Welcome to the Space Safety Industry Day 2024

ESA S2P Team

28 November 2024

PROTECT ASSETS FROM SPACE HAZARDS

Protection of our planet, humanity and assets in space
and on Earth from hazards originating in space

AGENDA

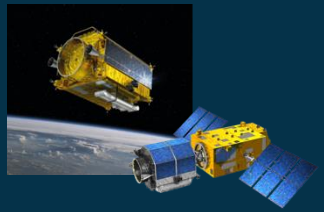
9.00	Space Safety Overview	Holger Krag, Head of ESA's Space Safety Programme
9.20	ADRIOS Cornerstone: Clearspace-1	Christian Steimle, Clearspace-1 Project Manager
9.30	ADRIOS Cornerstone: Rise	Andrew Wolahan, Rise Project Manager; Diego Garcés de Marcilla, D-Orbit
9.40	VIGIL Space Weather Cornerstone	Giuseppe Mandorlo, Vigil Project Manager
10.00	RAMSES Planetary Defence Cornerstone	Paolo Martino, Ramses Project Manager
10.20	COSMIC Space Weather Services	Juha-Pekka Luntama, head of ESA's Space Weather office
10.40	COSMIC Space Weather Sensors	Juha-Pekka Luntama, head of ESA's Space Weather office
10.50	COSMIC Space Weather Sensors: Aurora	Stefan Kraft, Aurora's project manager
10.55	COSMIC Space Weather Sensors: Nanosat	Melanie Heil, Space ESA's Weather Space Segment coordinator
11.00	Networking Coffee	
11.20	COSMIC Planetary Defence	Richard Moissl, head of ESA's Planetary Defence office
11.40	COSMIC Space Debris	Tim Flohrer, head of ESA's Space Debris office
11.55	COSMIC Space Debris: Visdoms	Stefan Kraft, Visdoms project manager
12.00	COSMIC Towards a Clean and Zero Debris	Tiago Soares, ESA's Clean Space lead engineer
12.15	COSMIC Towards a Clean and Zero Debris: CAT	Tiago Soares, ESA's Clean Space lead engineer
12.20	COSMIC: Competitiveness	Tim Flohrer, head of ESA's Space Debris office
12.40	Wrap-up	Holger Krag, head of ESA's Space Safety Programme
13.00	Lunch break	
14.00 to 19.00	B2B meetings	

S2P Period 3 Proposal: high-level structure

S2P Period 2

Hera

ADRIOS (CS-1, RISE, ENCORE)



Vigil

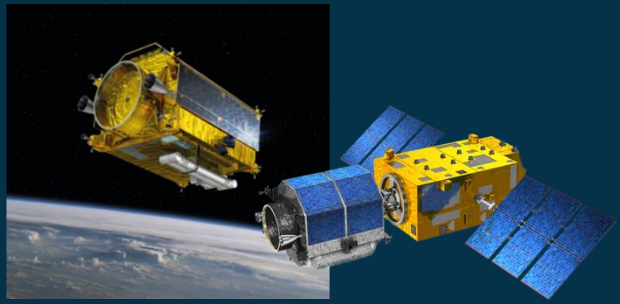
COSMIC

Reorganised
75% Continuation
25% New

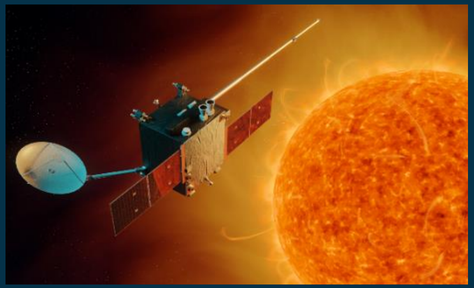
S2P Period 3

Planetary Defence Cornerstone (RAMSES)

ADRIOS Cornerstone (CS-1, RISE, ENCORE)



Space Weather Cornerstone (Vigil)

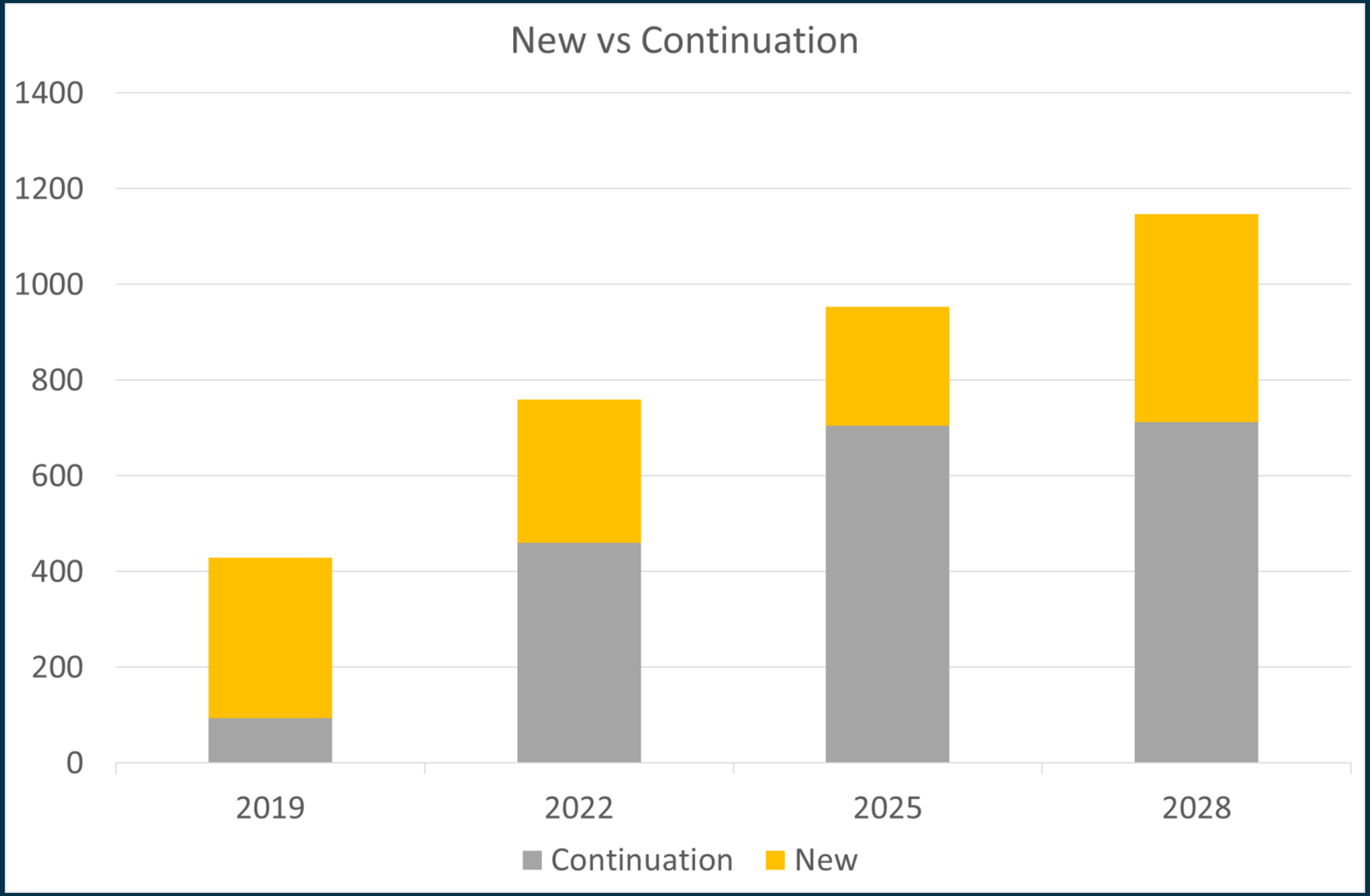


COSMIC

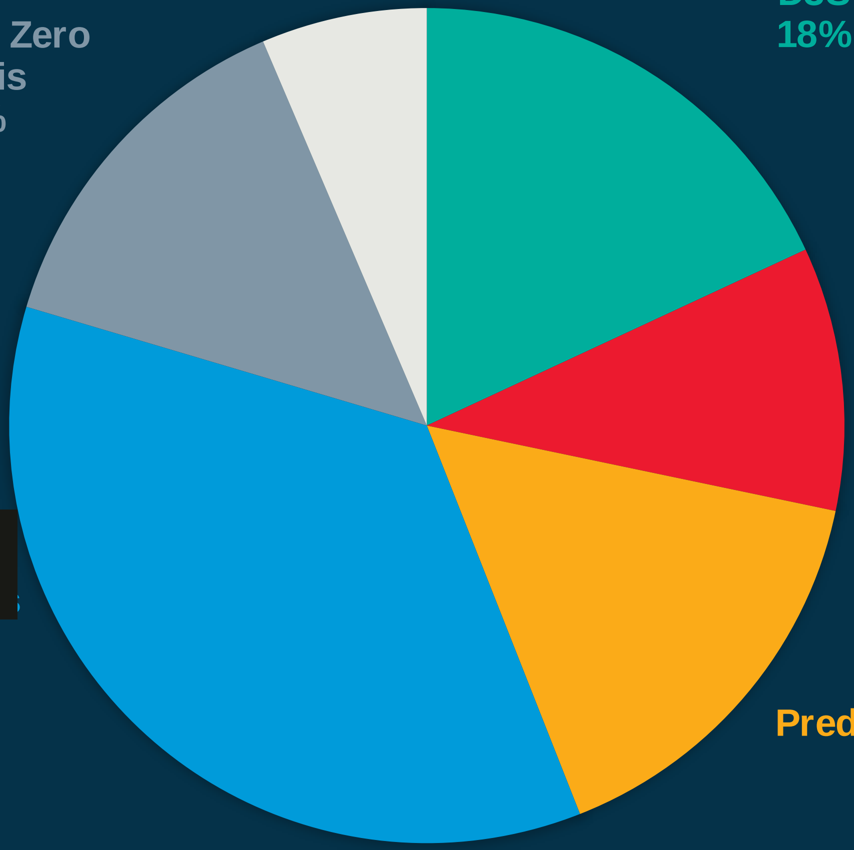
S2P – New vs Continuation

Key Aspects:

