

Space Safety Industry Day - Hungary

S2P Team

15/02/2023

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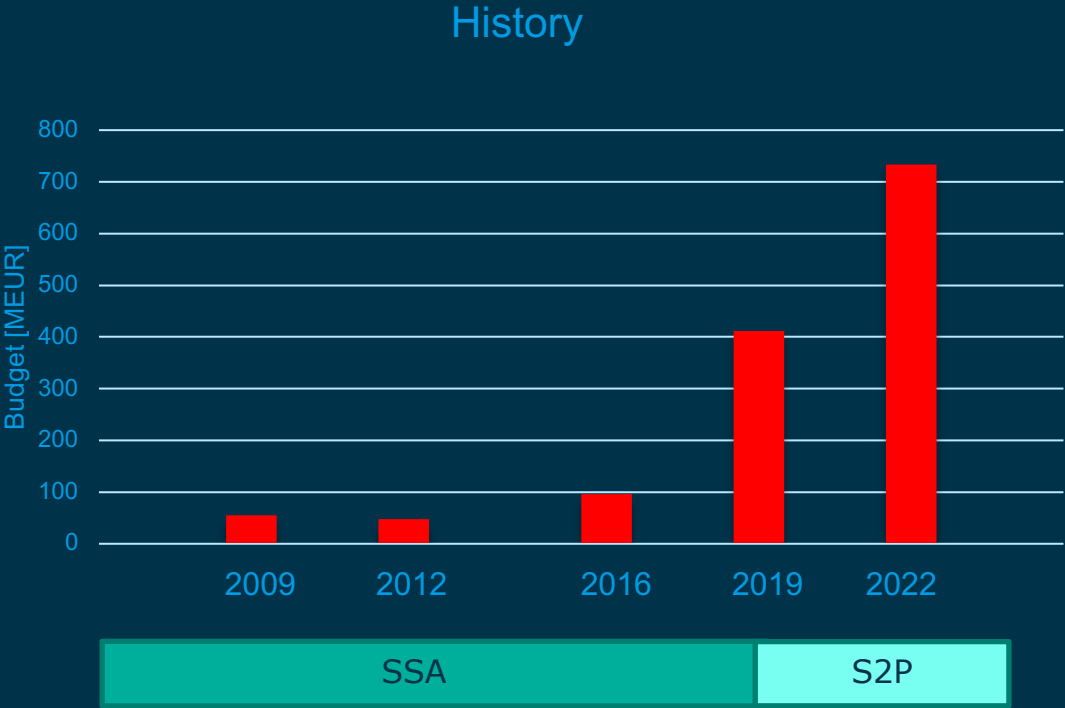


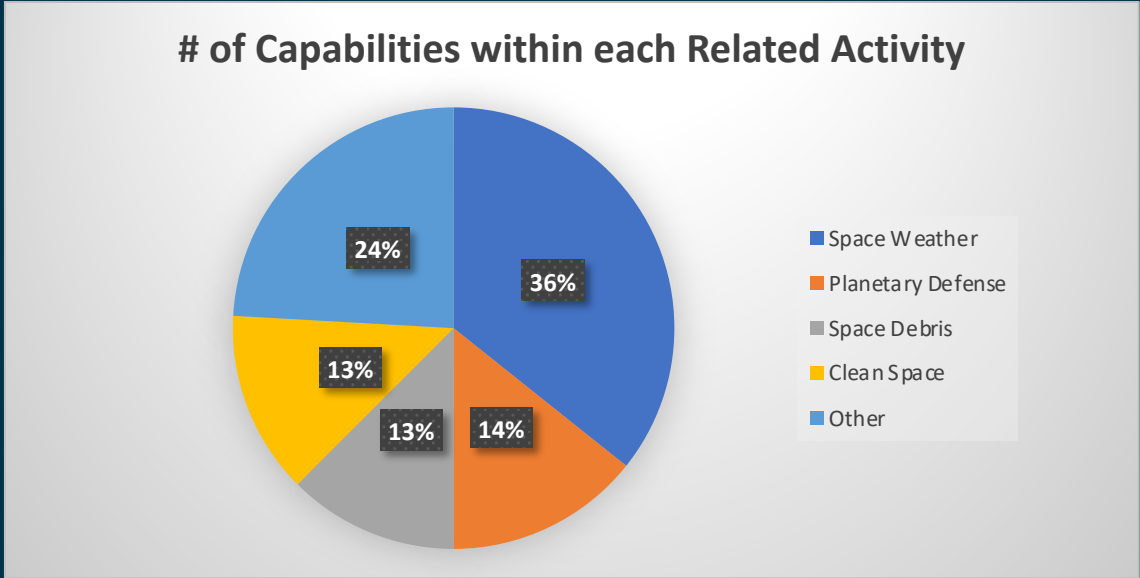
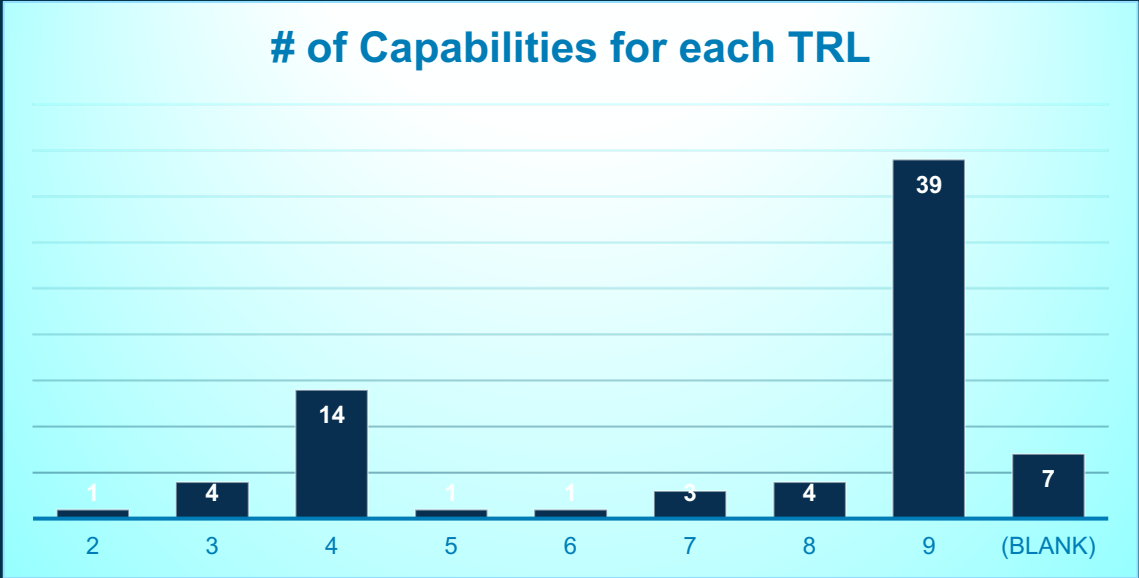
- Welcome and Period 2 Overview (5min – H. Krag)
- Space Weather related Projects (20min – J. Luntama)
 - Space Weather Core
 - Aurora Monitoring Mission
 - SWE Nanosat Missions
- Planetary Defense related Projects (20min – R. Moissl)
 - FlyEye Telescope
 - NEOMIR
 - Apophis Mission Study
 - Planetary Defense Core
- Space Debris related Projects (20min – T. Flohrer)
 - DRACO
 - Laser Tracking and Momentum Transfer
 - VISDOMS (space-based optical component)
 - CREAM (Collision Risk Estimation and Automated Mitigation)
- Cleanspace related Projects (10min – A. Wolahan)
 - Cleanspace Core
- The Competitiveness Element (5min – J. Amador Monteverde)
- Cornerstone Missions
 - Vigil, Hera (5min – H. Krag)
 - Cleanspace-1, IOS (5min – A. Wolahan)

PROTECT ASSETS FROM SPACE HAZARDS



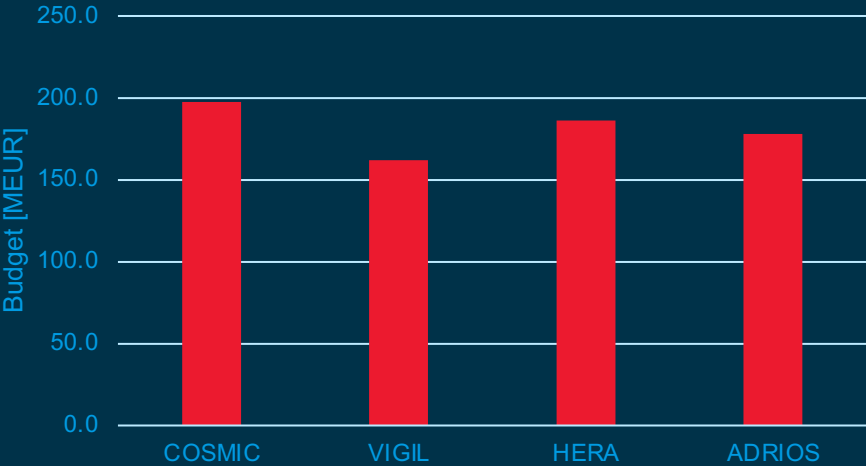
From SSA to Space Safety



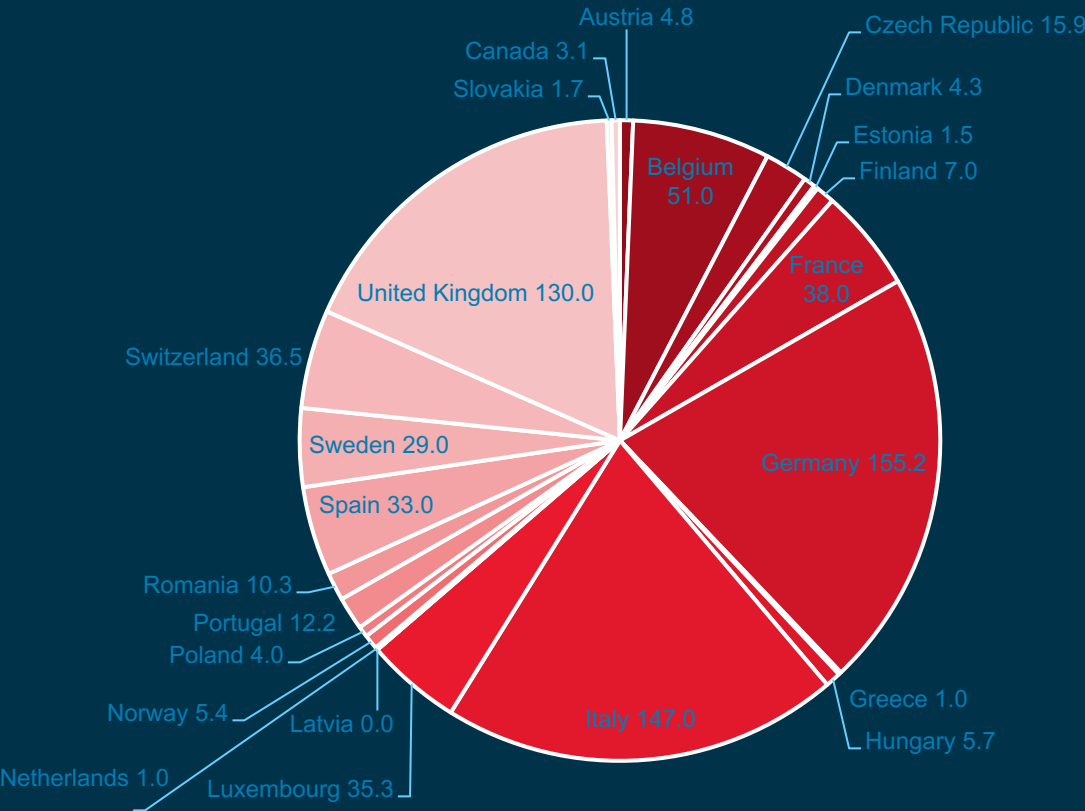


Space Safety budget summary

S2P Programme envelope



Country distribution [MEUR]



COSMIC Projects



Aurora Mission

NEO Survey System

Apophis Mission

CREAM

```
ComLink:
ESA-0017: Debris positions update sent...
ESA-0017: ROR: Computing collision risk...
ESA-0017: ROR: Computing collision risk...
ESA-0017: Computing new orbit...
ESA-0017: New orbit is safe, initiating dump...
ESA-0017: ROR:
```

Space Debris Core

DRACO

VISDOMS

NEOMIR

Space Weather Core

- Solar Weather
- Magnetospheric Weather
- Ionospheric Weather
- Space Radiation
- Geomagnetic Conditions

Cleanspace Core

SWE Nanosats

DE-ORBITING KIT

LASER

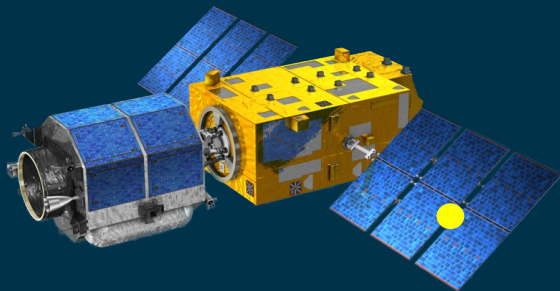
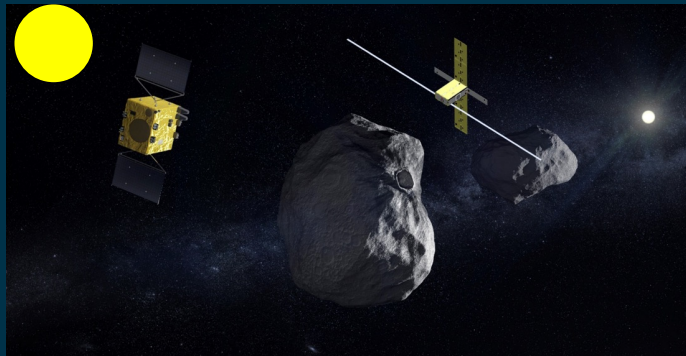
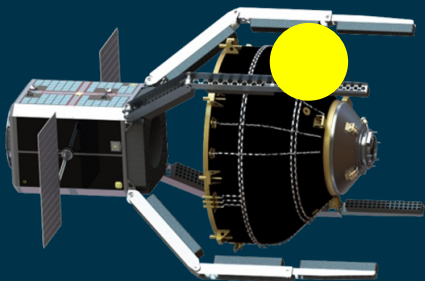
Planetary Defense Core

```
graph TD
    TBT1[TBT-1  
• Cebreros  
• ES, 2016] --> NEOCC((NEOCC))
    TBT2[TBT-2  
• La Silla  
• Chile  
• 2021] --> NEOCC
    Flyeye1[Flyeye-1  
• M. Mufara  
• IT, 2023] --> NEOCC
    Telescope[Telescope Array  
(2025)] --> NEOCC
    Flyeye2[Flyeye-2  
(2027)] --> NEOCC
    External[External  
telescopes] --> NEOCC
```

