissioning:

- Satellite stabilization
- Commissioning of critical subsystems (EPS, ADCS, OBC, Propulsion)
- Payload commissioning

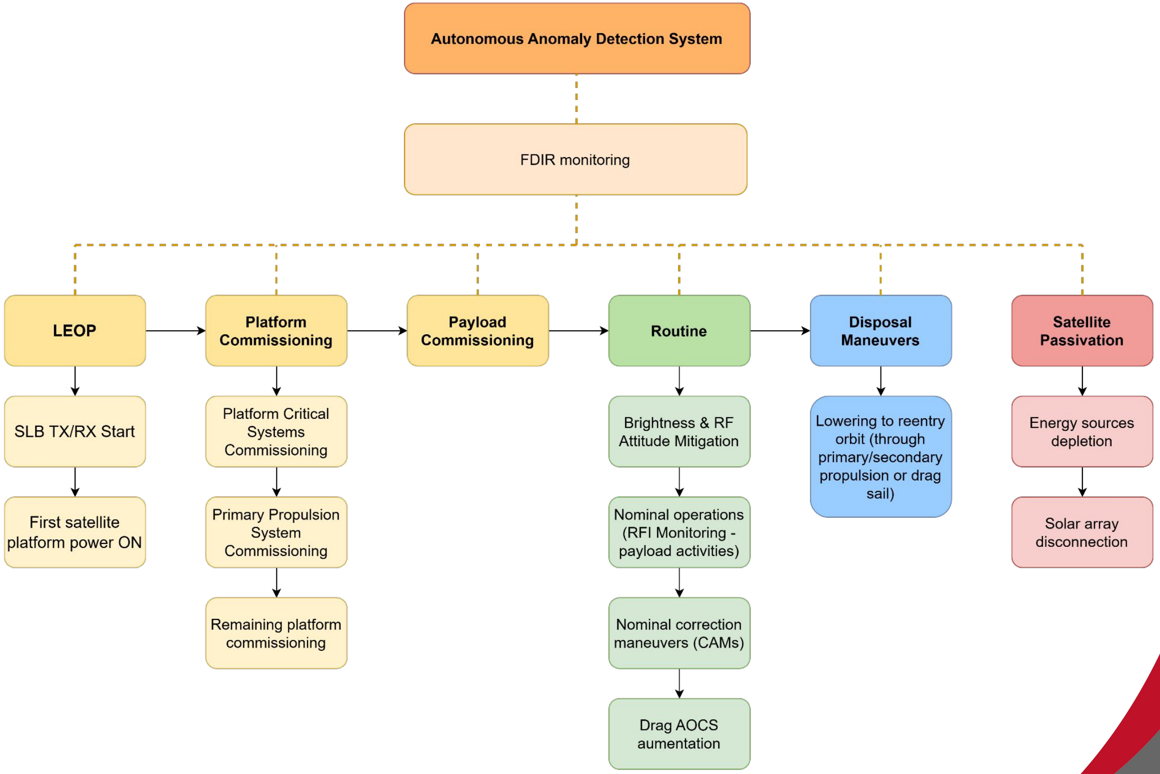
Routine:

- Zero Debris experiments
- Nominal operations (payload + platform)

Disposal:

- Orbit lowering (whenever necessary)
- Satellite passivation

Satellite reentry → <5 years



Main Mission Drivers

- LEO Orbit → Enables reliable disposal, and representative conditions for the mission experiments
- Compatible with a launch in 2028
- Tackling the five ZD technical objectives
- Compatible with Space Debris Mitigation requirements (e.g. ESSB-B-ST-U-007)
- Based on a CubeSat form-factor, maximum 16U-equivalent satellite sized
- Having a recurrent maneuvering capability
- Having a minimum 1-year lifetime period
- Compatible with European launchers