- Funds for Continuation would rely on repeating the output of CM22
- New subscription target assumes additional 300M (300M has been the increase of the past 2 Ministerials)



COSMIC Draft Breakdown



Space Weather D3S

- Aurora
- Nanosat
- Nanosat PL
- Nanosat X
- SWE GTO mission

Towards Zero Debris

- Core CS
- LEO Platforms Evolution
- ECO-SAT IOD
- CAT
- De-Orbiting Kit
- Circular Economy

Space Weather Services

- Core SW, incl. PDC
- SWE Service Network, incl. R2O(2R)

Space Traffic Technologies

- VISDOMS
- Core SD
- SBOM
- DRACO
- CREAM
- Laser
- SAILOR
- Cis-Lunar ST (LUMOS)

Predicting Asteroid Impact

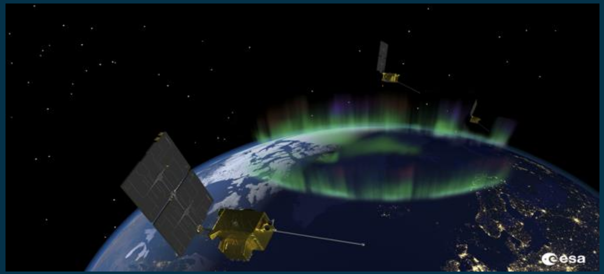
- NEOMIR
- FlyEye #2 and #3
- NEOCC Ops and Obs
- Core PD

New vs Continuation

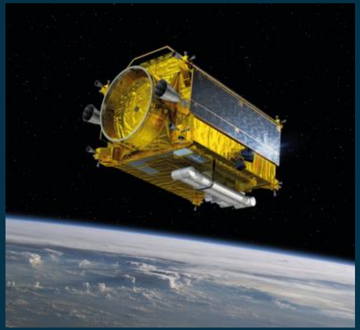
RISE

RAMSES

VIGIL

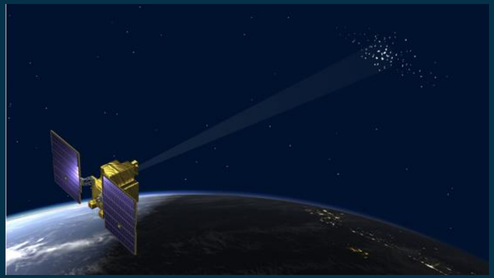


AURORA

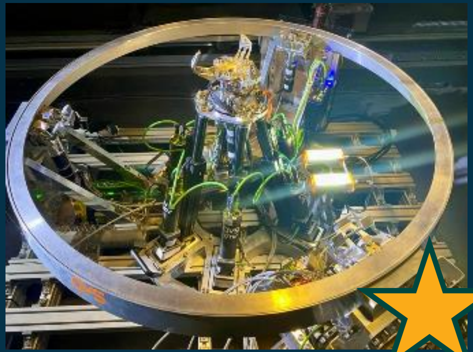


ENCORE

FLYEYE #3



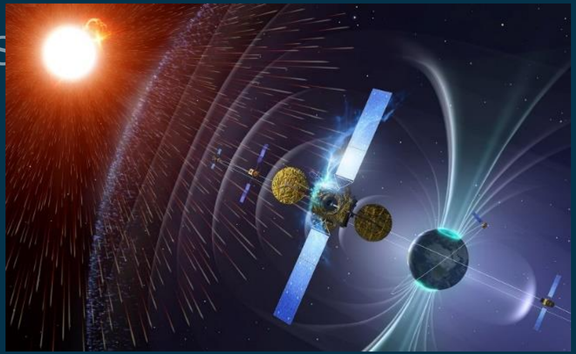
VISDOMS

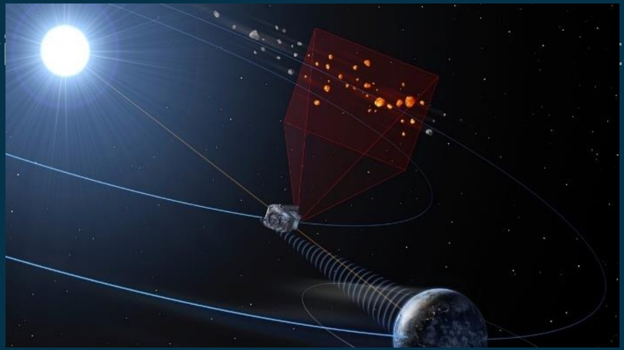


CAT

NANOSAT #2

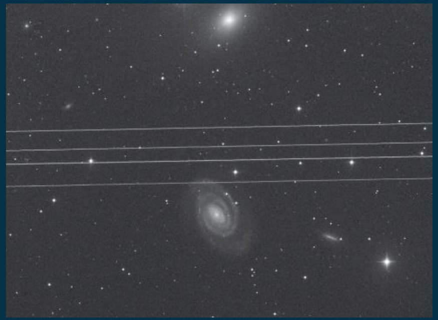
Mission Studies (26.1M€)





NEOMIR: Operational Infrared NEO Observatory at L1

LUMOS: Surveillance of cis-lunar space traffic

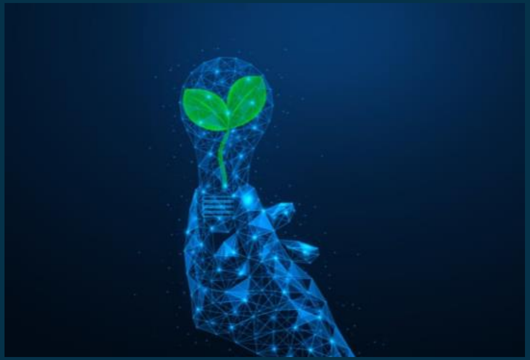


SBOM: Space-based Optical Mission

Space Weather Nanosat #3

SATIS: Small Asteroid Inspector

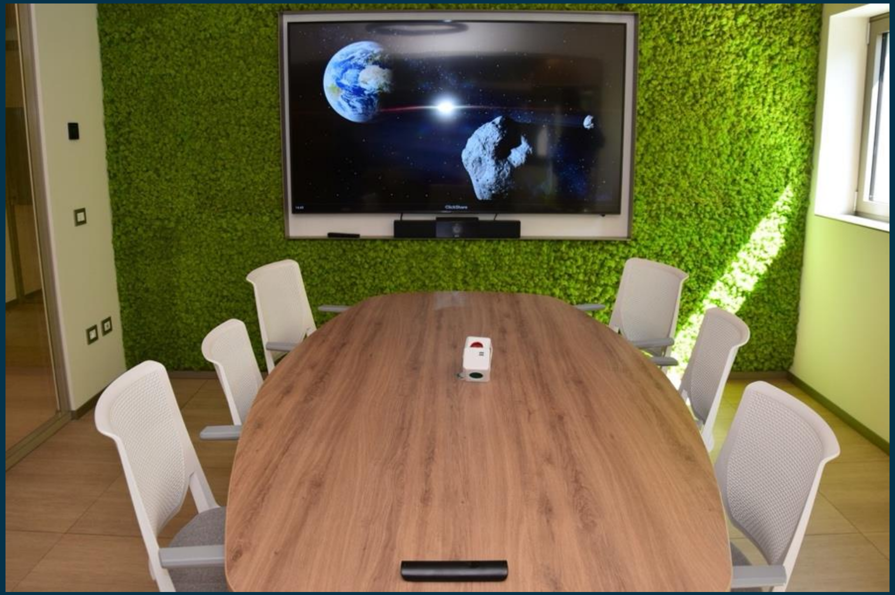
SAILOR: Debris Impact Measurements

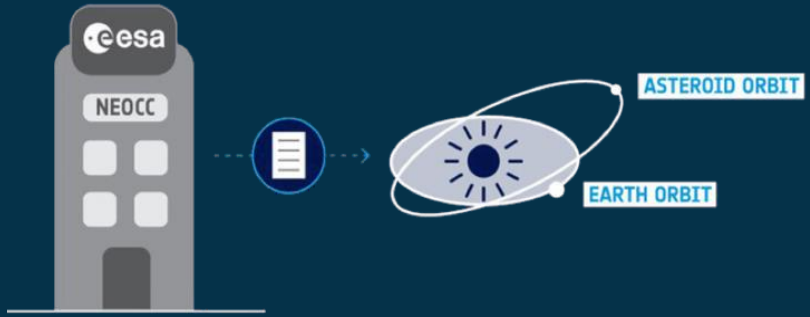


ECOSTARS
IOD of green platforms

(Pre-Operational) Services Development (35M€)

N





- Tailored to use cases or domain on request
- How to navigate & utilise key tools
- At users premises or online webinars

- Bespoke dashboards
- Content tailored together with test users
- Individual product adaptation

- Outreach to registered user community
- Feedback on service content and presentation

- At users' premises or part of a conference or workshop e.g. European Space Weather Week