Competitiveness Segment



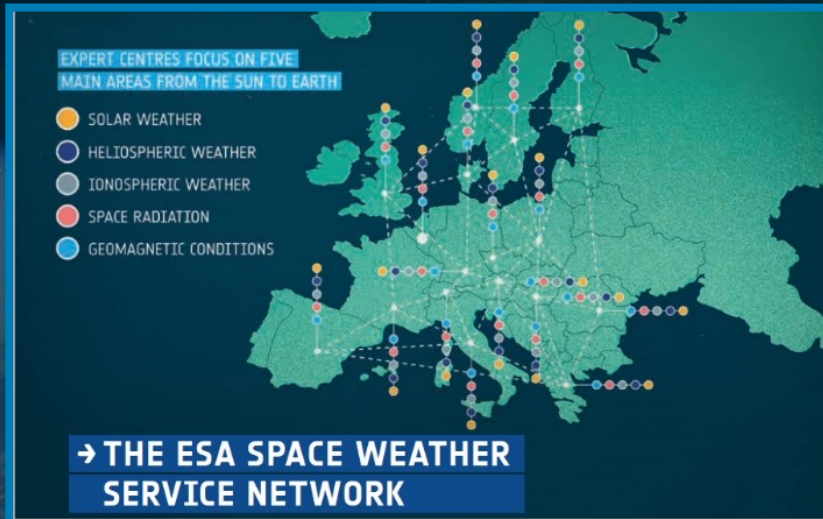
Hungary in Space Safety



Aurora Mission 	NEO Survey System 	Apophis Mission 	CREAM 	Space Debris Core
DRACO 	VISDOMS 	NEOMIR 	Space Weather Core 	Cleanspace Core
SWE Nanosats 	DE-ORBITING KIT 	LASER 	Planetary Defense Core 	Competitiveness Segment

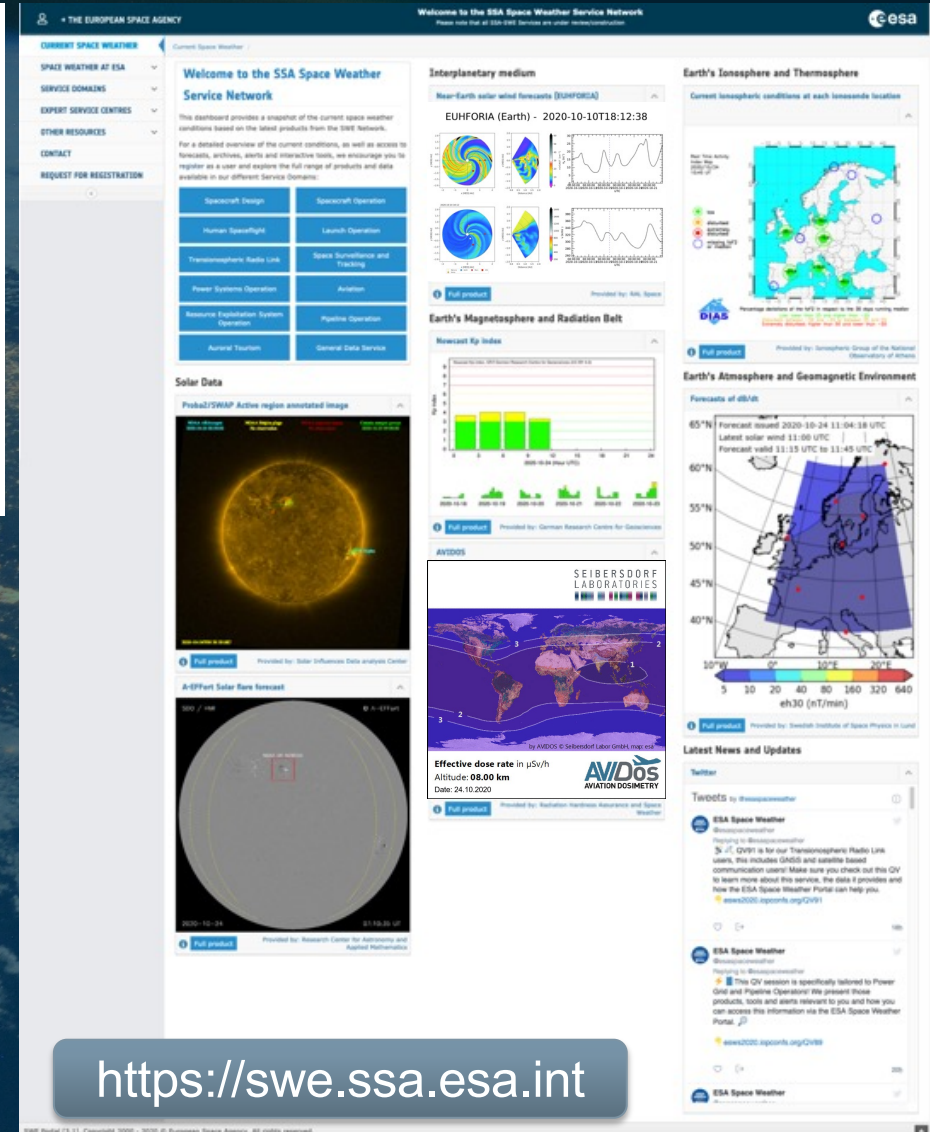


ESA Space Weather Service Network Today



Spacecraft Design	Spacecraft Operation
Human Spaceflight	Launch Operation
Transionospheric Radio Link	Space Surveillance and Tracking
Power Systems Operation	Aviation
Resource Exploitation System Operation	Pipeline Operation
Auroral Tourism	General Data Service

- 29 pre-operational services based on >250 products
- Service user support and staffed helpdesk
- European Service Network of >50 participating entities
- > 2500 registered users
- > 1.5-2.0M hits on service portal monthly
- Coordinated Communication Protocol

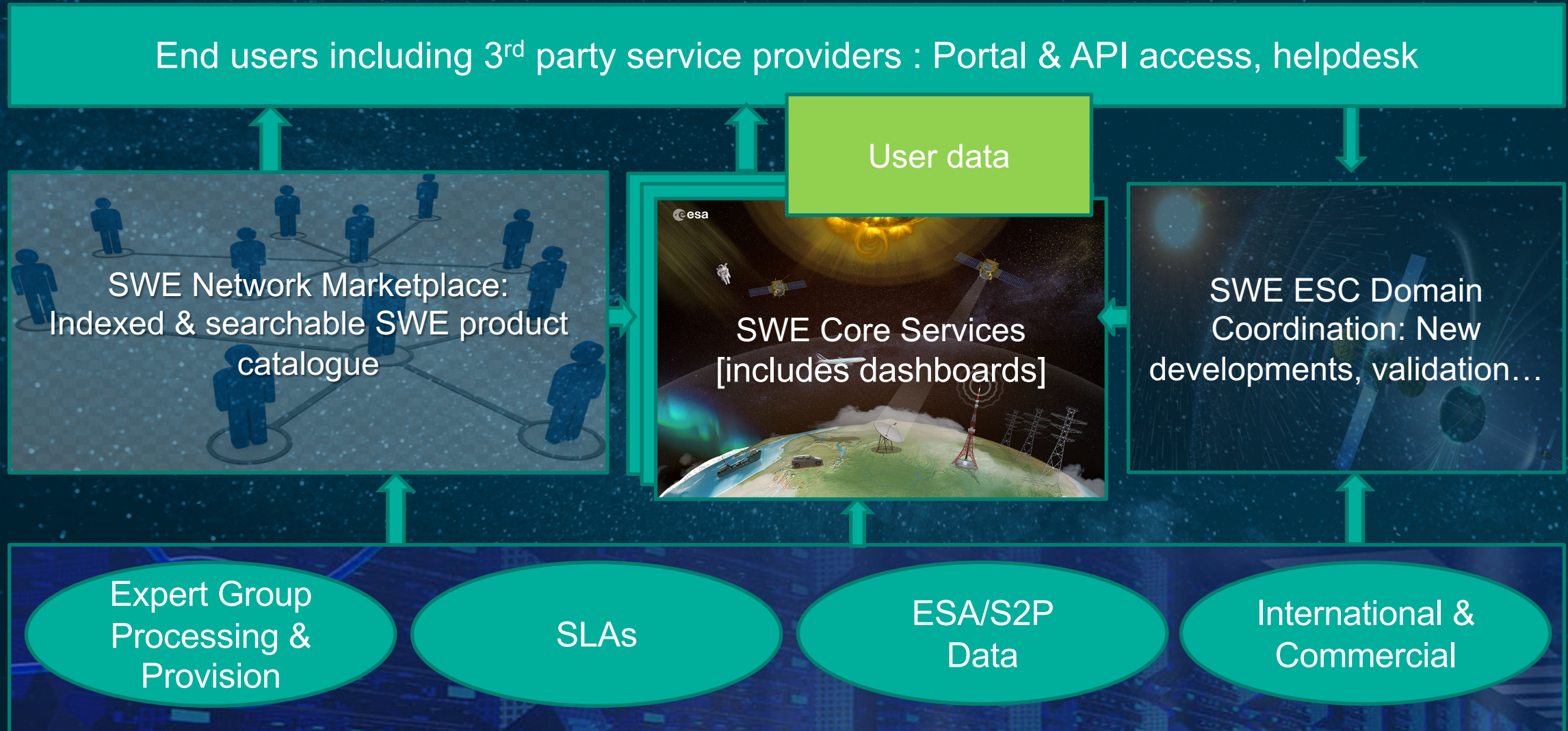


<https://swe.ssa.esa.int>



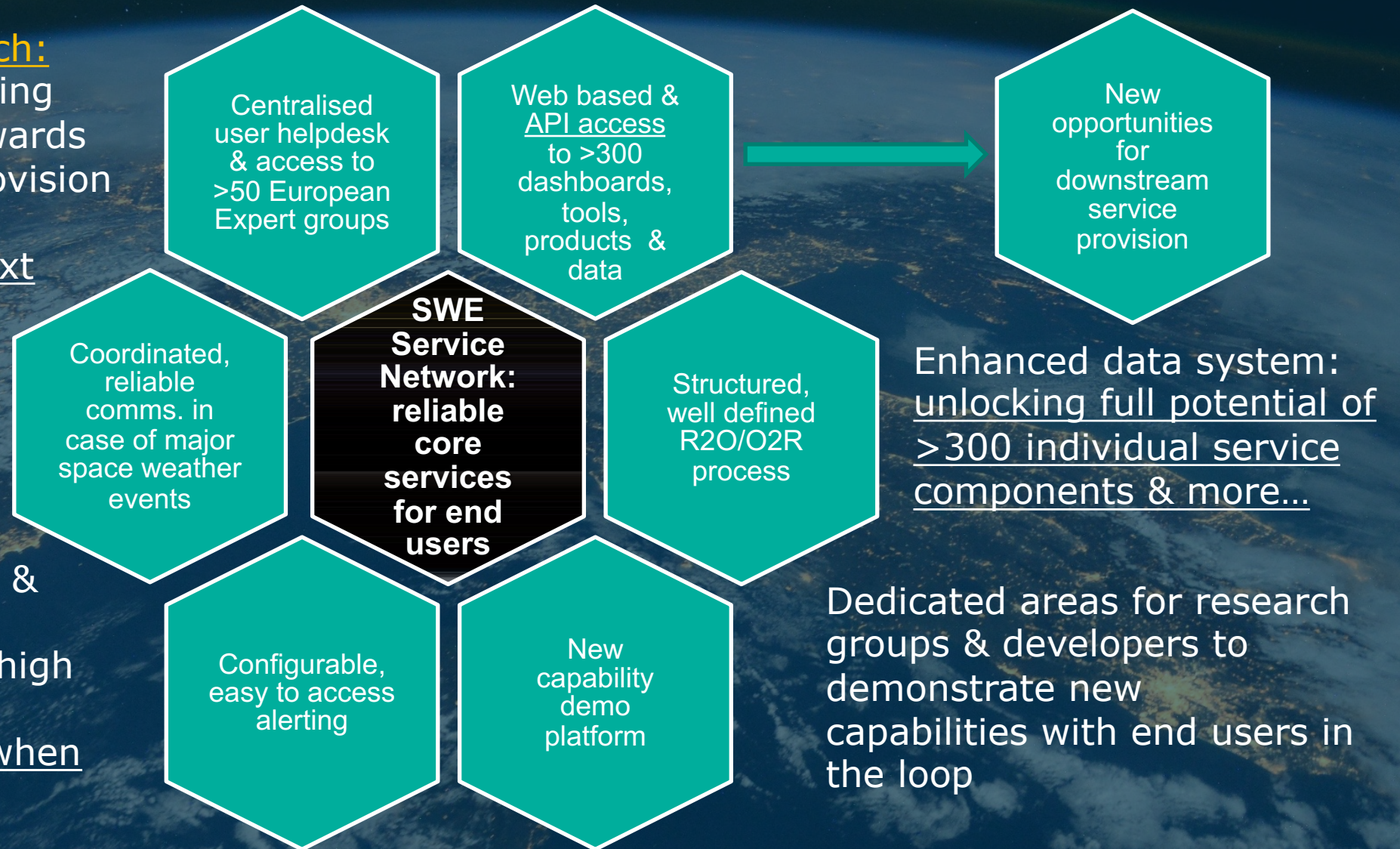
→ THE EUROPEAN SPACE AGENCY

ESA Space Weather Service System Overview



COSMIC: SWE Service Network Evolution

Hybrid system approach:
essential step in enabling
Europe's transition towards
operational service provision
taking interfacing &
performance to the next
level