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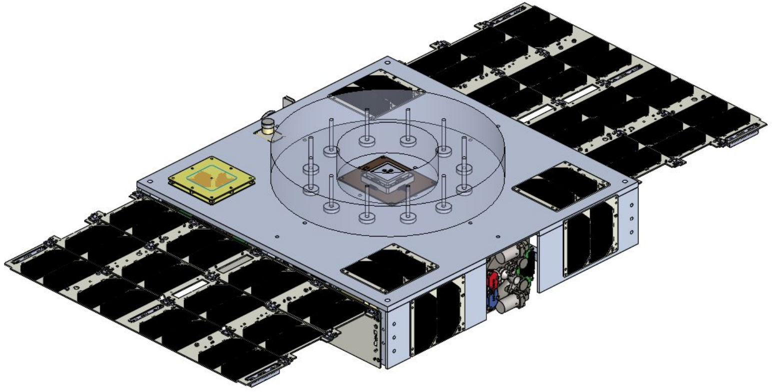
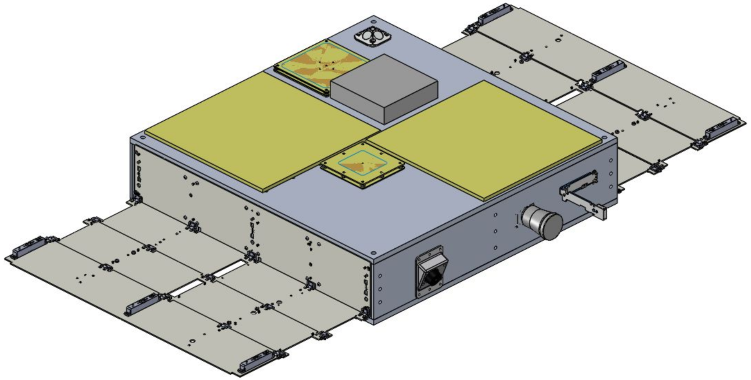
System Overview

16U-equivalent satellite

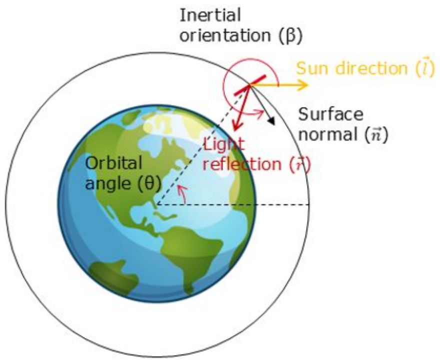
- **Enables external extended surface for antennas** → RF Monitoring payload & TTC
- **Provides faces with high-surface area contrast** → Brightness mitigation experiments & increase/decrease of drag area
- **Enables easier diagnostics & integration →** Reduced risk and AIV time

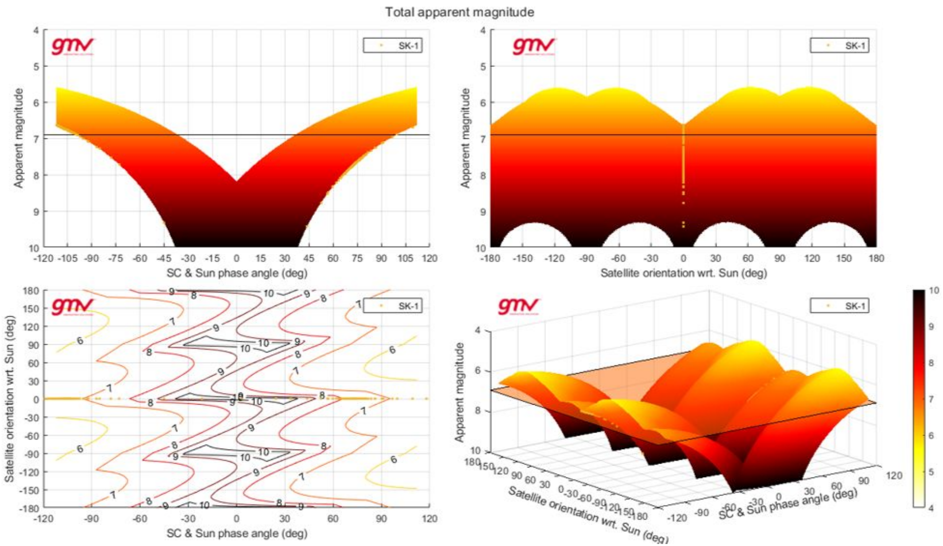




Brightness Characterization

- Numerical characterization tools developed to estimate apparent visual brightness magnitudes
- Contribution of brightness of the different satellite faces → dependant on attitude (Sun/Earth positioning) and surface materials (optical properties)