SWENET: Space Weather Network

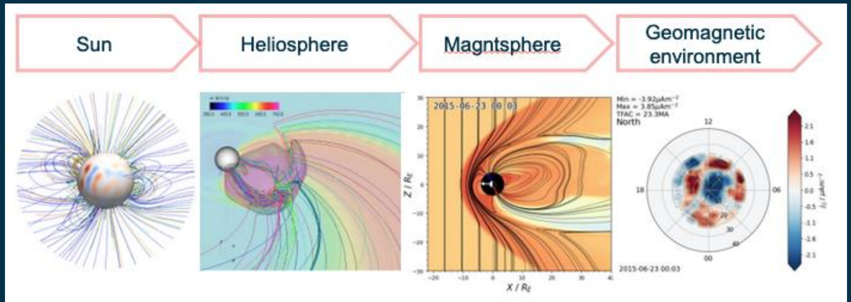
Core Technology Elements (94.4M€)

CREAM

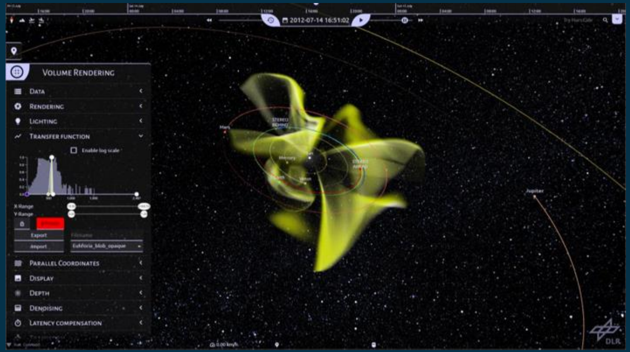
Debris Laser & Momentum Transfer

DRACO Exploitation

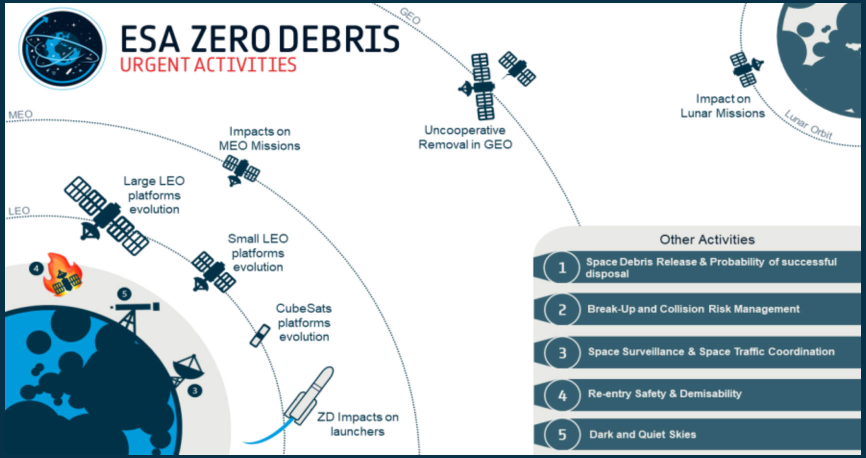
Virtual Space Weather Modelling Centre



Advanced Space Weather Visualisation



Competitiveness



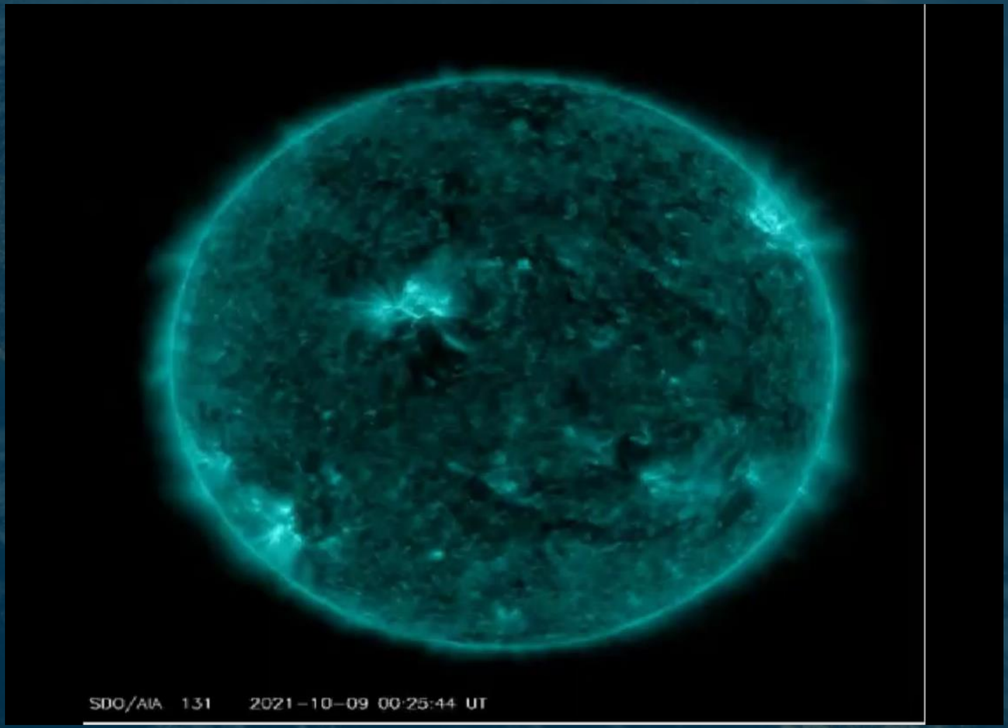
VIGIL: Space Weather Cornerstone Mission

Giuseppe Mandorlo
Vigil ESA Project Manager

S2P Industry Day 2024
28-11-2024

Space Weather Impacts

- Carrington Event, 1859 is the "reference" event where first "tech" impacts observed;
- Extreme SW now impacts power distribution, aviation, internet, navigation, space based assets;
- Wide variety of damage cost estimates with some studies claiming up to **$1-3 Trillion impact after 1-year;**
- Greater reliance on 'foundation' technologies (Internet, GPS, Comms etc) increased risk/impact over time.
- Extreme solar event on Sun-Earth Line, 12-18 hrs from onset to impact – LATENCY and AVAILABILITY the driving req'ts.



Mission Objectives

Vigil is an operational mission at L5 providing the capability to monitor and predict space weather activity and provide a timely warning of extreme solar events.

A system which;

- Is capable of operating nominally during severe SWE events
    - With high system **availability & reliability.**
- Provides **low latency** data to users enabling;
    - Event-based warnings and alerts
    - **"Now-Casting"** Providing at least 12 hrs warning of fast moving, earth bound CME's
    - **"Forecasting"** - tracking, and in the longer-term prediction, of Solar activity onset up to 4-5 days in advance

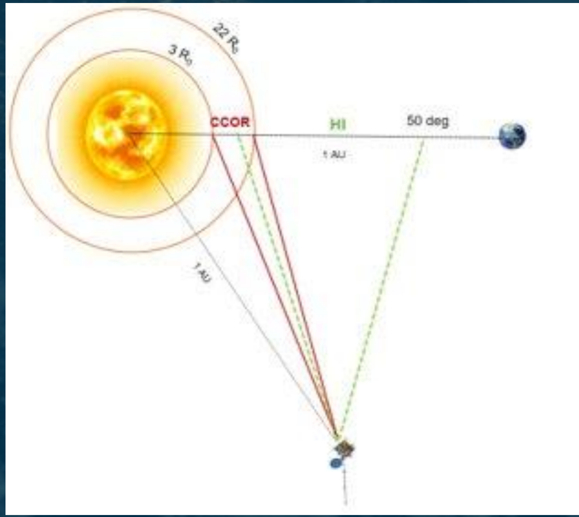
Mission Objectives

REF.	OBJECTIVE
• L5 – 1	To provide improved assessment of CME motion and density, in the corona and heliosphere (CCOR + HI)

Space Weather Now-Casting - Improving the prediction of Coronal Mass Ejection (CME) Earth arrival time and location.

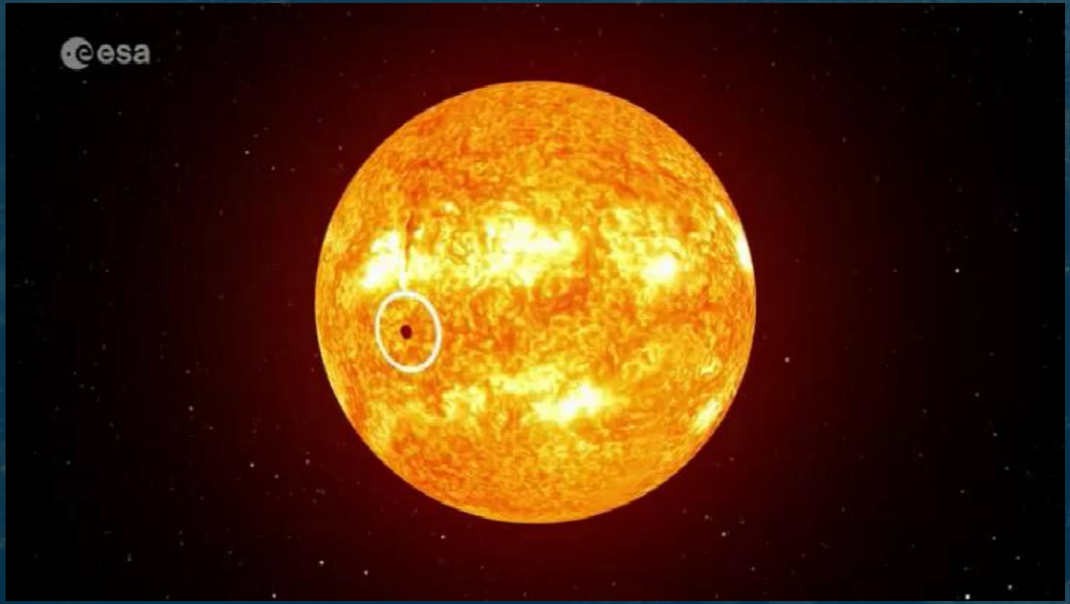
CME

A coronal mass ejection is a significant release of plasma and accompanying magnetic field from the Sun's corona into the heliosphere. CMEs are often associated with solar flares and other forms of solar activity.