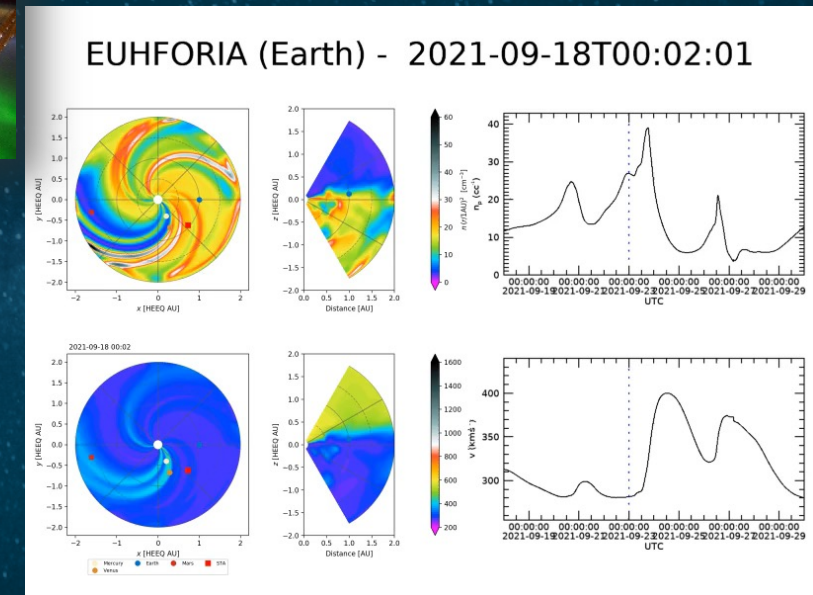
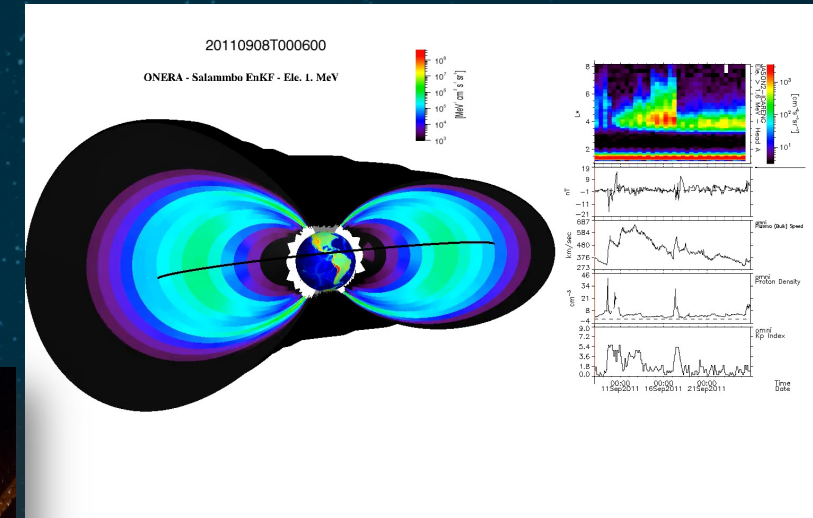


New alert registration & aggregation module, enabling provision of high priority, consistent information to users when it's most needed

Dedicated areas for research groups & developers to demonstrate new capabilities with end users in the loop

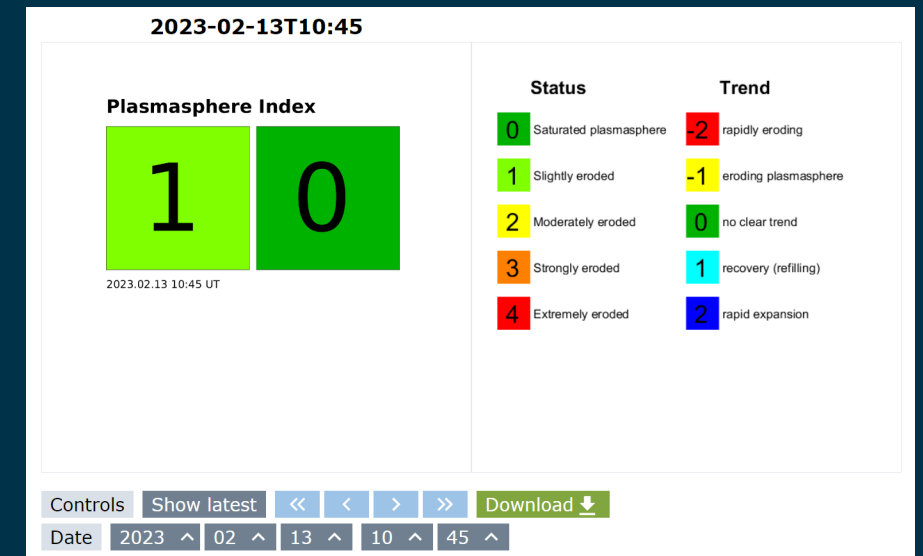
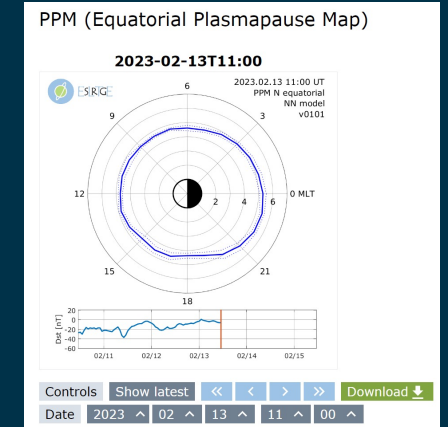
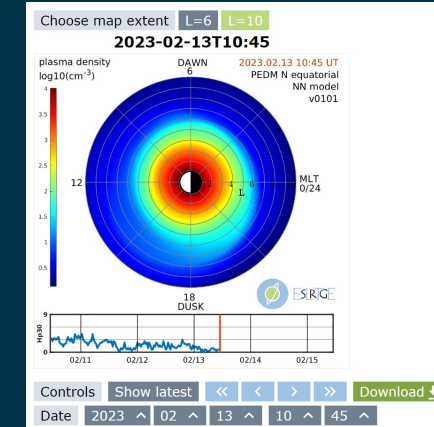
COSMIC: End-To-End Space Weather Modelling

- Targeted core model development including e.g.
 - solar event onset modelling
 - CME propagation and solar wind modelling
 - global magnetospheric modelling
 - radiation belt modelling
 - 3D ionospheric modelling
- Development of **VSWMC** framework
 - Architecture development
 - Key underpinning tool targeting increased forecast lead times up to several days ahead
 - Core model developments targeting increased accuracy
 - End-to-end modelling capability



COSMIC: Opportunities for Hungary in SWE Service Network

- Space Weather Service Network
 - Space Radiation, Ionospheric Weather & Geomagnetic Conditions ESCs
 - Integration and continued provision of P3-SWE-LII PLASMA products (SSE, ELTE, MBFSZ), RB-FAN2 integration and provision (ELTE, SSE)
 - Evolutionary maintenance
- SWE Product and capability developments
 - Utilisation of magnetospheric monitoring data
 - Ground based monitoring e.g. building on results of BNMS neutron monitor station utilisation study currently ongoing
 - Targeted product & tool development partnering with end users e.g. power grid operations, GNSS
- Commercial space weather services



Preliminary nowcast outputs from P3-SWE-LII, due for release later this year

COSMIC: Aurora Mission



Objectives

- 24/7 observation for Identification, monitoring and nowcasting geo-magnetic storms and sub-storms
- Improved services for communication, satellite navigation, aviation, transport, resource utilisation,...

Small satellite mission

- Class 150-200 kg satellite, ground stations and operations services
- OHB SE proposed prime contractor, consortium forming underway

Wide Field Auroral Imager

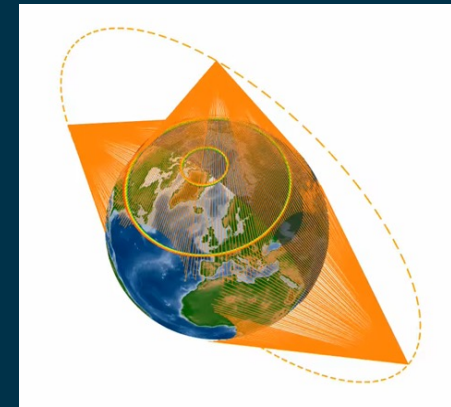
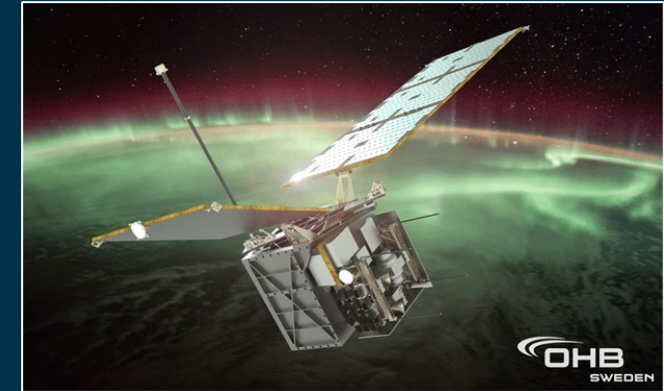
- Aurora Optical Spectral Imager (AOSI) & UV Imager (AUI)
- Control and Data Processing Unit(s)

In-situ instruments

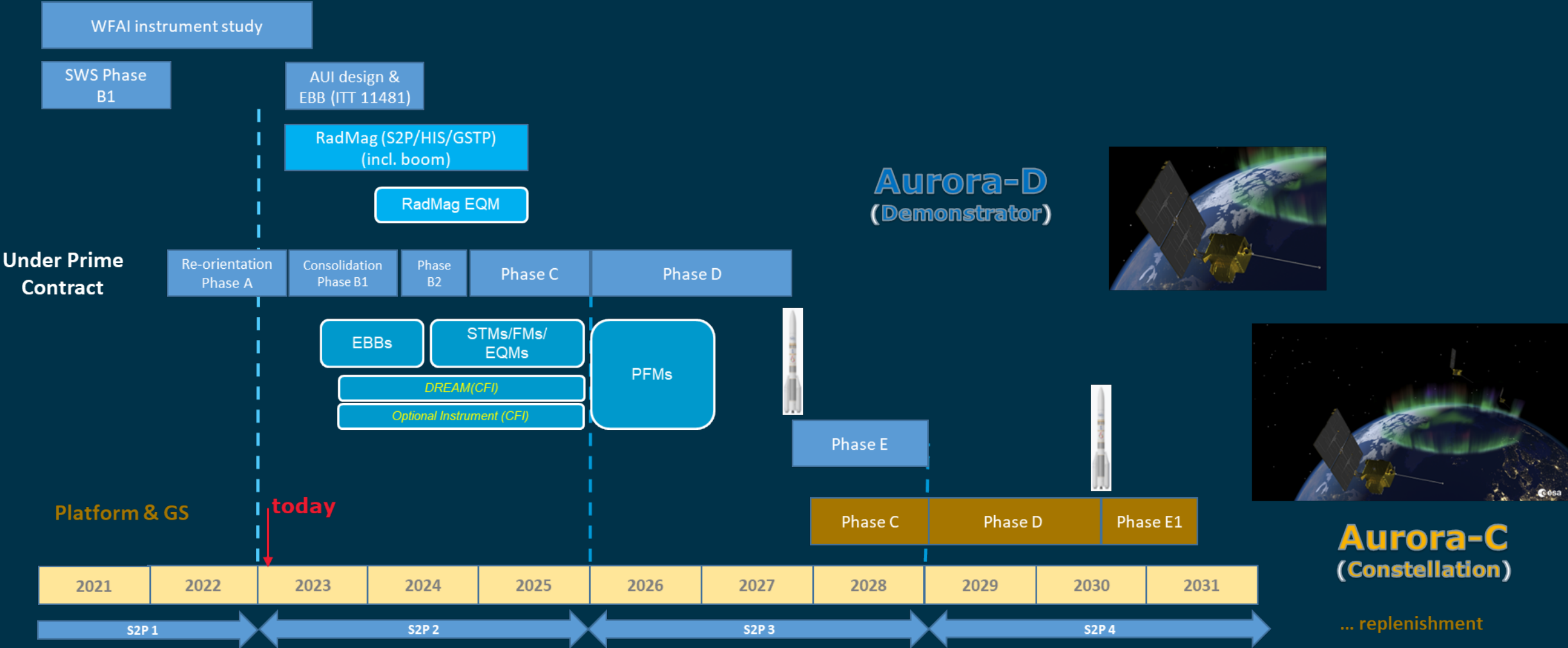
- **Radiation monitor & Magnetometer (RadMag – EK & REMRED)**
- **Note: Urgent boom development required (Astronika – PL)**