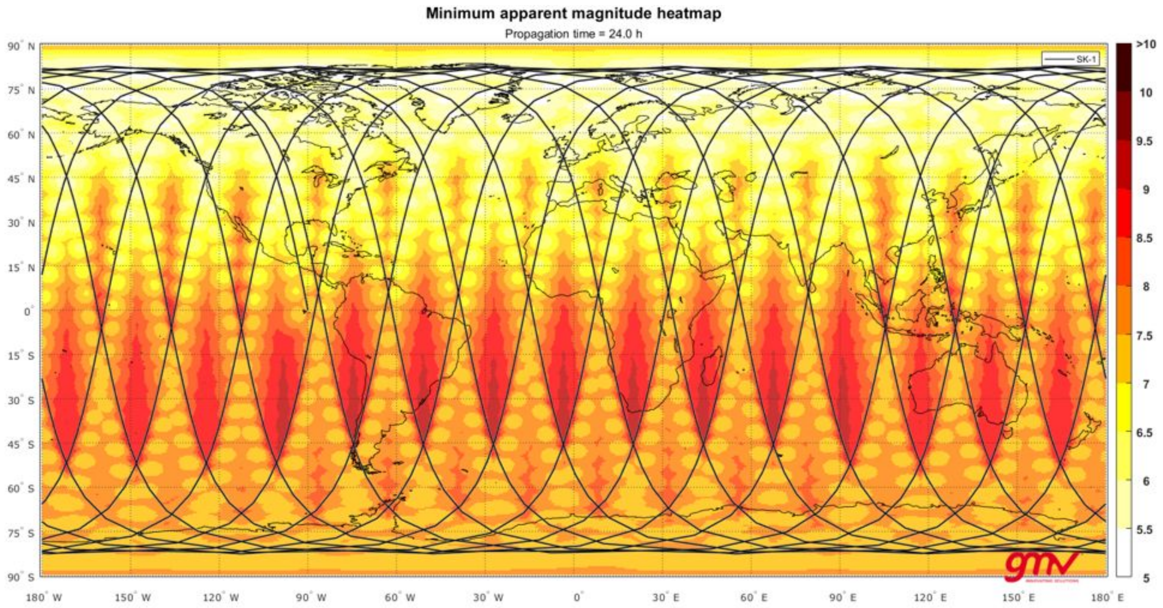


- Sensitivity analysis considering the relative position and distance of the observer to the reflected light vector and surface normal
- Orbital angles near the eclipse region are associated with lower apparent magnitude (higher brightness)

Brightness Characterization

T-OBJ5 → Assessment of Visual Brightness

- Characterization along the whole satellite orbital trajectory
- Brightness can exceed (lower) the visual magnitude thresholds whenever close to certain latitudes, although this shifts over the year → Interest for model comparison and refinement of ZD brightness requirements



Attitude Experiments

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Attitude in-orbit changing experiments can increase value to the mission.

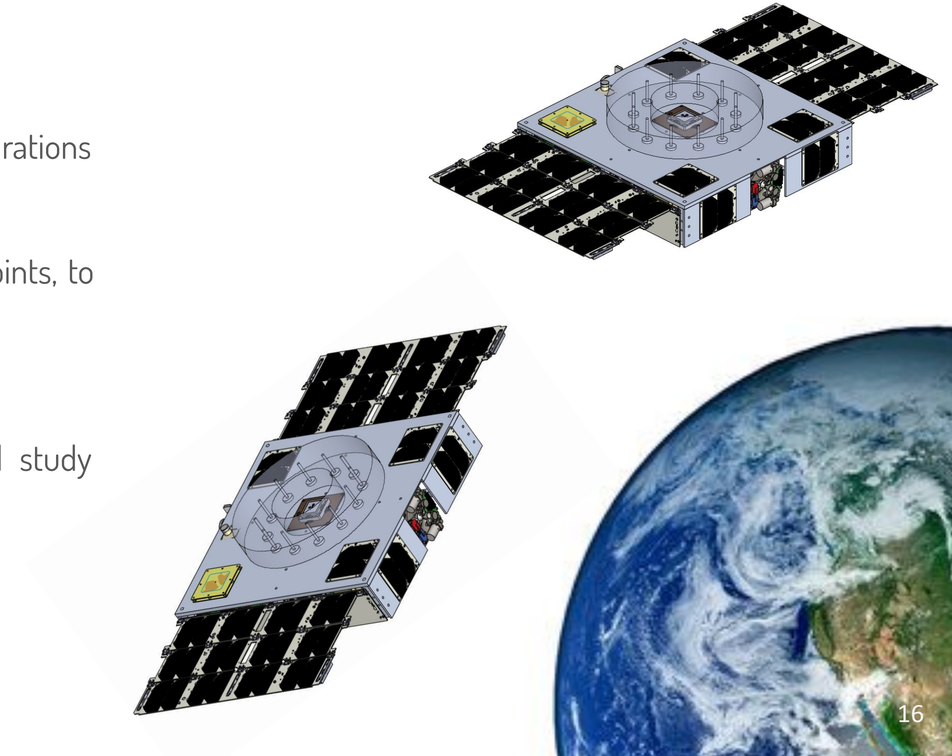
Two main experiments studied:

Brightness

- During nominal operations, brightness for several configurations (16U and 4U faces) can be characterized from ground.
- Attitude can be changed during high brightness orbital points, to reduce brightness.