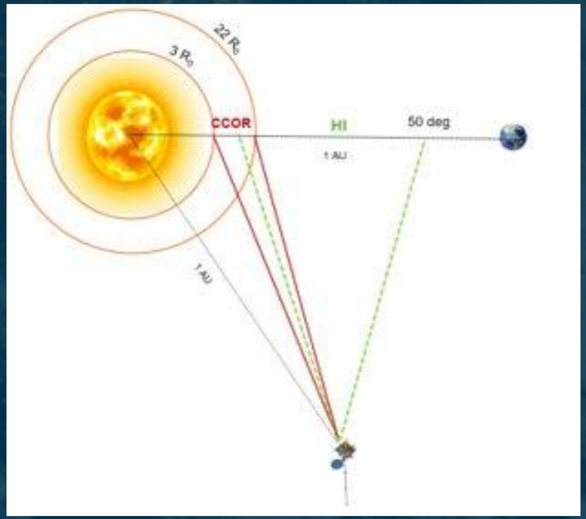


Mission Objectives

REF.	OBJECTIVE
• L5 – 1	To provide improved assessment of CME motion and density, in the corona and heliosphere (CCOR + HI)
• L5 – 2	To provide observations necessary to improve solar activity onset detection (PMI)

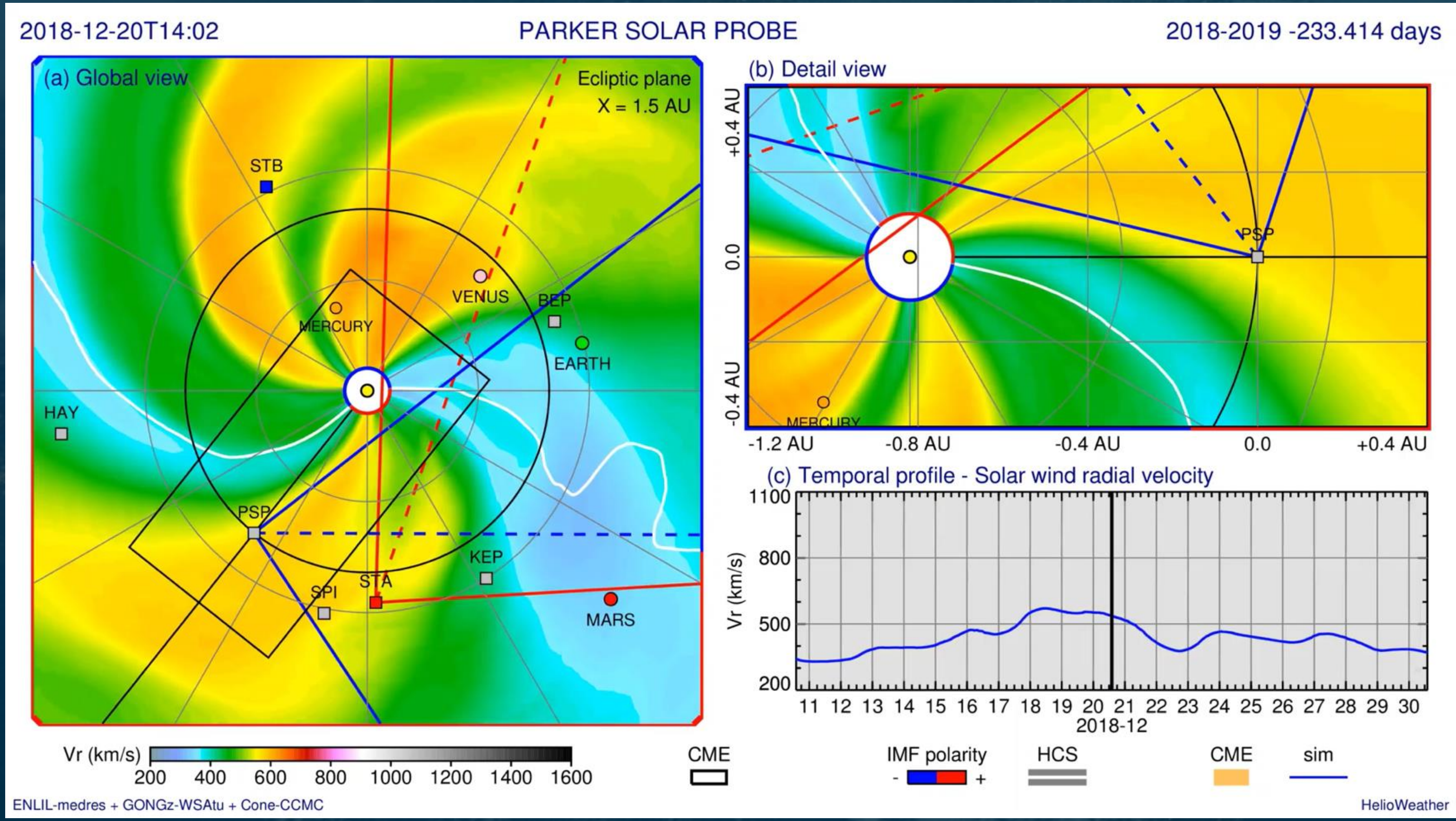


Space Weather Forecasting - tracking of Solar activity up to 5 days before being visible from the Earth



Mission Objectives

REF.	OBJECTIVE
• L5 – 1	To provide improved assessment of CME motion and density, in the corona and heliosphere (CCOR + HI)
• L5 – 2	To provide observations necessary to improve solar activity onset detection (PMI)
• L5 – 3	To determine the speed, density and temperature in solar wind features (e.g. SIRs) rotating towards Earth from an in-situ perspective (MAG + PLA)
• L5 – 4	To monitor vector components of the Interplanetary Magnetic Field (MAG + PLA)

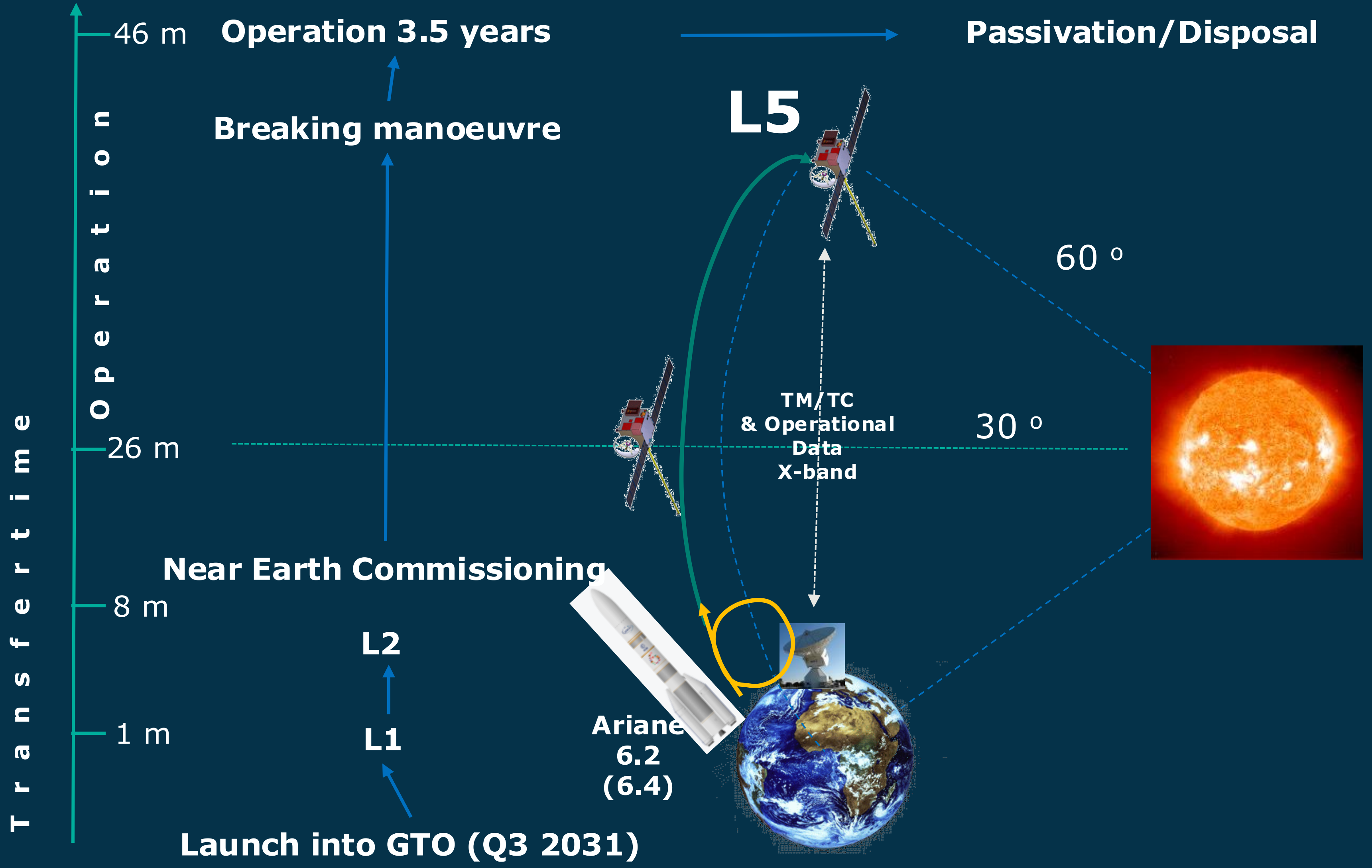


Space Weather Forecasting – Solar wind and IMF characterisation up to 5 days in advance