Ground segment, operations and data processing

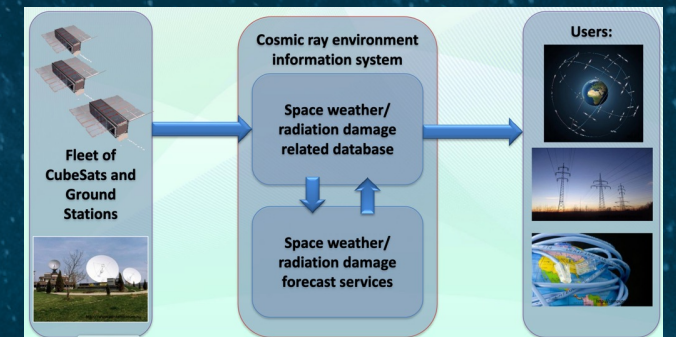
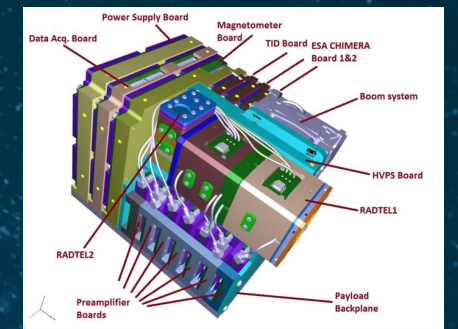
Launch: New European small or micro launchers



Aurora Preliminary Implementation Schedule



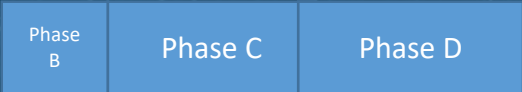
- Hungary is developing expertise for nanosat activities:
 - Instruments
 - Platforms
 - Subsystems
 - Ground segment
 - Full missions
- Participation to ESA's first Space Weather Nanosatellite:
 - monitoring the ionosphere and the radiation belts
 - LEO sun-synchronous orbit
 - providing processed Level 1 data-as-a-service



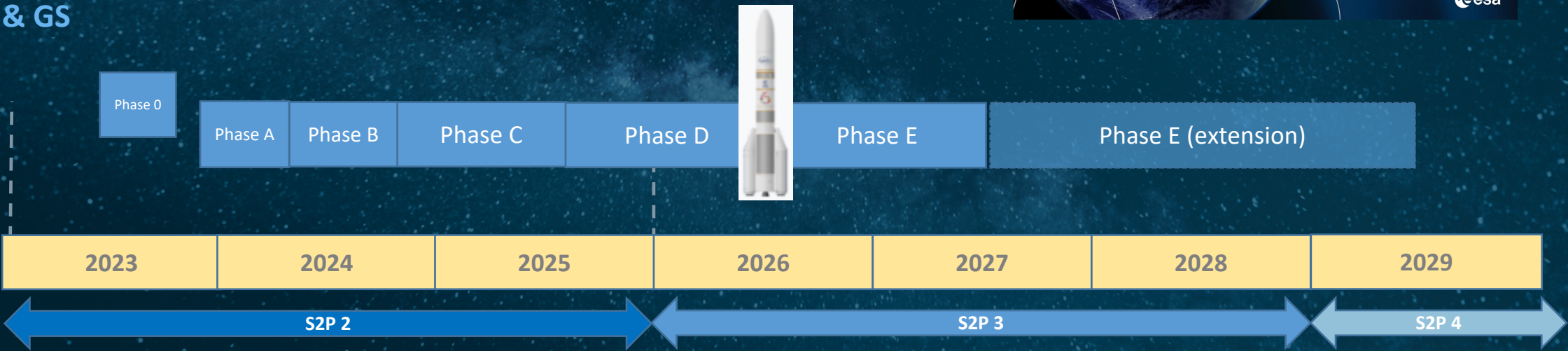
Nanosatellites: Preliminary Implementation Schedule



Instruments Procurements



Platform & GS



Flyeye-1 telescope:

- validation and deployment to site in S2P-P2.

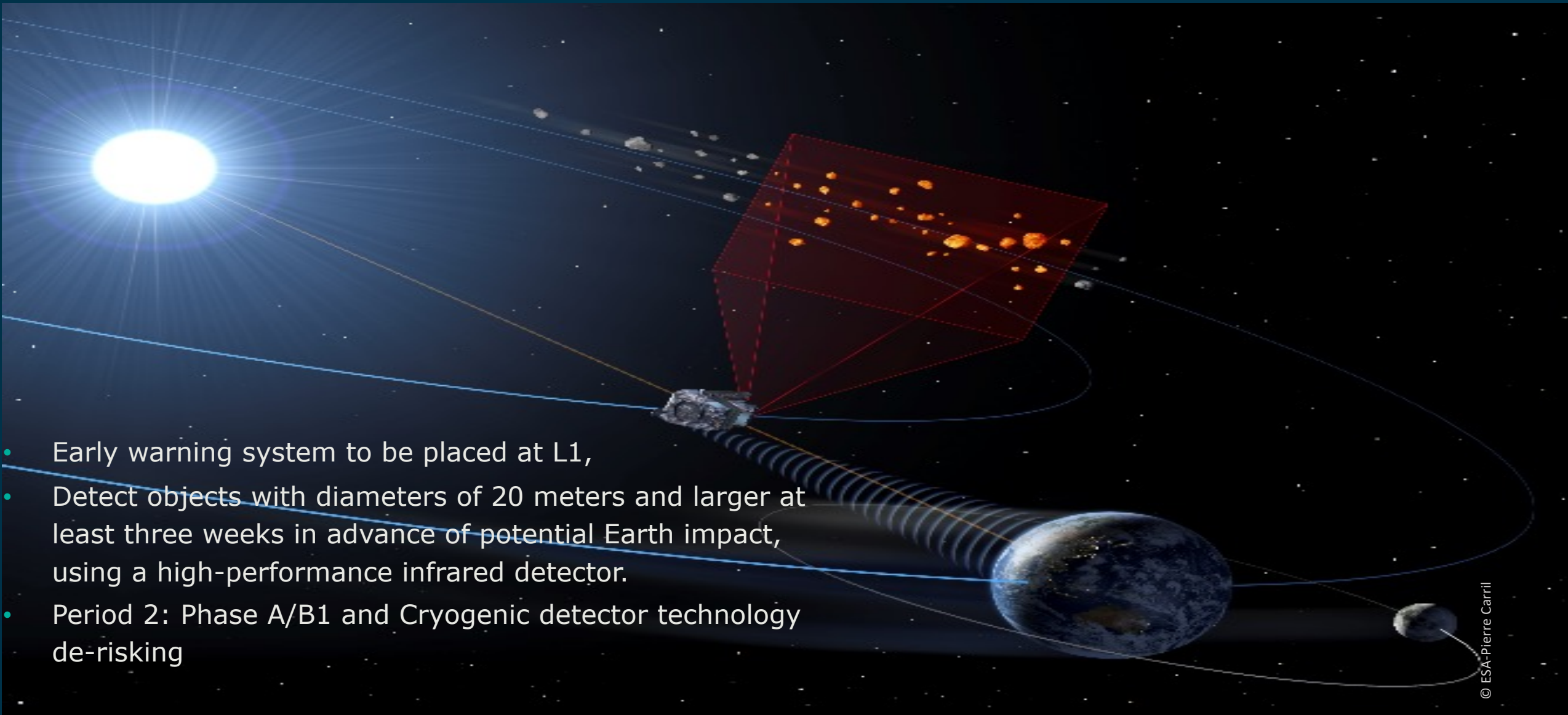
Flyeye-2 telescope (featuring a fully revised design)

- development in S2P-P2, deployment to site in S2P-P3.

[Potential participation in observatory infrastructure design study]



COSMIC: NEOMIR (Near-Earth Object Mission in the Infra-Red)



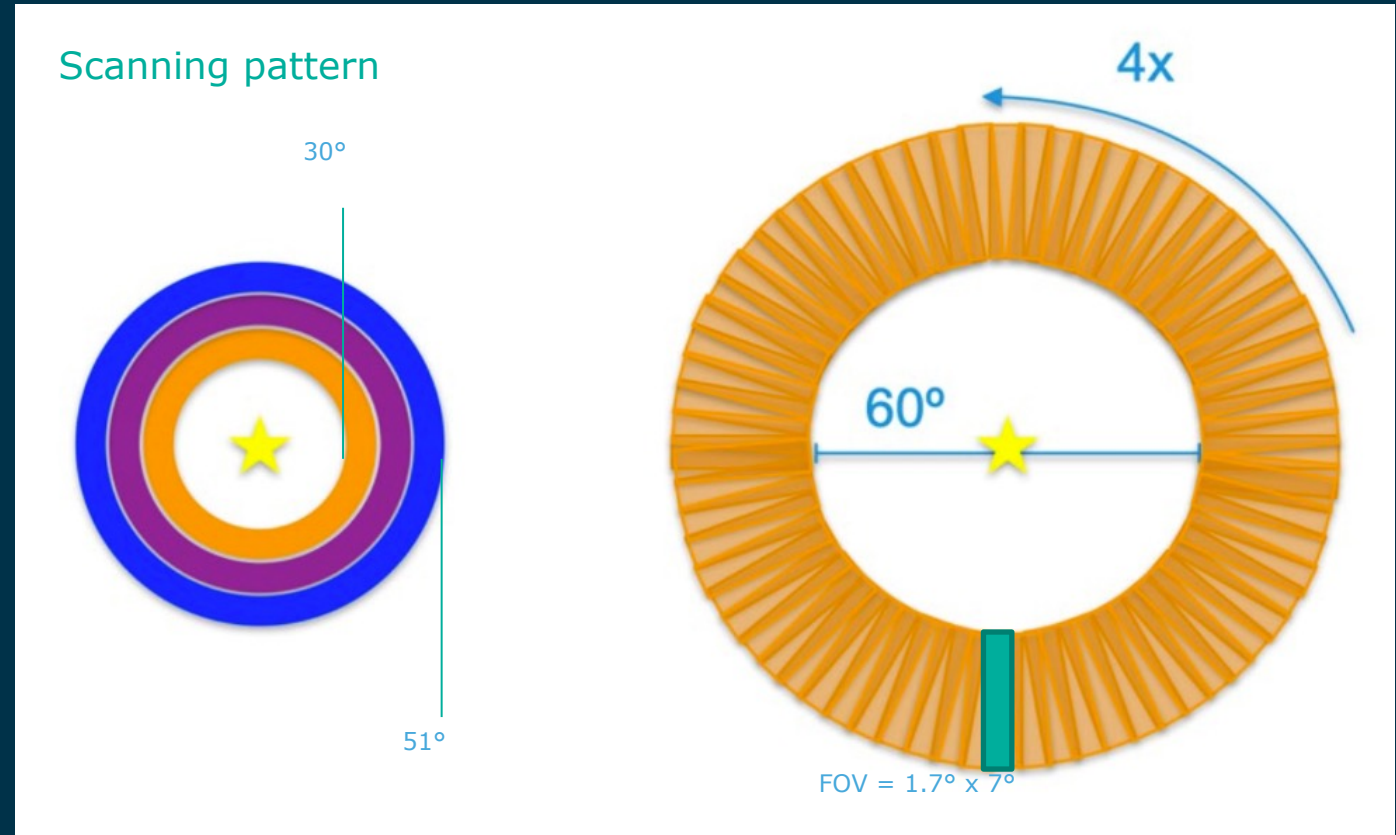
- Early warning system to be placed at L1,
- Detect objects with diameters of 20 meters and larger at least three weeks in advance of potential Earth impact, using a high-performance infrared detector.
- Period 2: Phase A/B1 and Cryogenic detector technology de-risking

© ESA-Pierre Carril

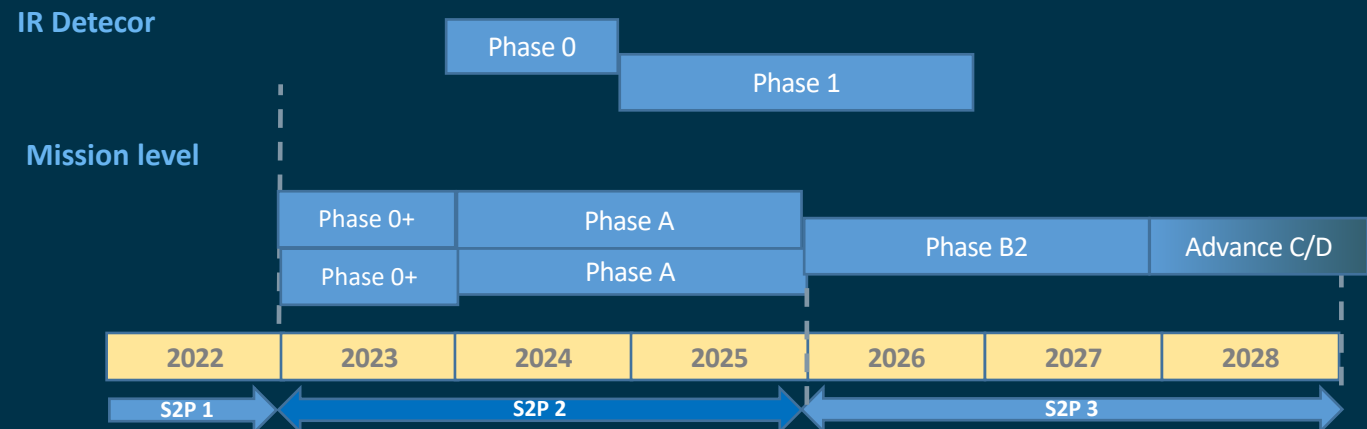


- Field of View: $1.7^\circ \times 7^\circ$
- Scan ~ 3 concentric annular regions around sun in overlapping 60s (stacked) exposures
- Repeat scan of each region 4x to acquire “tracklets” of NEOs
- Total scan time ~ 39 h

→ Detection of NEOs with diameters of 20 m and larger already 3-4 weeks before potential impact



- IR Detector development:
 - End 2023: Phase 0 Study via Preparatory Element
 - 2025 : Phase 1 Study from S2P
- Mission level studies:
 - 2022: contract for creation of a Science Advisory Group [Potential for auxiliary studies on Zodiacal light]
 - 2023: 2x Phase 0+ study from Preparatory Element
 - Currently under negotiation
 - 2024: 2x Phase A/B1 studies
 - 2026: Start of Phase B3 Study (Period 3)
 - 2027+: Start Advance C/D
 - Period 4: Phase C/D(/E)