Disposal

- Attitude can be modified to increase drag surface and study accelerated decay (before propulsive disposal operations).



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Hosted Payloads

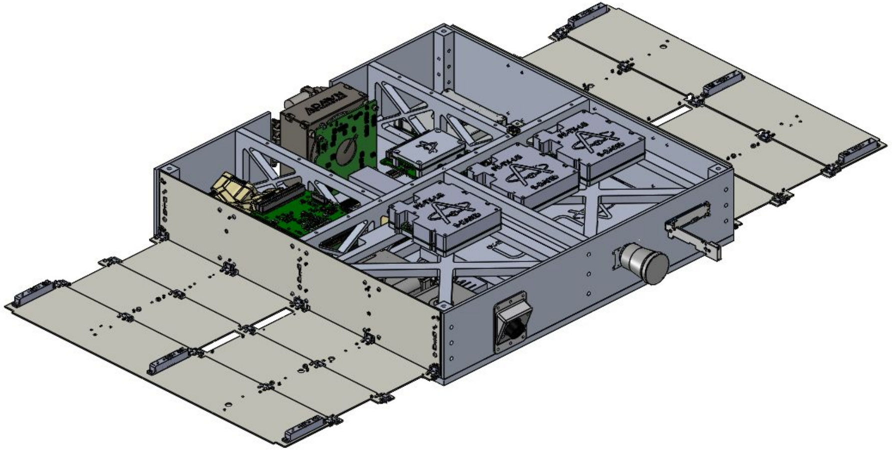
RF Monitoring

- RF monitoring capabilities to prospective customers.
- E.g. spectrum regulatory compliance monitoring, GNSS/RF interference, radio astronomy protection.

Automated Collision Avoidance Capabilities

- In-orbit demonstration of automated maneuvering capabilities.
- Development of reliable indicators of conjunction criticality assessment and planning.

SK-1 is dimensioned to on-board one or both of these hosted payloads, supporting additional consortium commercial support to the ZD mission objectives.



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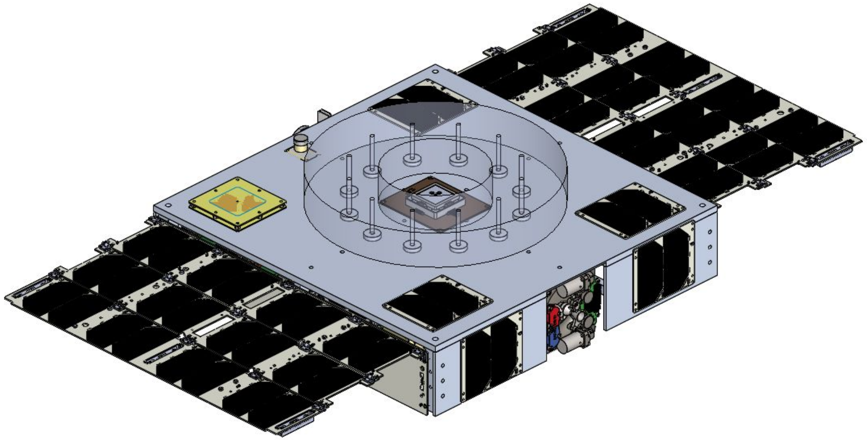
Conclusions → Towards ZD Commercially Viable Missions

- 16U-equivalent platform with ZD capabilities, including recurrent maneuvering capabilities and health monitoring and early error detection.
- Innovative brightness characterization and reduction measures.
- Early satellite identification and commissioning of critical components (e.g. propulsion).
- Dimensioned to provide support for two secondary payload concepts, useful to the consortium and aligned with future EU strategic areas.
- Designed for a launch in 2028, and compatible with European launchers.



Thank you

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Questions?

Alén space

A GMV COMPANY