Solar Wind

A stream of energized, charged particles, primarily electrons and protons, flowing outward from the Sun, through the solar system

Mission architecture



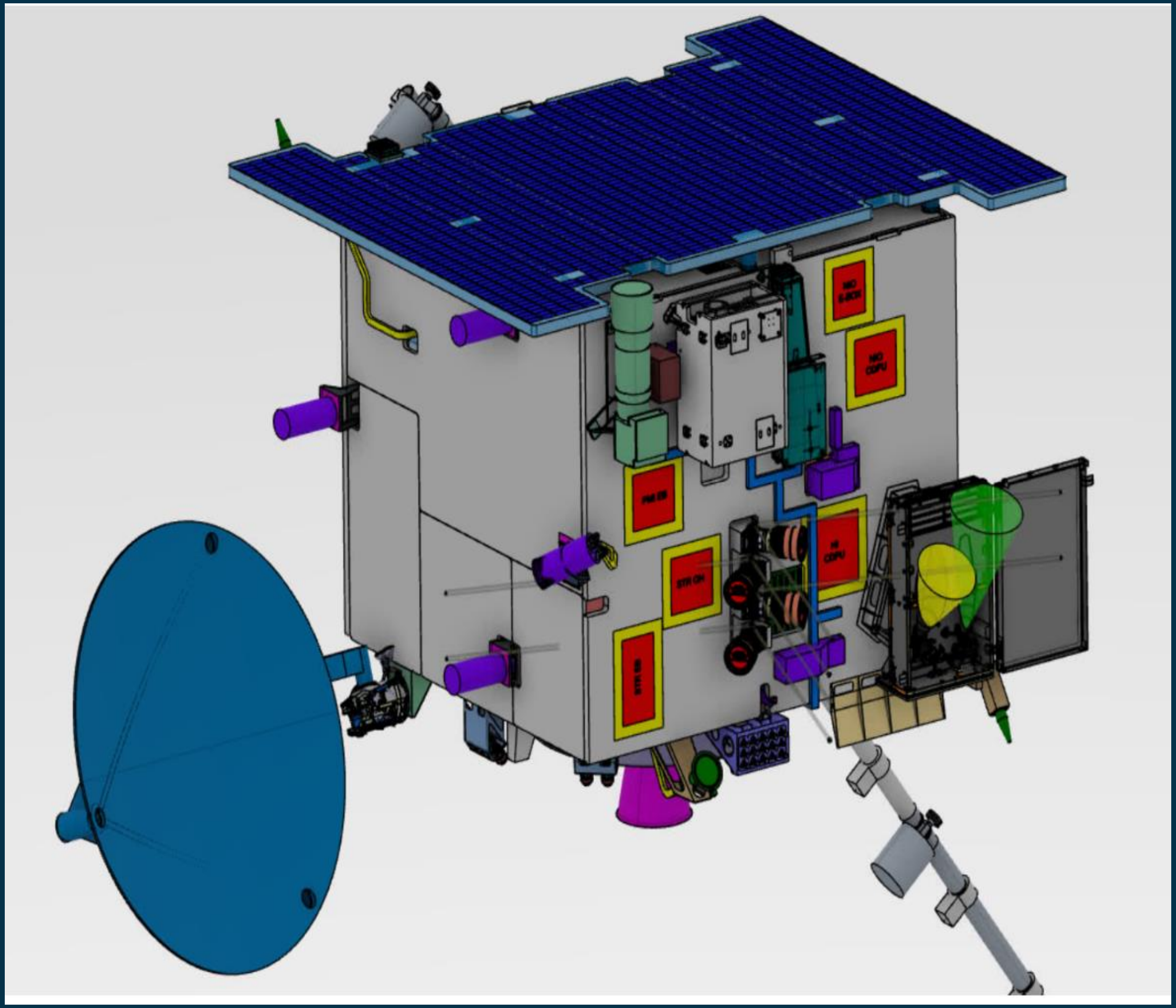
- 8/7 operation after Near Earth Commissioning
- 24/7 operation using <u>deep space antenna (i.e. Goldstone, Cebreros etc)</u> after 30 degree trailing point is passed

<u>Data Priority Concept</u>

- Two distinct data streams – Priority-1 and Priority-2;
- <u>Priority-1 = Data utilized to provide the service. Full latency and availability requirements</u>
- Priority-2 = 'Spare' data bandwidth that can be used for higher cadence science data.

Vigil Spacecraft - Main Information

Vigil	
Lifetime	Nominal: 7.5 years, inc. ≈ 3 years transfer Extension: 5 years
Operational Orbit	Sun-Earth Lagrange 5 1AU from Sun and from Earth
Launch Volume	2.5m x 2.0m x 2.5 (stowed)
Launch Mass	2500Kg
Launcher	Baseline: Ariane 6.2 (dual launch) Alternative: Ariane 6.4 and Falcon 9
Propellant (Oxidiser + Fuel)	1200Kg ➔ $\Delta V \approx$ 1700m/s
Power class	1400W
Solar Array	Body mounted
TT&C	X-Band, 24/7 link
Data Rate	≈300kbps
On-Board memory	255GB



VIGIL INSTRUMENT SUITE Overview

Instrument	Instrument Prime	Observation	Utilisation
Photospheric Magnetic field Imager (PMI)	MPS/IAA	Vector magnetic field mapping of the solar photosphere	Evolving magnetic complexity: input into solar wind modelling and activity forecast
Compact Coronagraph (CCOR)	NOAA/NRL	Solar coronagraphy	Evolution and propagation of CMEs- Overlapping observation close to the SUN from 4 deg between CCOR and HI
Heliospheric Imager (HI)	Leonardo SpA	Heliospheric imagery	
Plasma Analyser (PLA)	MSSL	Solar wind particle densities, temperatures and velocity	Solar wind monitoring, detection and characterisation of high-speed solar wind streams
Magnetometer (MAG)	IPL/IWF	Interplanetary Magnetic Field vector-magnetic field	
JEDI	NASA/SWRI	Extreme Ultraviolet Images	Complementary to existing instruments for the forecasting service

VIGIL Mission Status [1]

- Vigil Mission System Requirements Review (M-SRR);
  - M-SRR reviewed the flowdown of requirements from User Requirement to Mission Requirements and lead ESA satellite/ground requirements (Ground and Space Segment System Requirements) => Closed in mid-October 2024;
  - Vigil Payload Data Segment development re-organized - moved under Vigil Project;
  - Results directly fed into the Satellite System Requirements Review (S-SRR)

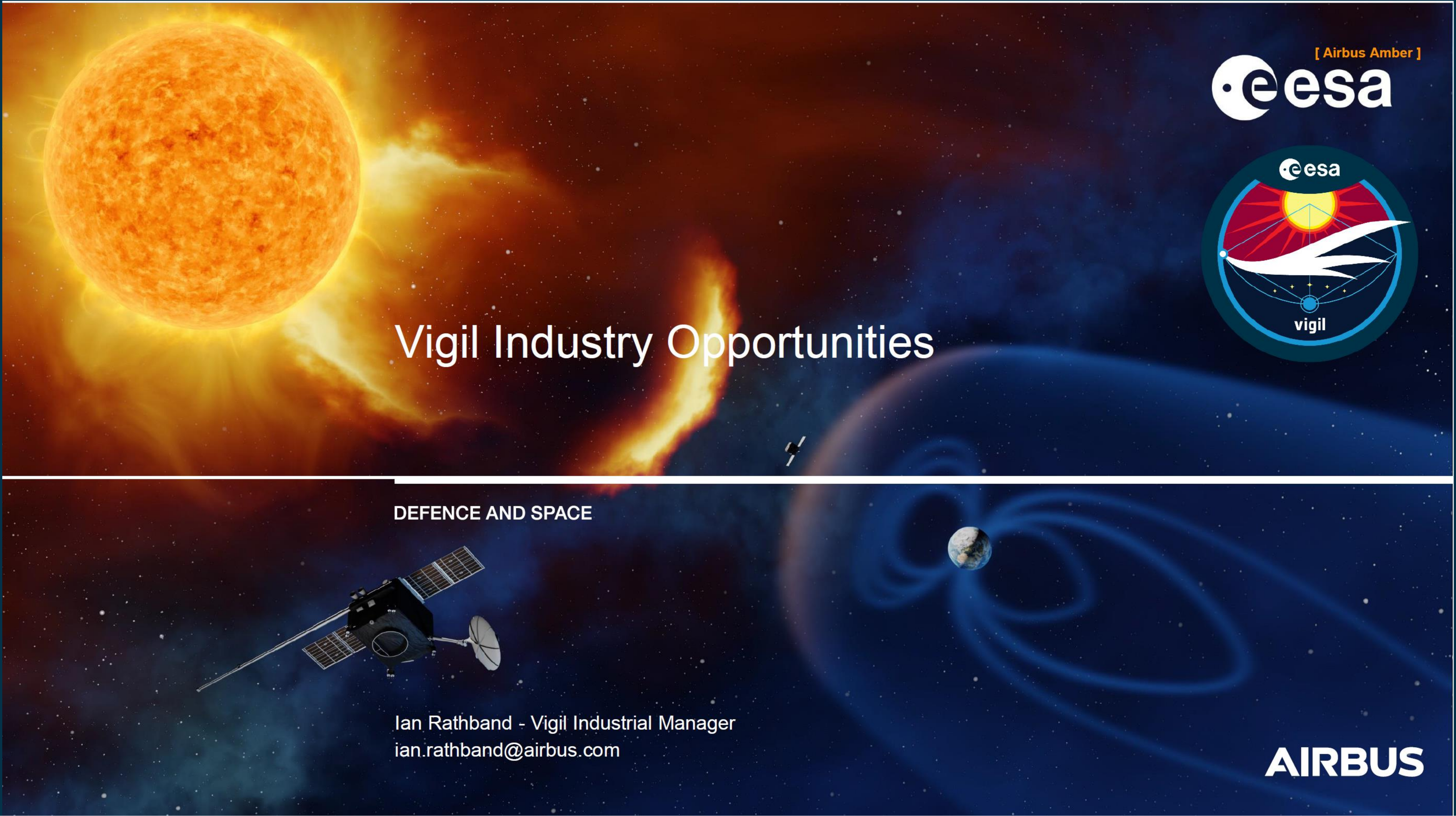
- Vigil S-SRR:
  - S-SRR Board held end October
  - All review objectives fully met => Solid requirements foundation confirmed
  - Procurements can proceed for all sub-systems and platform equipments as specifications quality is confirmed by the review.