COSMIC: Apophis Mission Study



- The Apophis mission, named "Satis", will be agile and cubesat-based
- re-use Hera/M-ARGO concepts for a rendezvous mission
- NASA expressed its interest
- Period 2: Phase A/B1



© Mark Garlick/Science Photo Library/Getty Images



COSMIC: Apophis Mission Options

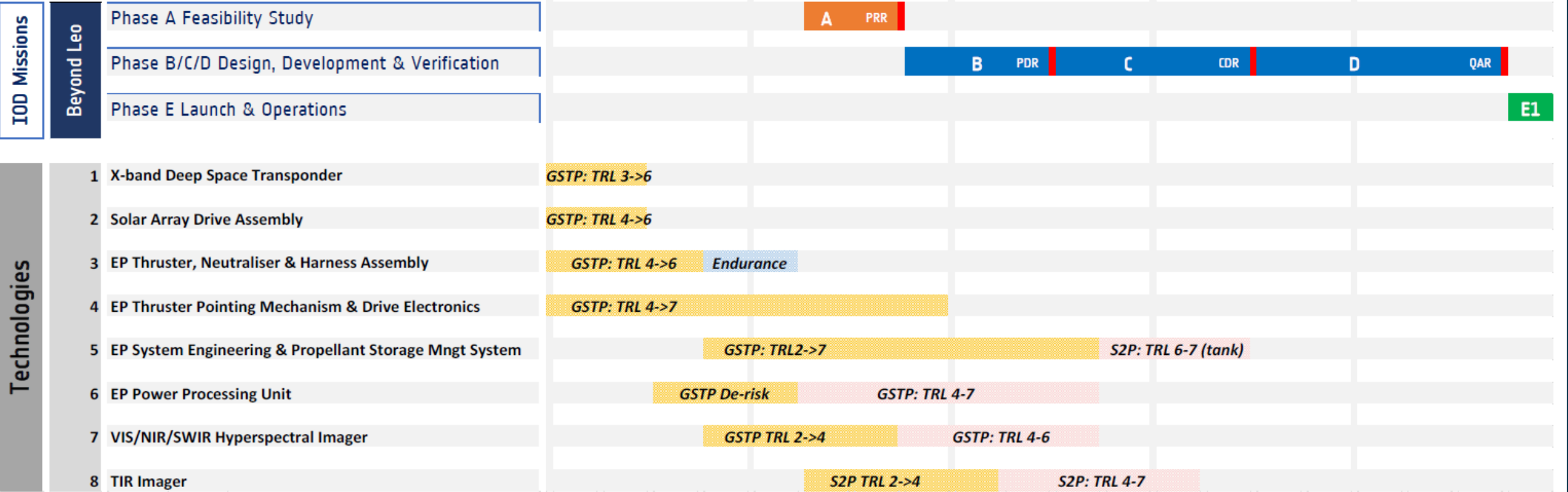
- CDF Study in 2022, evaluating a fast flyby and a rendezvous option
- Rendezvous Scenario chosen for further studies:
 - Heliocentric orbit with rendezvous 1-2 months in advance of close approach to earth.
 - 12UXL Cubesat (baselined to follow closely the M-ARGO design)
 - Baseline Payload:
 - Hyperspectral Imager [Contribution/ Calibration]
 - IR imager
- Launch window ends on 13th May 2027
- Dedicated Launch on Mircolauncher Vehicle
- Upgrade option to larger S/C being evaluated via GSTP under the name RAMSES



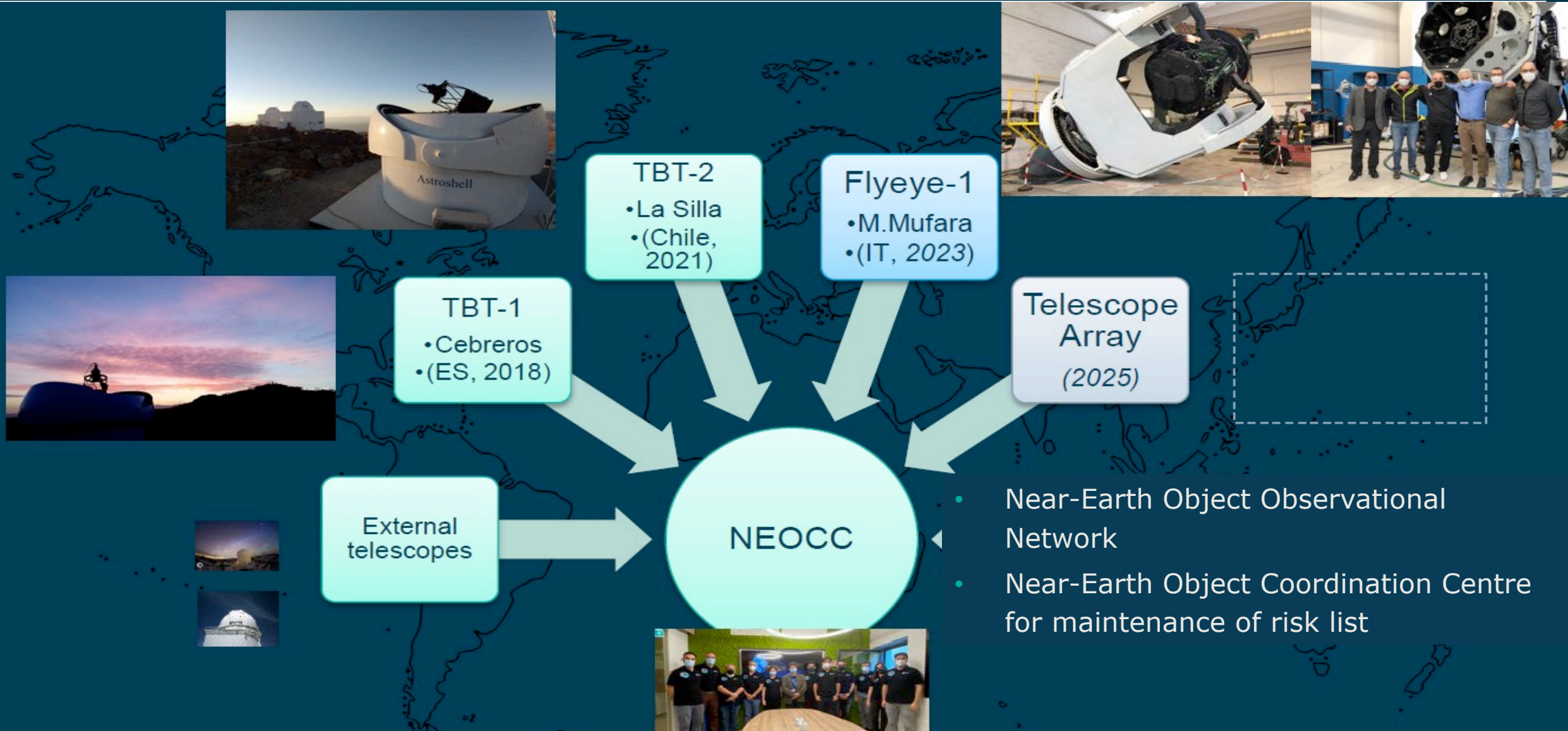
Satis mission Roadmap (Baseline mission)



SATIS RDV SCHEDULE



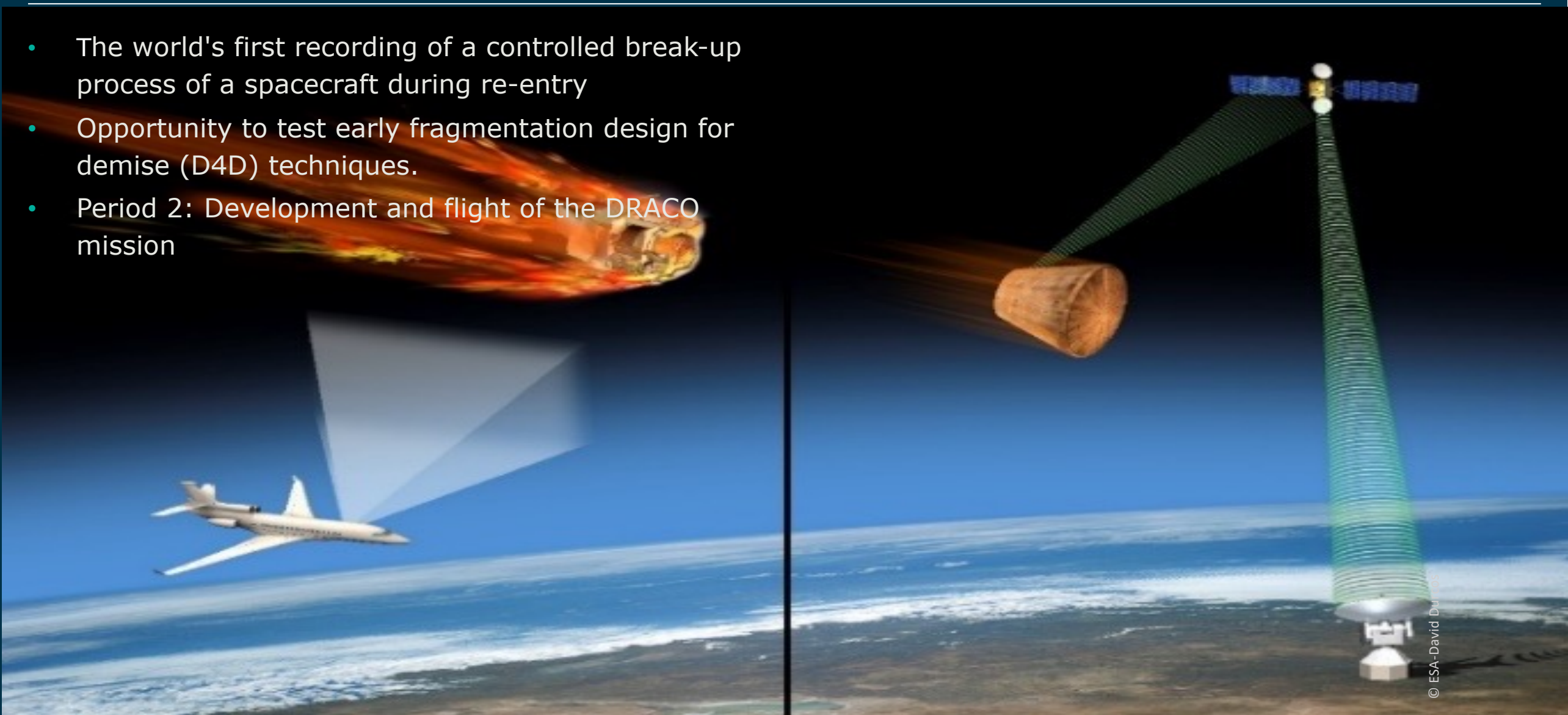
COSMIC: Planetary Defense (Core)



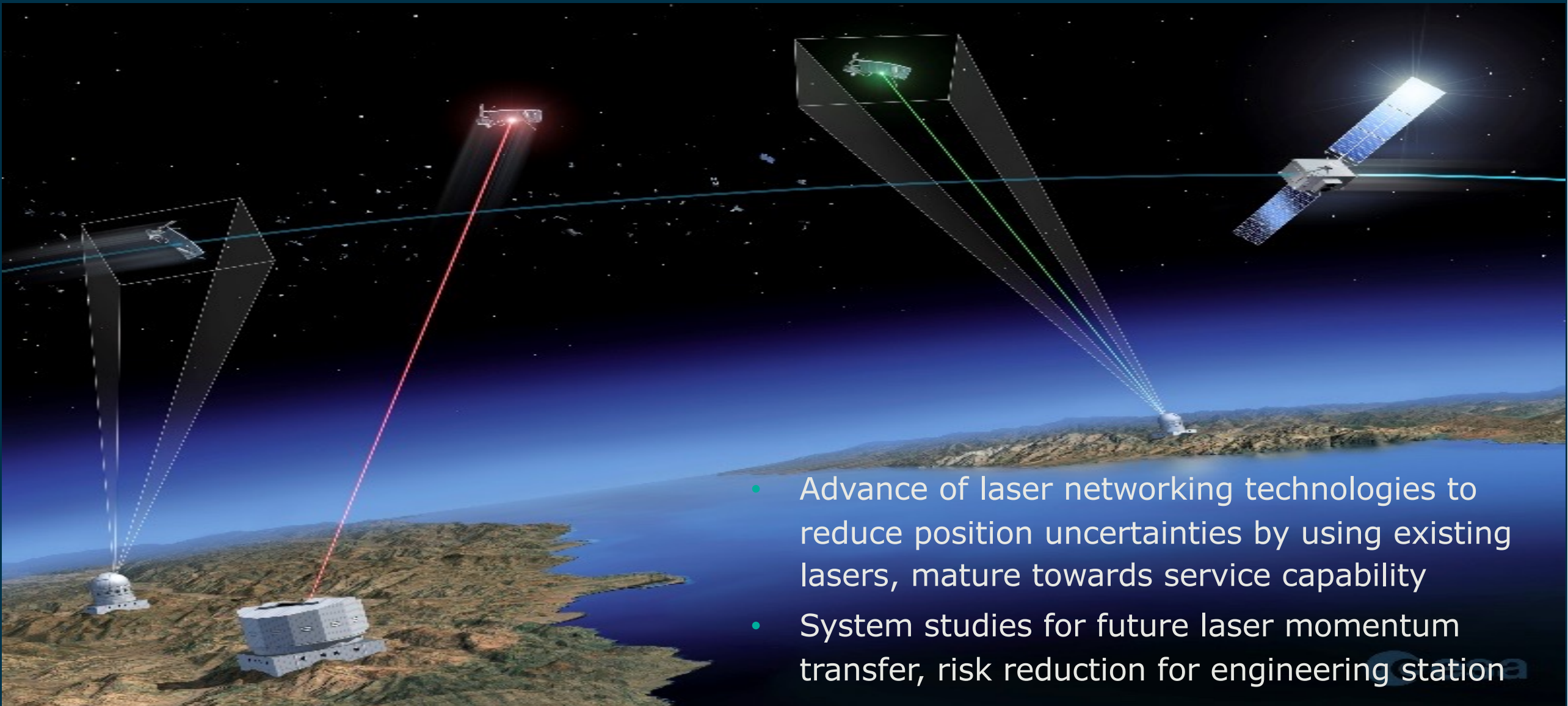
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COSMIC DRACO (Destructive Re-entry Assessment Container Object)

- The world's first recording of a controlled break-up process of a spacecraft during re-entry
- Opportunity to test early fragmentation design for demise (D4D) techniques.
- Period 2: Development and flight of the DRACO mission



© ESA-David Durand



- Advance of laser networking technologies to reduce position uncertainties by using existing lasers, mature towards service capability
- System studies for future laser momentum transfer, risk reduction for engineering station

COSMIC VISDOMS (Verification of In-Situ Debris Optical Monitoring from Space)



- Enhance statistical knowledge about LEO debris by detecting and characterising objects with a diameter of 1 mm or larger.
- Period 2: hosted payload mission and preparation of a dedicated small satellite mission.
-



© ESA-Jacky Huart



-
- bit demonstration
icated satellite)
- sent.
risk ...
- ating burn.

Space Debris (Core) with **HU opportunities (TBD)**



34 000 objects
900 000 objects
128 million objects
2000 billion objects

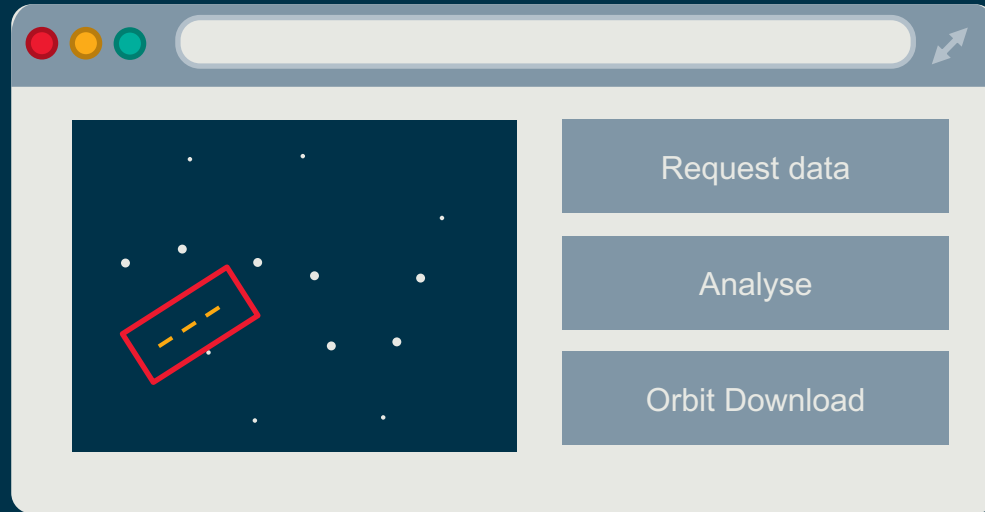
- Further development, tailoring, and incorporation of user contributions to the **Core Software**
 - **Hosting of the community platform**
 - Support community efforts
- Method developments for **space debris consequence analyses** and space capacity management
 - Focus on algorithm improvements for on-orbit risk and definition of critical capacity level
 - Align with CREAM developments for short term risks
 - Target **knowledge gap on small debris (untracked) debris models**, e.g. through a generic break-up model for **improved risk assessments**
 - Support definition and establishing “zero debris policy”, i.e. inclusion of associated Zero Debris Policy elements from the CDF studies
- **Small particle sensors** (DISCO= Innovative large detector surface in orbit)
 - **Phase A/B1**
 - Technology risk reduction to complement commercially proposed small detectors (DEBIE-like)
- Fostering **space debris observation** capabilities (see SC-09/18 with AstroTech)
 - Finalisation of the Expert Centre development and test operations with focus on **attitude cataloguing** and to assess needs for **cis-lunar activities**
 - Related observations support for sub-catalogue data
 - Collaborate in international remote re-entry observation campaigns, i.e. novel detectors for air pollution and improve ground based all-sky systems for spectrographic data acquisition



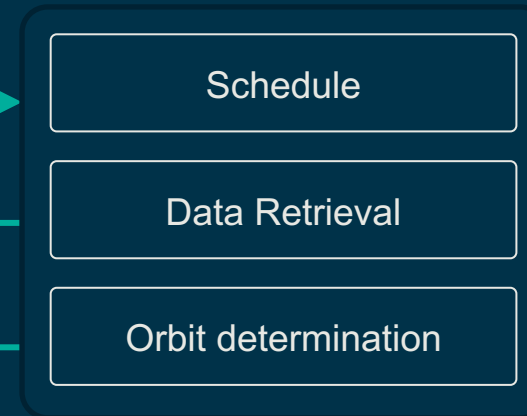
S1-SC-09/18: Efficient networking of optical telescopes

Objective: Demonstrate, test and validate, a complete customer/user-driven end-to-end process

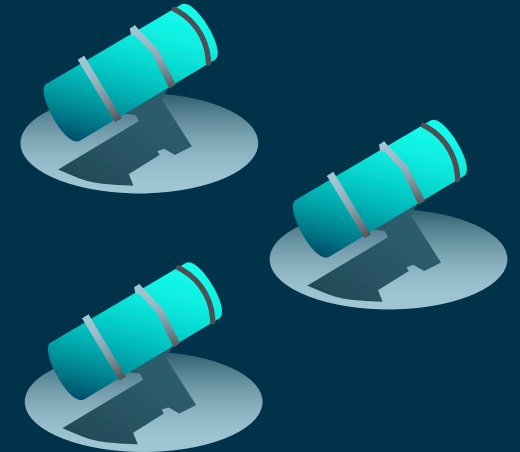
User interface



*Networking /
Coordination*



*Installation /
Upgrades*





→ REDUCING IMPACTS

→ SPACE DEBRIS REDUCTION





To understand how much space activities pollute on Earth and to identify alternatives to reduce the environmental impacts

1. LCA (Life Cycle Assessment)

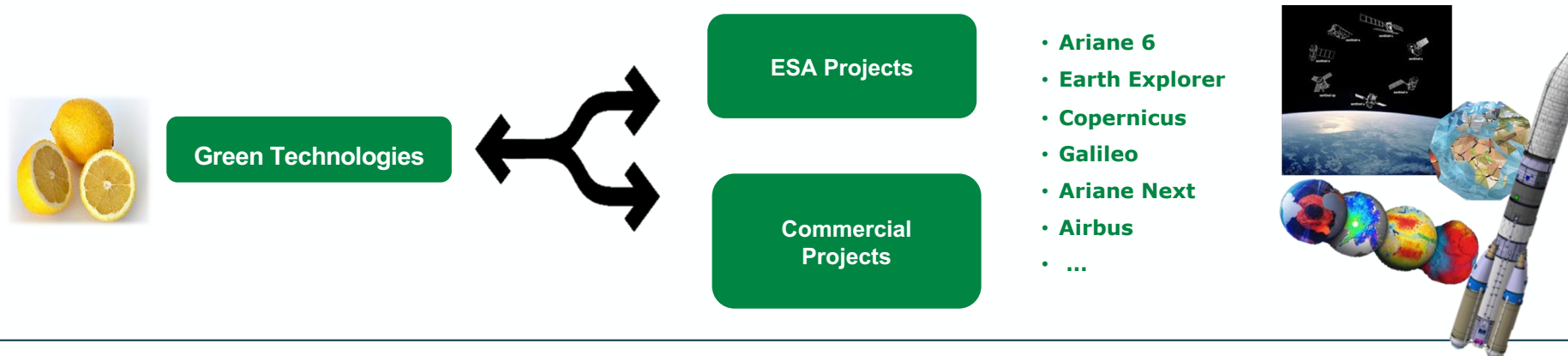
Assessing the environmental impact of the space missions during the whole life cycle

2. Eco-design

Identifying alternative processes or technologies that can be used to reduce these impacts

3. Environmental regulation

Find alternatives to avoid costly disruptions and reply to legislations





“In ESA we are implementing a policy that by 2030, we have a ‘net zero pollution’ strategy for objects in space, by consistently and reliably removing them from valuable orbits around Earth immediately after they cease operations. We need to lead by example here.”

ESA Director General, Josef Aschbacher

Zero Debris CDF Study

Technical Recommendations Summary

1

Definition of valuable orbits



- Extend orbital protection to other earth orbits e.g. **GNSS operational orbits**

* final numerical values under consolidation

2

Guarantee successful disposal



- Improve probability of successful **self-disposal**
- **Prepare for removal**
- **Removal services**

3

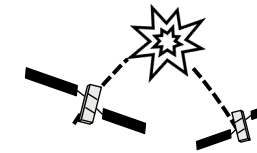
Improve orbital clearance



- **Reduce time** left in protected regions **below 5 years ***
- Improve clearance in **other Earth orbits**

4

Avoid in-orbit collisions



- Improve **collision avoidance strategy**
- Cumulative **probability of collisions after EoL** $< 10^{-3}$ *
- Share **maneuver data**
- Improve **trackability**

5

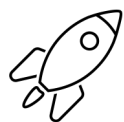
Avoid internal break-ups



- **Mandatory** passivation features
- **0.99 *** probability of **successful passivation**

6

Prevent intentional release of space debris



- **Prevent release** of launcher related objects and interference with valuable orbits

7

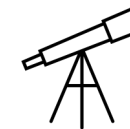
Improve on-ground casualty risk assessment



- Standardize models and methods to assess demise
- **Impact on ground** of launcher related objects

8

Guarantee dark and quiet skies



- Mitigate impacts on **ground astronomy**



In the coming months, several new studies, technology developments and platform developments will be released, the activities being distributed in S2P and other ESA programmes: Discovery, TDE, ARTES, EOP

Objective: Copernicus will adopt the space debris mitigation regulations, but will also embark technologies the support capture and removal from orbit in the case of failure.

Markers to Support Navigation (MSN)

2D markers and 3D markers to help relative navigation (attitude, distance, velocity, etc.)

Mechanical Interface for Capture (MICE)

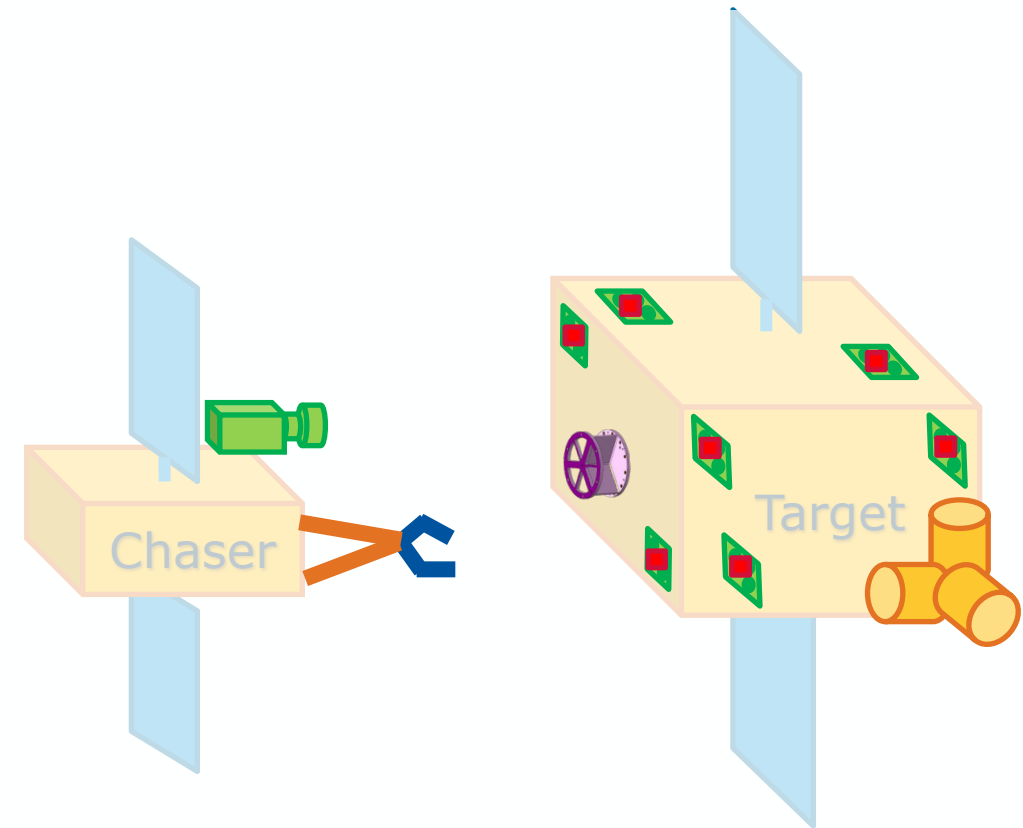
Passive interface on satellite for capture

Passive Magnetic Detumbling (PMD)

Passive magnetic detumble at EoL

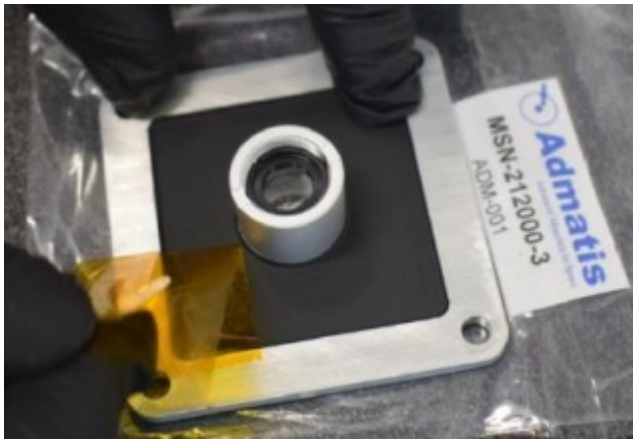
Retroreflector-based Attitude Determination System (RADS)

LRR embedded on 2D Markers to enhance ground based attitude reconstruction





Admatis awarded a contract to develop and qualify 2D and 3D markers, to reach TRL7 in 2023. Enabling adoption of the technologies for ESA's Copernicus missions.