VIGIL Mission Status [2]

- Instrument requirements reviews/EQSRs completed;
- Start of instrument PDRs => PMI PDR Kick-Off held last week;
  - Technology developments to be confirmed as being at Technology Readiness Level – 6 (System PDR as last date for TRL confirmation);
  - All schedule critical procurements preparation is underway;

- Satellite PDR planned for Q1 2026 => **ON-TRACK**
- Funding for remaining satellite items => Member states to confirm funding at ESA Council of Ministers Meeting, end-2025;
- **ESSENTIAL** that funding needs are met in order to maintain the schedule/cost;

- **ESA needs Industry support during lobbying phase!**



Vigil Industry Opportunities

DEFENCE AND SPACE

Ian Rathband - Vigil Industrial Manager
ian.rathband@airbus.com

Export Control Information

Section 1 (not applicable in France, please go to section 3)

This document contains Technical Information:

Yes ☒ No ☐

If No to section 1: please complete Section 2
If Yes to Section 1: please complete Section 3 as applicable

Section 2 (not applicable in France, please go to section 3)

I confirm the document does not contain Technical Information and is **"non-Technical"**.

Name: n/a

Date: n/a

Section 3

3a. National and EU regulations Export Control Assessment

This document has been assessed against applicable export control regulations in

☐ France ☐ Germany ☐ Spain ☒ UK ☐ Other: [specify country]

☐ and does not contain Controlled Technology[1] and is therefore **"Not Listed / Not Controlled"**.

☒ and contains Controlled Technology with export control classification 9E001

Note: Any transfer of this document in part or in whole must be made in accordance with the appropriate export control regulations. Prior to any transfer outside of the responsible legal entity, confirmation of an applicable export licence or authorisation must be obtained from the local Export Control Officer (ECO).

3b. US (ITAR / EAR) Export Control Assessment

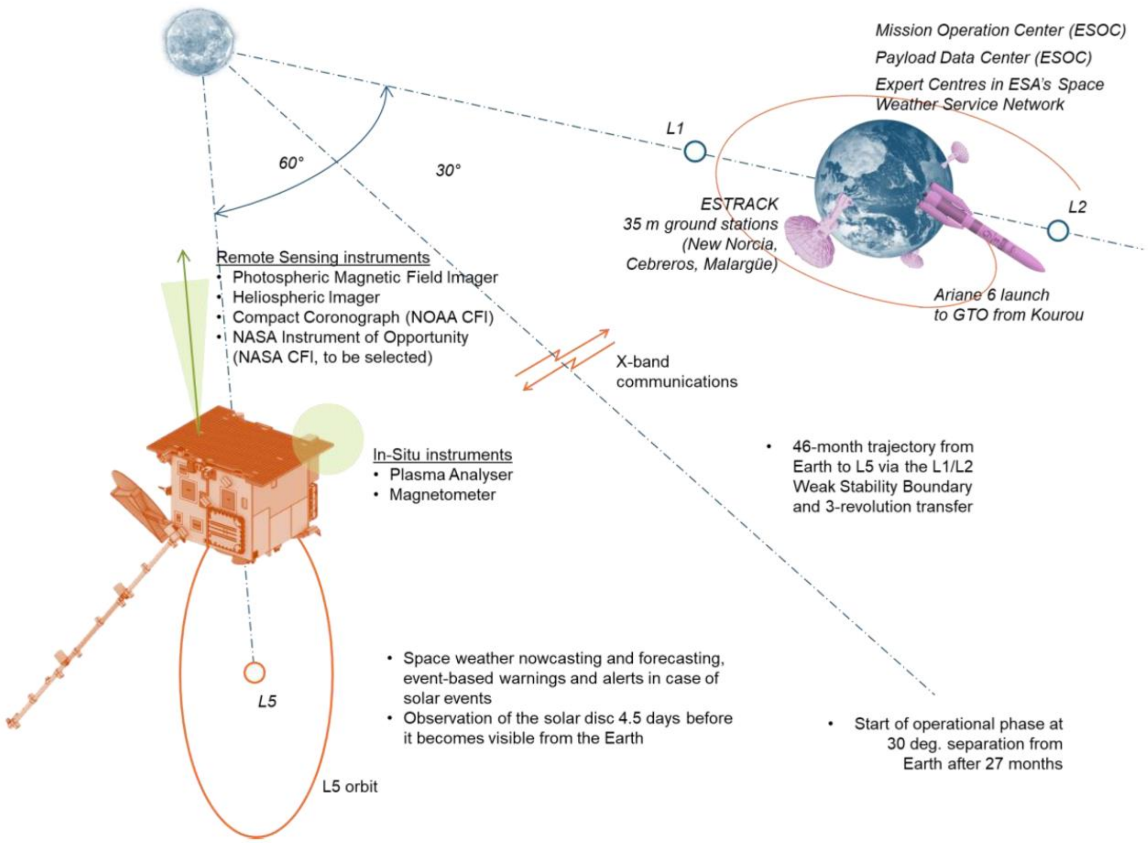
☒ This document does not contain US origin Technical Data (Technology)

☐ This document contains "Technology" which is controlled by the U.S. government under [USML category number / ECCN] and which has been received by [legal entity] under the authority of [licence number / ITAR exemption / EAR licence exception / NLR].

☐ This document contains technology which is designated as EAR99 (subject to EAR and not listed on the USML/CCL).

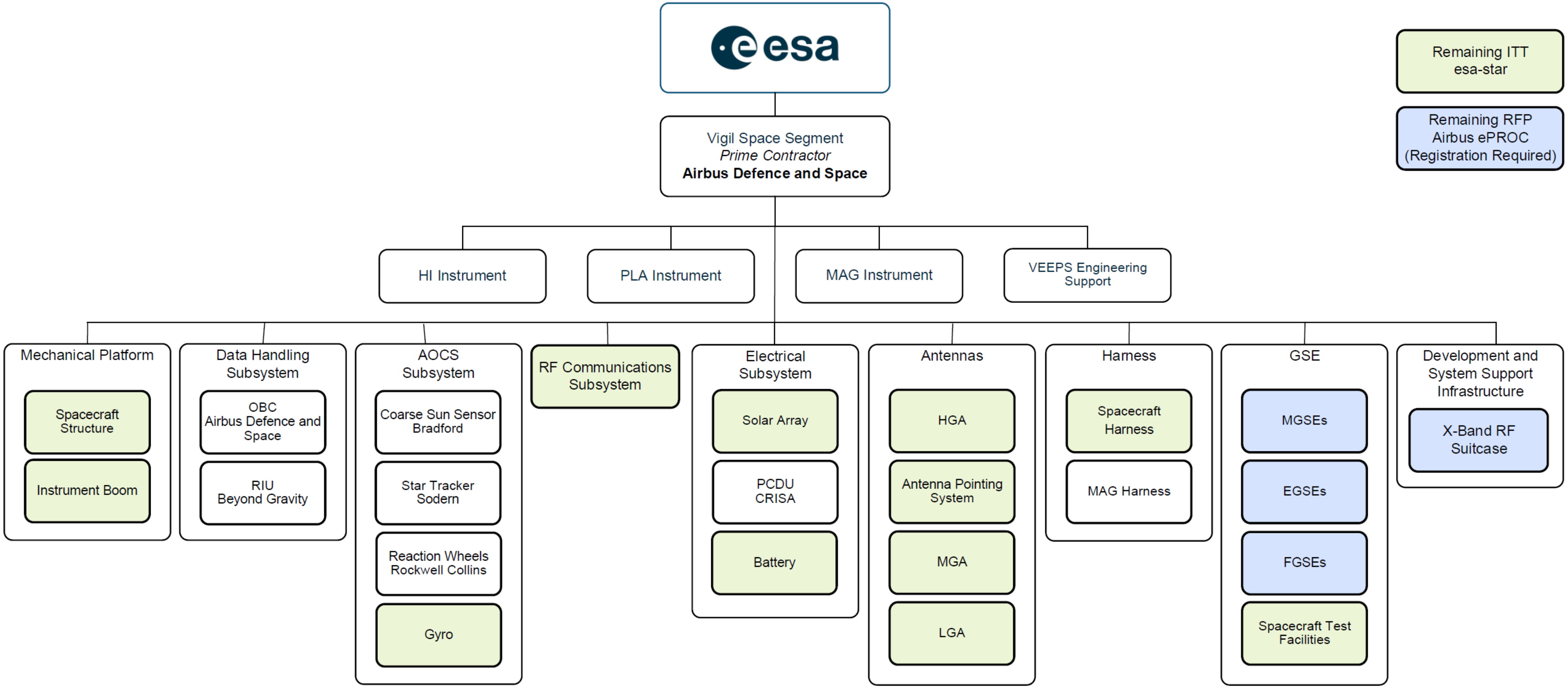
Note: Any re-export or re-transfer of this document in part or in whole must be made in accordance with the appropriate regulation (ITAR or EAR) and applicable authorization. If in any doubt please contact your local ECO.