2D Marker



3D Marker



Future Opportunities:

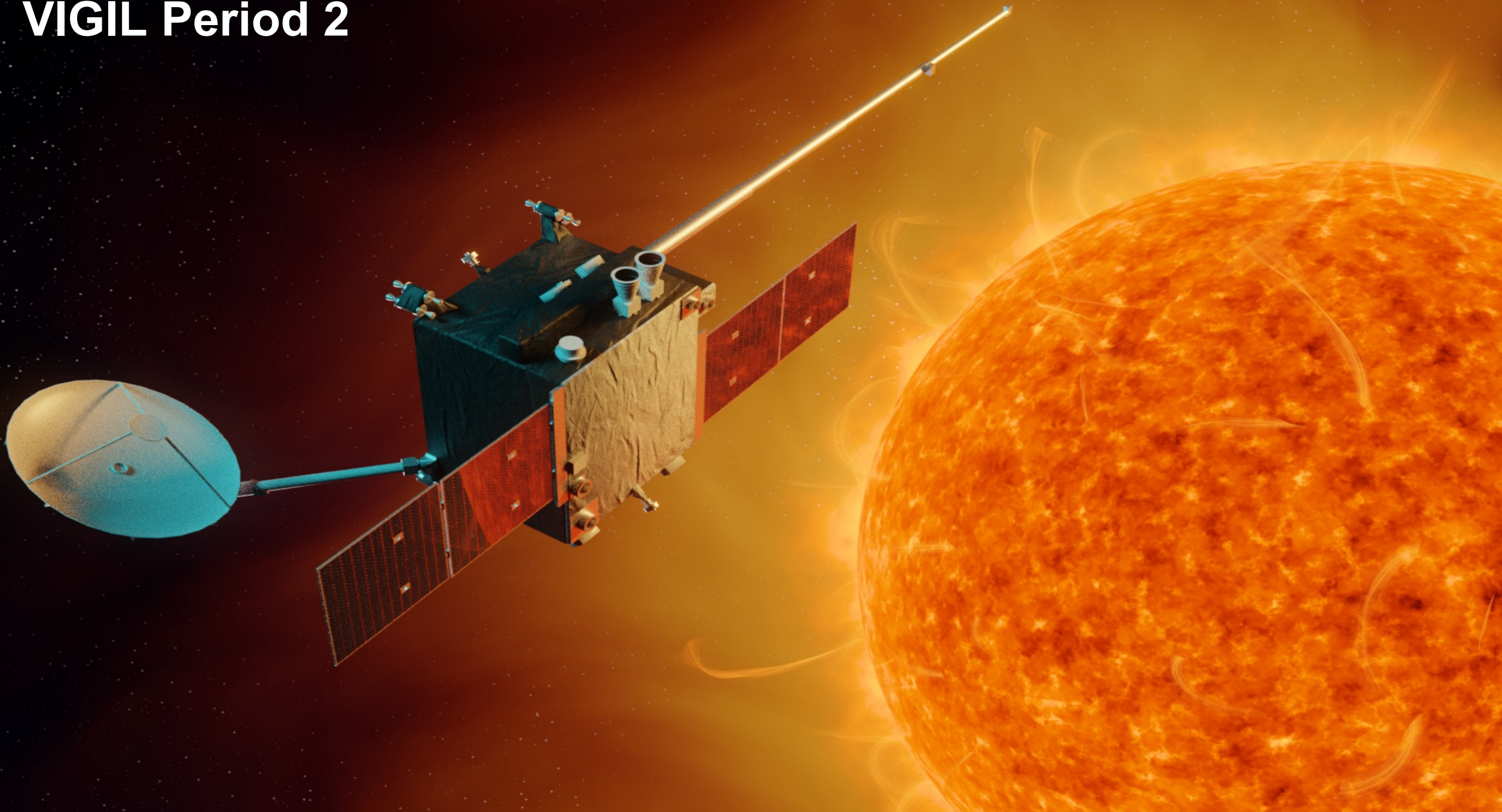
- Capture Payload Bay Part 2, on-ground validation and verification D4R – **Clean Space Core**
- Design for removal equipment development and qualification (e.g. MEO/GEO rendezvous markers) – **ARTES and EOP**

Competitiveness Segment

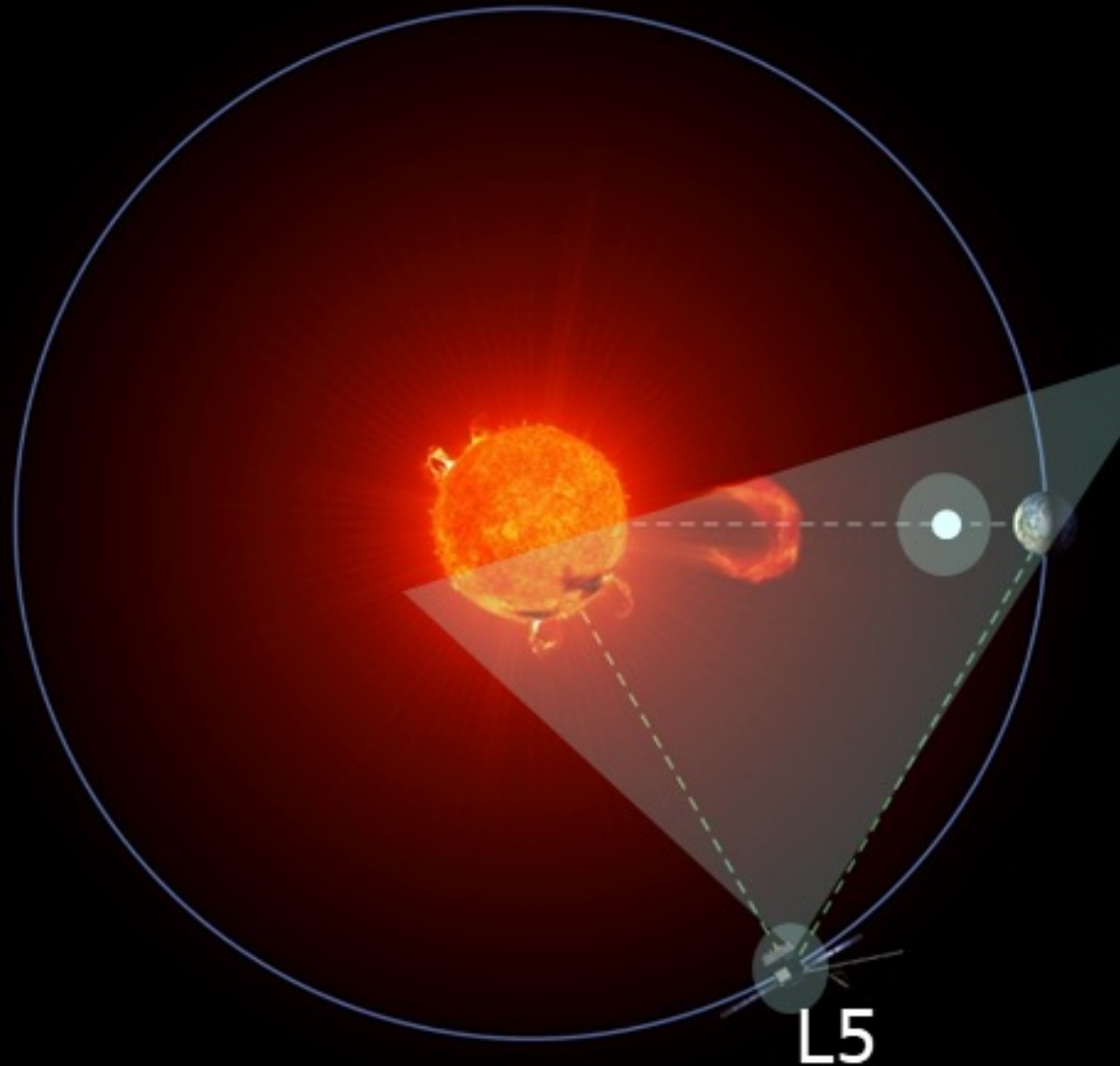
- Support the last mile efforts in developing a product/service for the space safety market
- ESA will act as a trial user and early adopter of the industry's products/services to reduce business risks.

- Open Call or Proposals
- To be available through ESA's OSIP web portal
- TRL 6 required
- Outline proposal + full proposal
- Support from MS needed

VIGIL Period 2

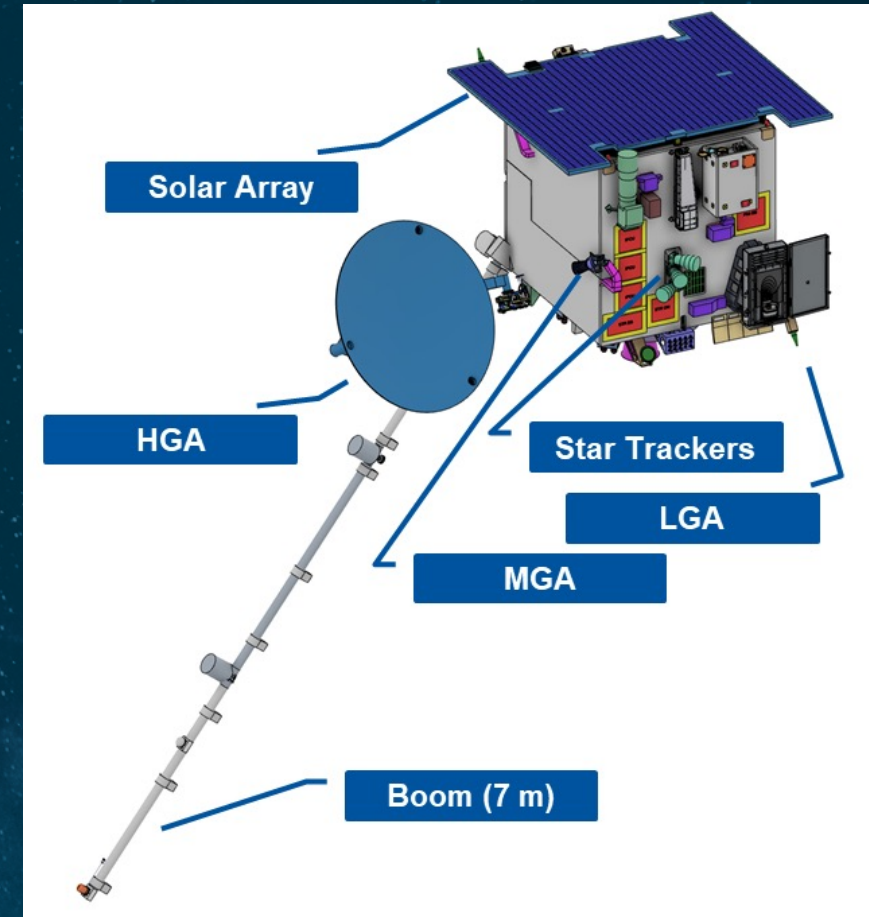


VIGIL Period 2

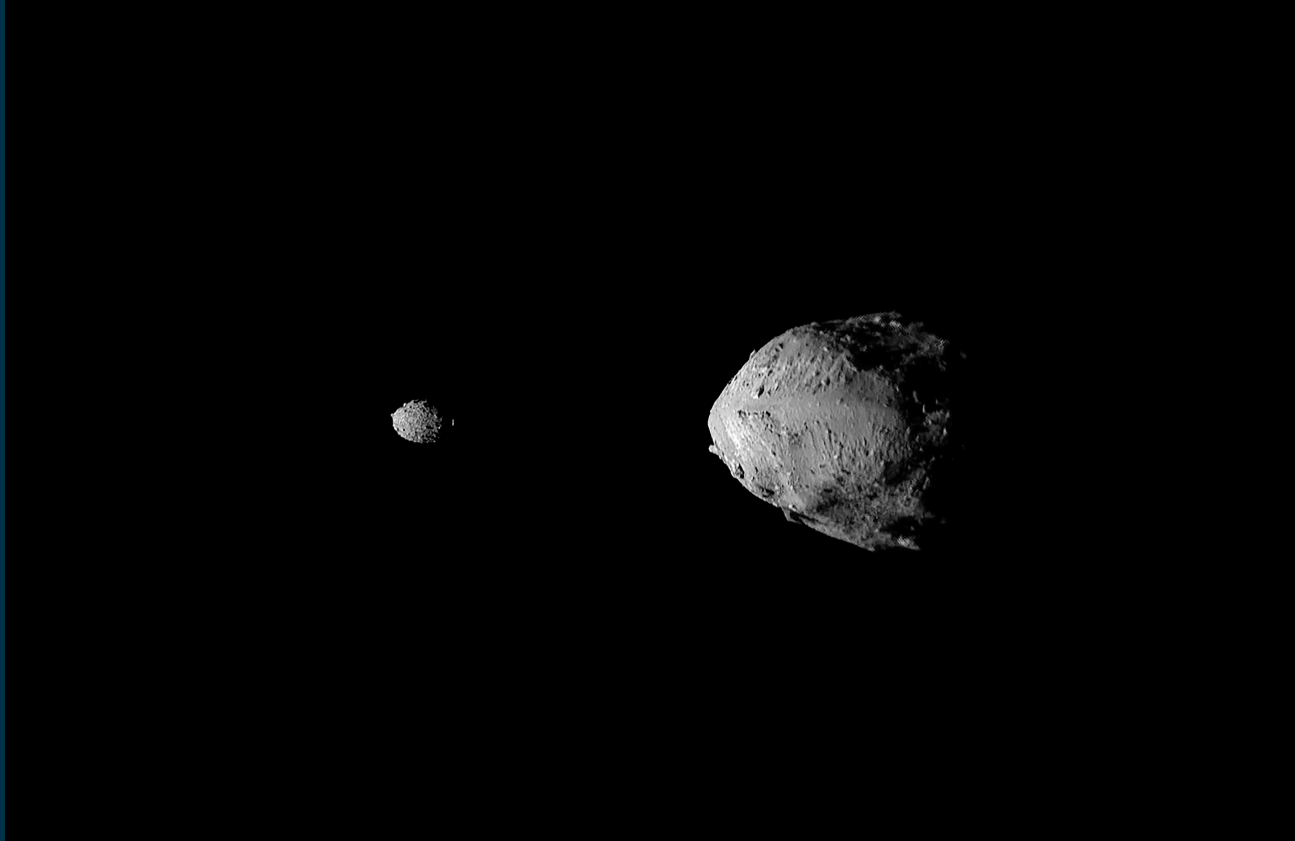


The following main satellite elements are to be developed

- EGSE Test Bench (incl Harness)
- instrument processing units
- simulator developers
- Magnetometer boom
- High Gain Antenna (HGA) and mechanism, Medium Gain Antenna, Low Gain Antennas (LGAs)
- Star Trackers, Reaction Wheels
- On-board Computer
- Remote Interface Unit
- Power Control and Distribution Unit
- Communication system
- Instrument CDPUs
- Ground segment