Vigil Mission



- First operational mission in L5 in ESA's Space Situational Awareness (SSA) Space Safety Programme (S2P)
  - Cooperation with the US (NOAA and NASA) in space weather monitoring
  - Offering an early warning capability to protect space and ground assets from major solar events
- Mission Profile
  - Operational orbit in L5 Lagrangian point
  - 46 months max. transfer, operational start 27 month after launch
  - 7.5 years design lifetime with possible extension by 5 years
  - High 98.5% operational availability
  - 7 to 75 min on-board latency (instrument-dependent)
- Transfer optimised to allow dual launch in GTO with Ariane 6.2 (secondary passenger with a commercial customer)
  - Transfer duration mitigated by operational phase starting as soon as Earth separation is above 30°
- Permanent real-time X-band communications for low latency, with a steerable high-gain antenna for permanent Earth pointing even during transfer

Vigil – Industrial Consortium Remaining Opportunities



Vigil – Procurement Calendar and Geo-Return Participation and Targets

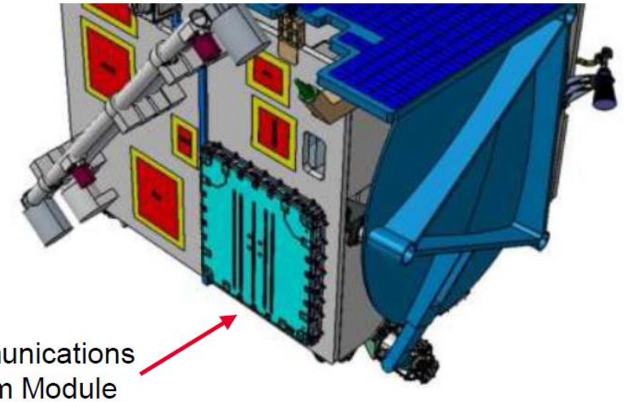
ITT / RFP Published-	Procurement Item	PFM Hardware Need
Q1 2025	RF Communications Subsystem High Gain Antenna Instrument Boom Antenna Pointing System	May 2028 June 2028 July 2028 July 2028
Q2 2025	Spacecraft Harness Spacecraft Structure MLI Blankets (Core Platform) Solar Array	November 2027 October 2027 July 2027 January 2029
Q4 2025	LGA + MGA	September 2028
Q1 2026	Battery Gyro MLI Blankets (Remaining)	August 2028 August 2028 February 2028
Q3 2025 - Q1 2026	MGSE + FGSE	-
Q2 2026	EGSE	From July 2026
Q4 2027	Environmental Test Facilities	From December 2025

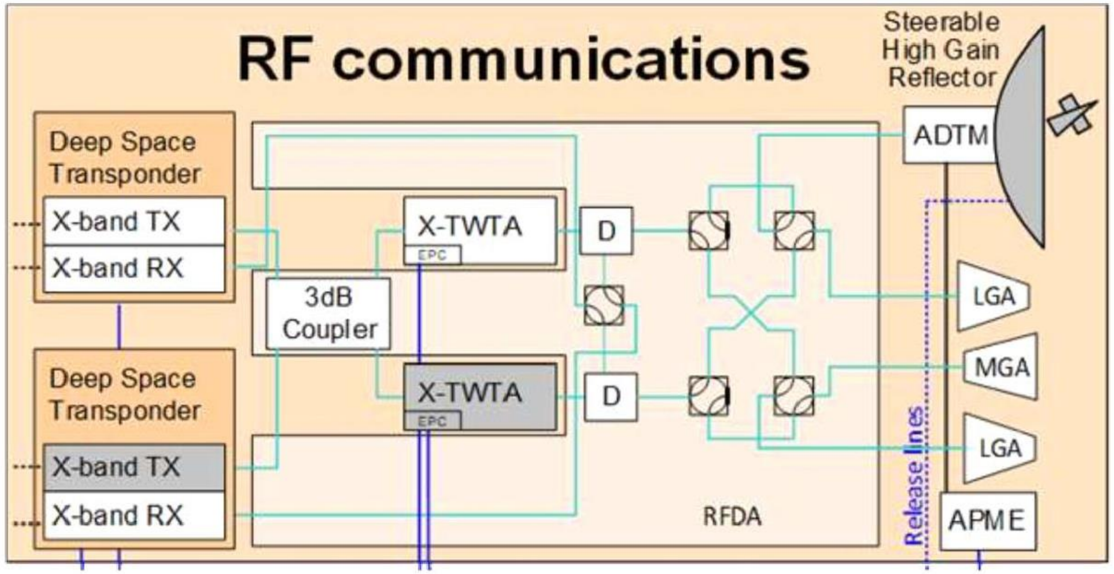
Participation Targets

- SME
- non-LSI (Large System Integrator)
- ESA ministerial delegate awareness of intent

Vigil – Communications Subsystem Equipment Opportunities

- **RF Communications Subsystem**
  - Supports the communications between Vigil Spacecraft and Earth throughout the mission, enables spacecraft tracking, command and telemetry in X-Band.
  - Provides the bridging interface for the transfer of data between On-Board Computer and High, Low and Medium Gain antennae.
  - Includes within x2 Deep Space Transponder (DST), x2 Travelling Wave Tube Assembly (TWTA), RF Distribution Assembly (RFDA) and harness on thermally equipped structural panel.
  - Anticipated Category D (overall) comprising of:
    - DST with minimum starting TRL7;
    - Remaining items (including RFDA elements of waveguides switches, diplexers isolators, coupler and interconnecting waveguides and coaxial cables, with minimum starting TRL 9.
  - Delivery of EM integrated unit, representing one communication chain (no redundancy).
  - Delivery of x1 PFM Subsystem Module and external Waveguide runs linking Subsystem Communications module to Antennae.

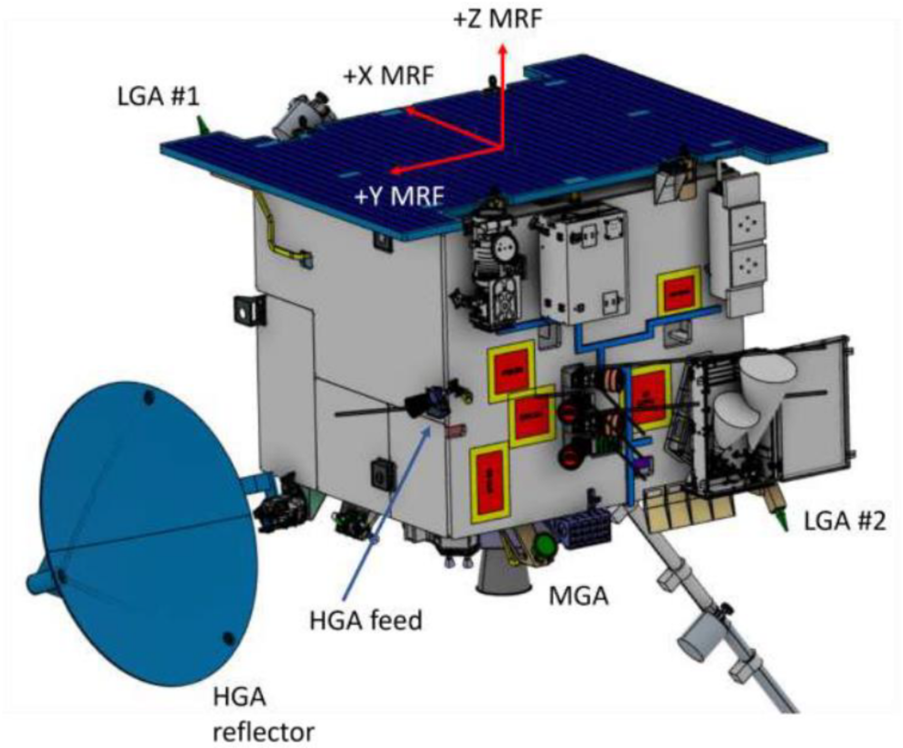




AIRBUS

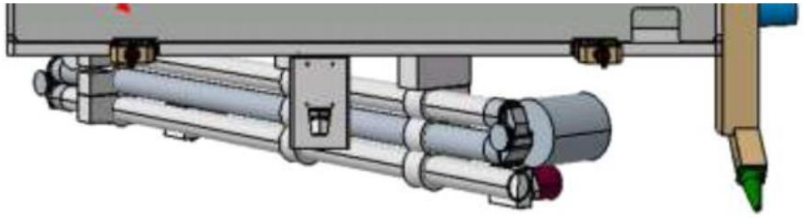
Vigil – Communications Subsystem Equipment Opportunities

- **High Gain Antenna**
  - Communication antenna for nominal operations after the instruments are commissioned and provides sufficient gain for high data rate downlink.
  - Includes a single feed, single offset deployable reflector that is parabolic in shape, of diameter approximately 1.85m being a lightweight structural design.
  - Scope includes nominally x4 peripheral HDRM.
  - Category C equipment with minimum starting TRL7, to TRL9 in constituent elements.
  - Delivery of x1 PFM flight set of reflector and feed.
- **Low and Medium Gain Antenna**
  - Both LGA and MGA Category B equipment with minimum starting TRL9.
  - Delivery of x2 LGAs, that provide omni-spherical coverage for near Earth uplink and downlink, and emergency telecommand capability at larger distances.
  - Delivery of x1 fixed MGA, used for strobing in survival mode.