Hera and DART



Dimorphos

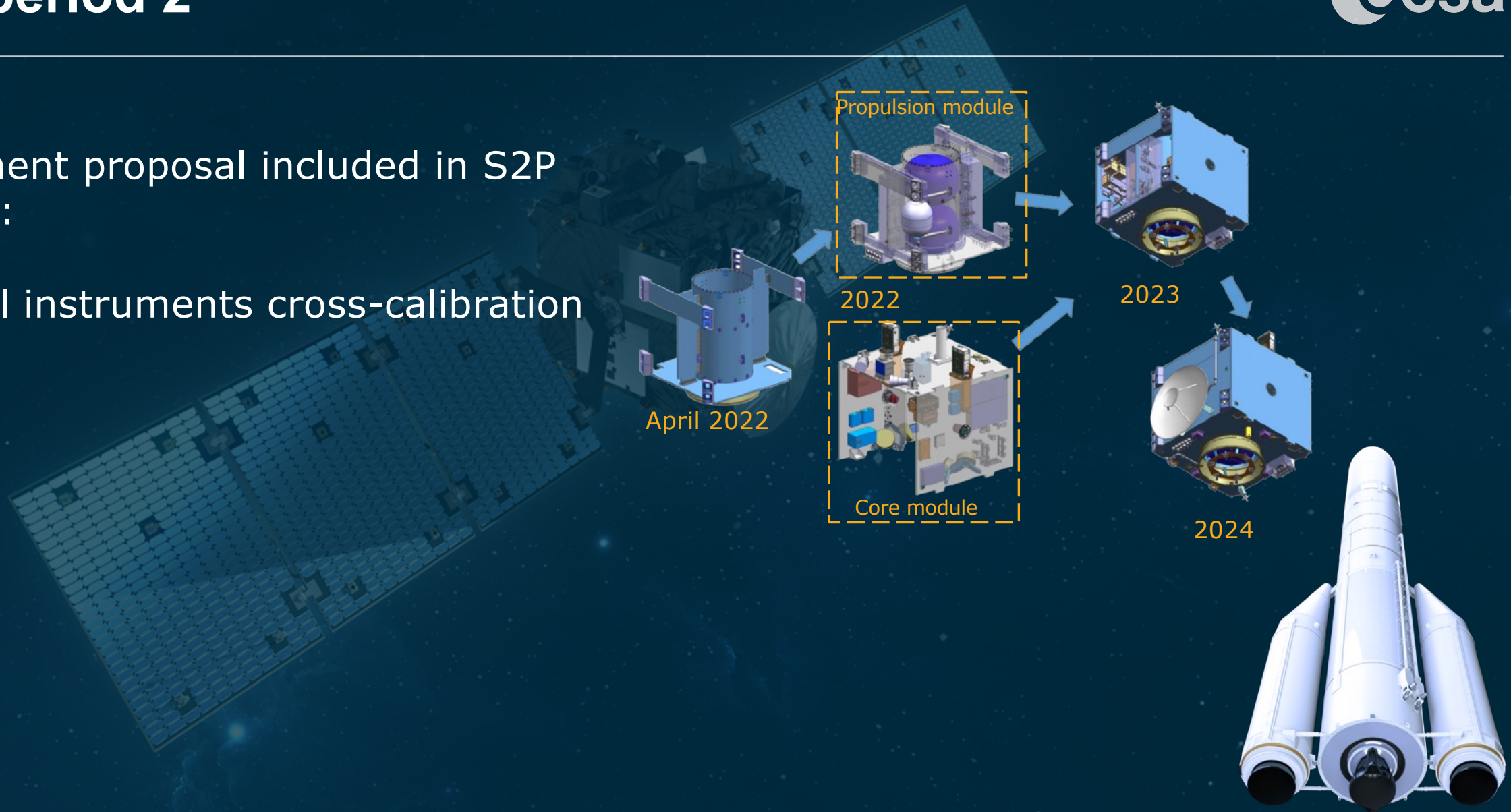
Hera



Launch, operations, cubesat MOC and Science

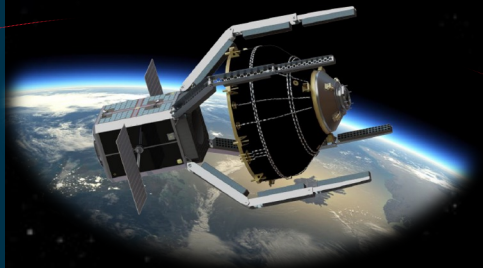
Procurement proposal included in S2P workplan:

- Optical instruments cross-calibration



ADRIOS / Circular Economy in Space

DEBRIS REMOVAL



TRANSPORTATION



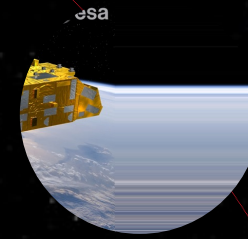
INSPECTION



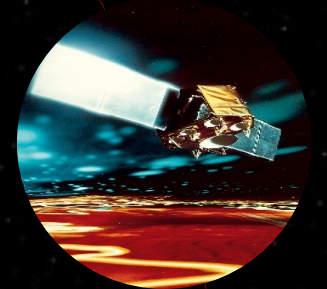
REFUELLING /
AOCS TAKEOVER



REFURBISHMENT



RECYCLING



ASSEMBLING /
MANUFACTURING



ClearSpace-1

2025

In-Orbit Servicing Mission(s)

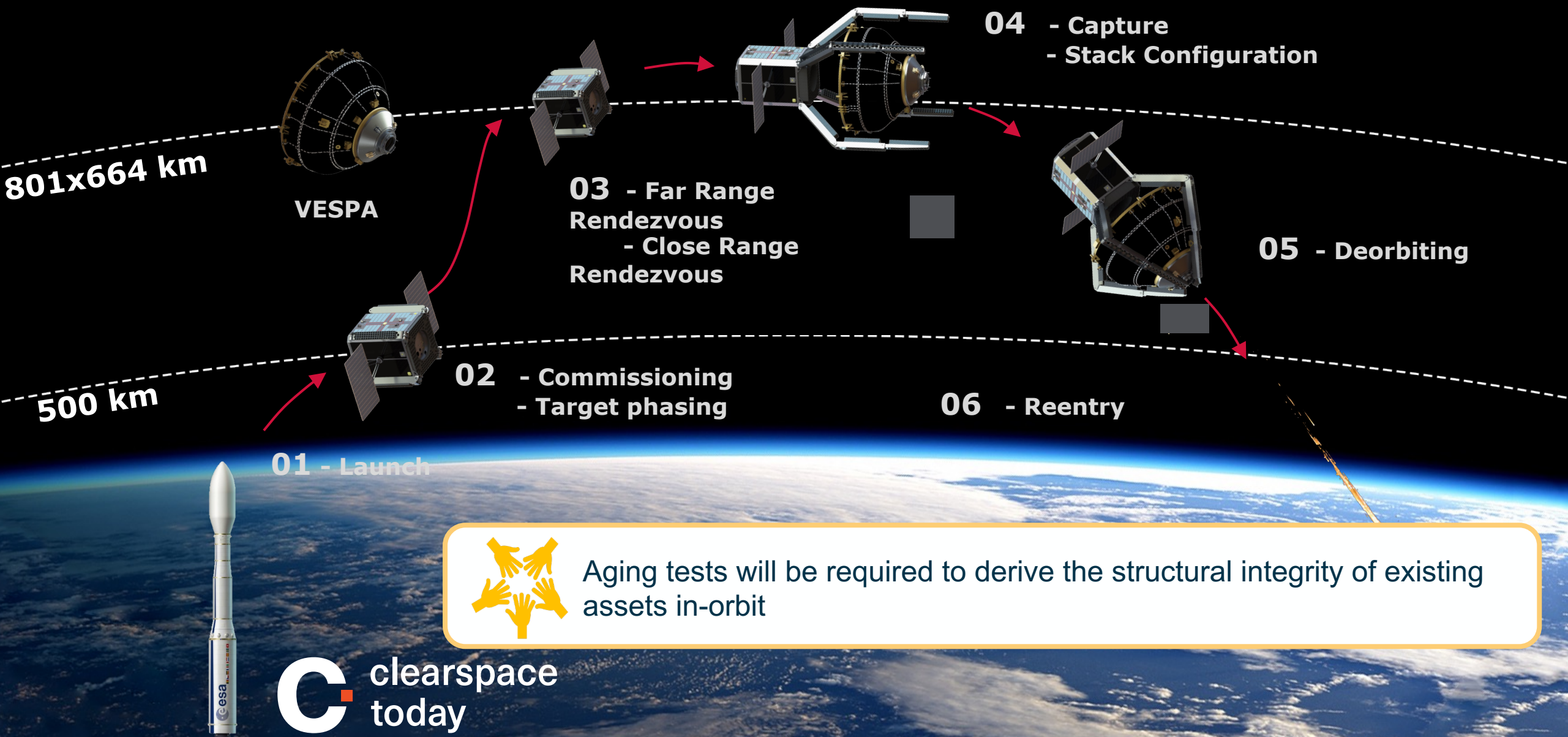
2030

2030 +

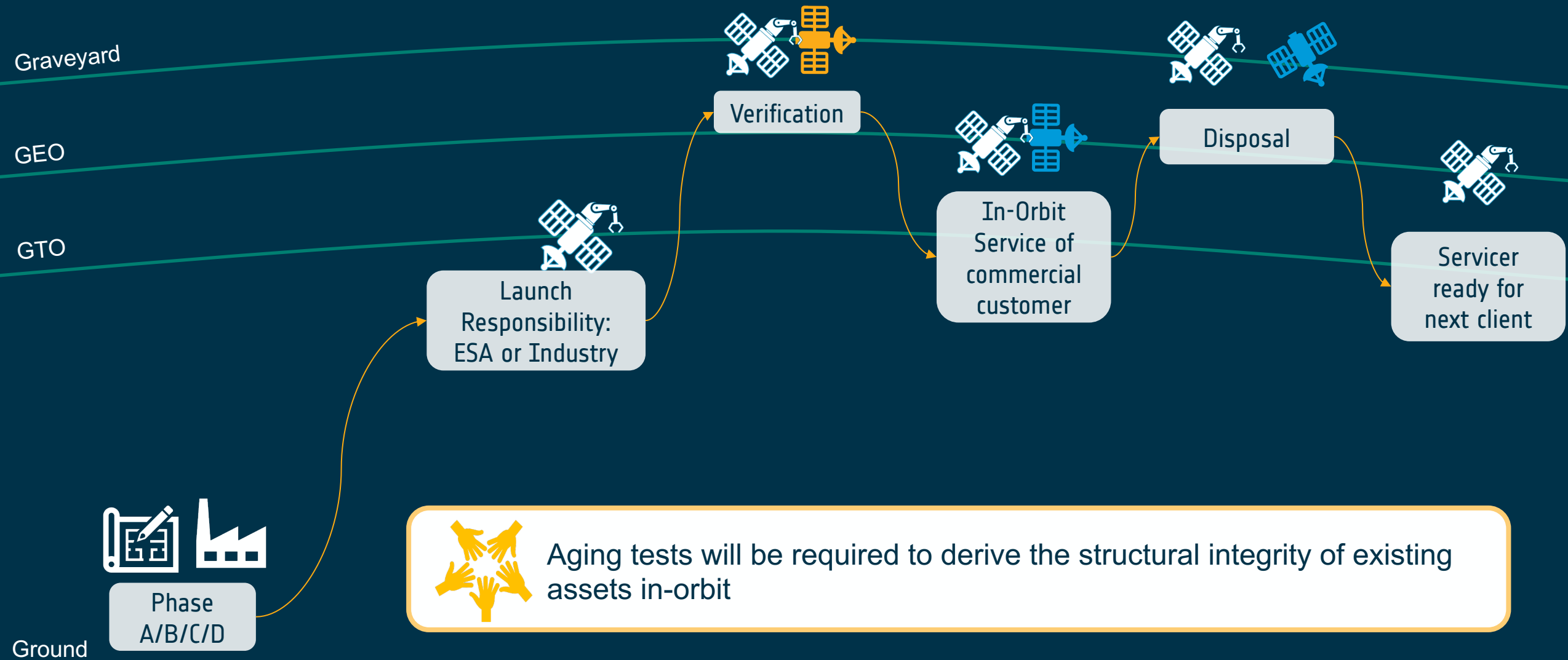


ESA will work on preparing future IOS missions moving towards a circular economy in space distributed amongst different ESA Programmes; S2P, Discovery, TDE, ARTES

ClearSpace-1



Commercial In-Orbit Servicing Mission(s)



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