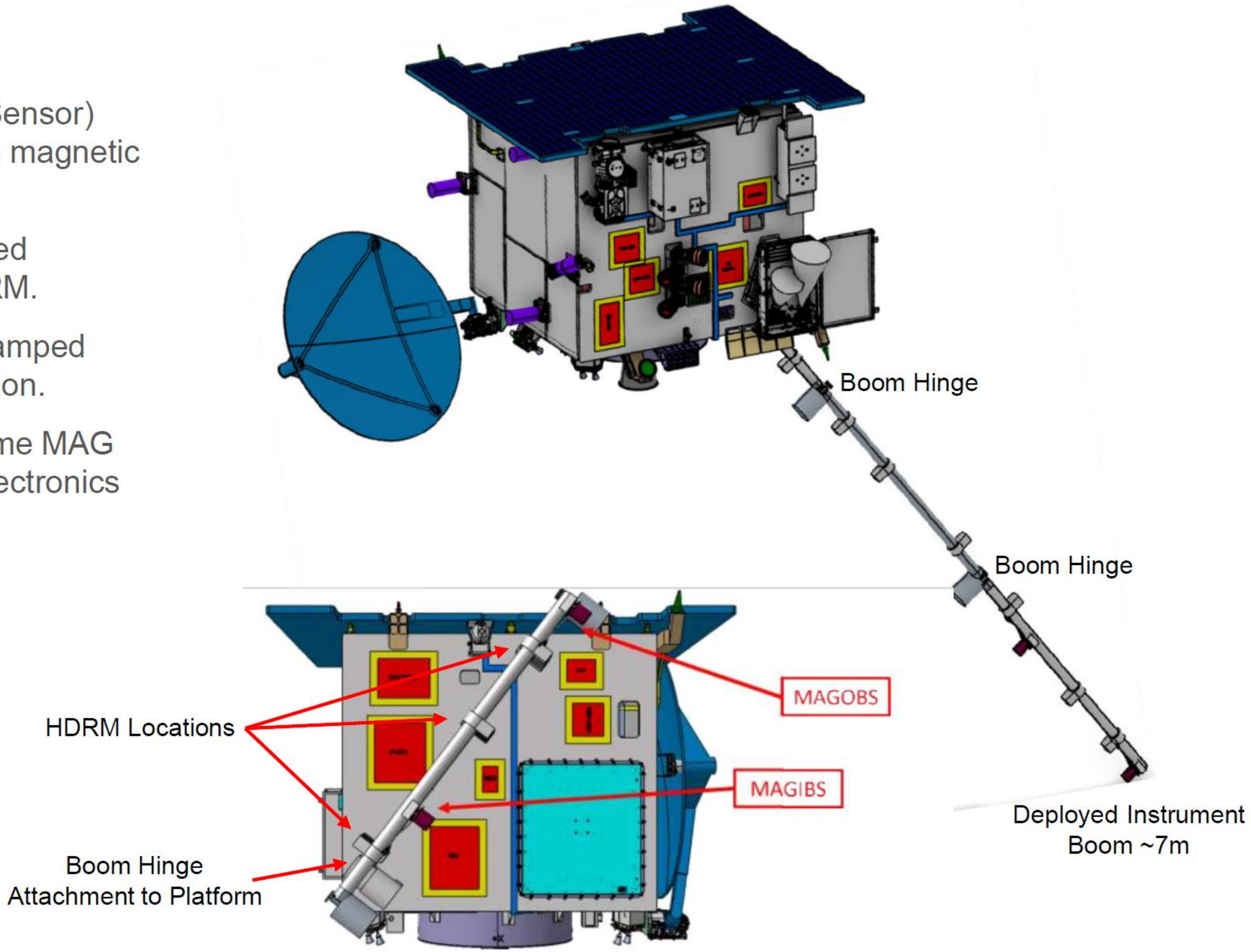


Vigil – Structures, Mechanisms Opportunities

- **Instrument Boom**
  - Positions Magnetometer Sensors MAGIBS (inboard Sensor) and MAGOBS (outboard Sensor) at distance from the magnetic interference of the Vigil spacecraft body.
  - 3 segment magnetically clean boom, secured in stowed configuration via x3 non-explosive i.e. low shock HDRM.
  - Deployment by synchronized release, spring motor damped actuation motion and latched into final deployed position.
  - Includes to accommodate separately procured by Prime MAG Harness, runs along boom and over hinge to MAG Electronics inboard Spacecraft.
  - Category D equipment with minimum starting TRL 6.
  - Delivery of x1 PFM Instrument Boom

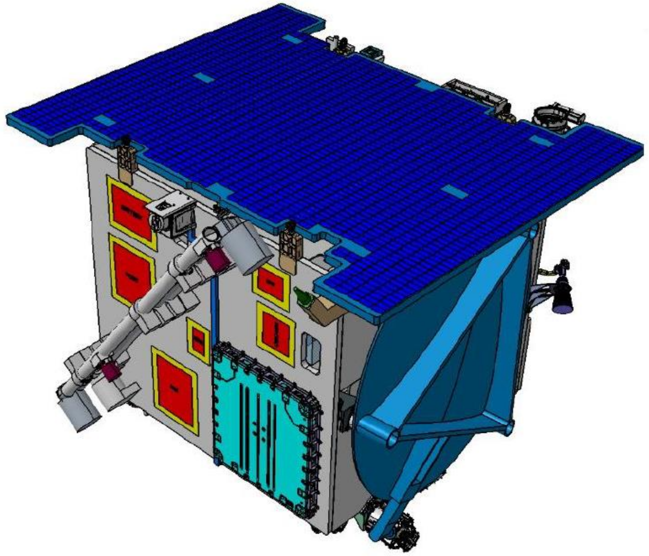


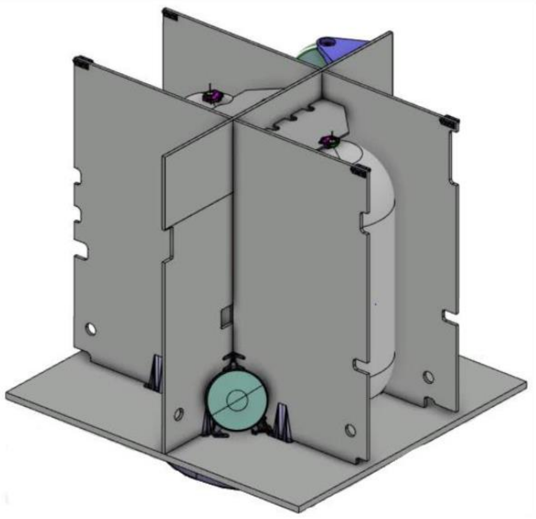
Stacked Boom Segments

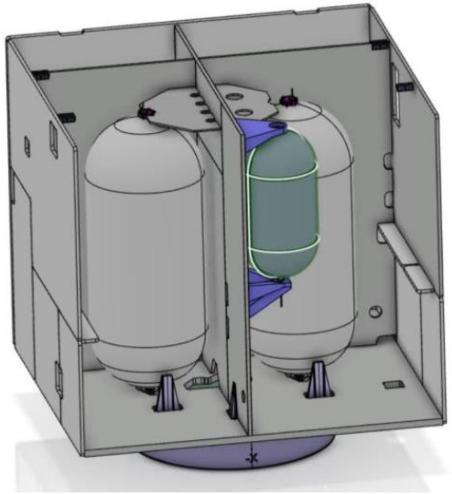


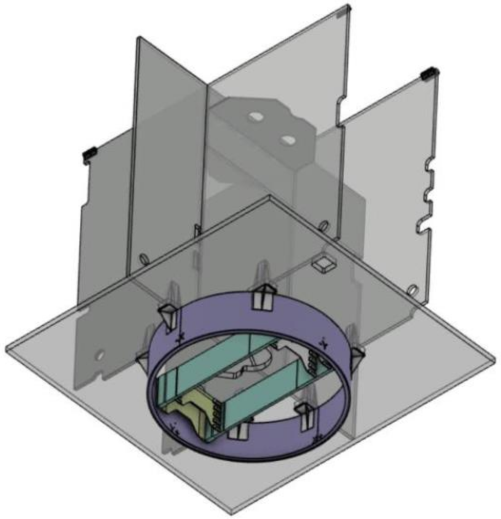
Vigil – Structures, Mechanisms Opportunities

- **Spacecraft Structure**
  - Aluminium sandwich panel based integrated structure to host platform and instrument.
  - ‘H-frame’ internal shear wall configuration with tanks support interfacing to polar mounted 517L propellant tanks.
  - Approximately cuboid structure 1.90 m (Z) x 2.15 m (Y) x 2.03 m (X). 1194 mm diameter launcher interface.
  - Category C equipment with minimum starting TRL7, to TRL9 in constituent elements.
  - Mission specific configuration but all foreseen material, processes, components, manufacture and test methods are anticipated to be fully qualified.
  - Scope includes, cleanliness bake out, static test of the primary FM structure including a global static stiffness measurement and loading of all key interfaces (e.g. tanks), and proof load testing of FM structure lifting points.
  - No heat pipes are foreseen to be included.
  - Delivery of x1 PFM model only (i.e. no SM).



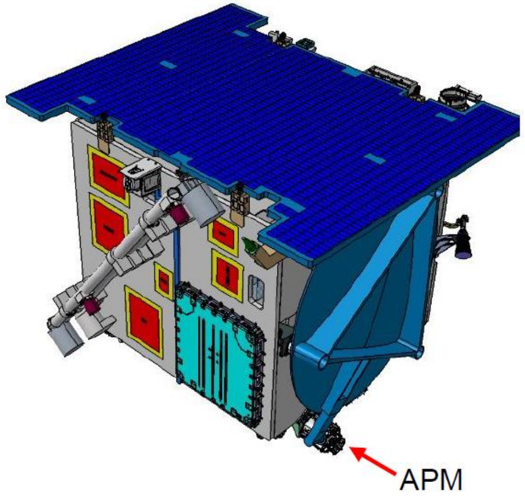


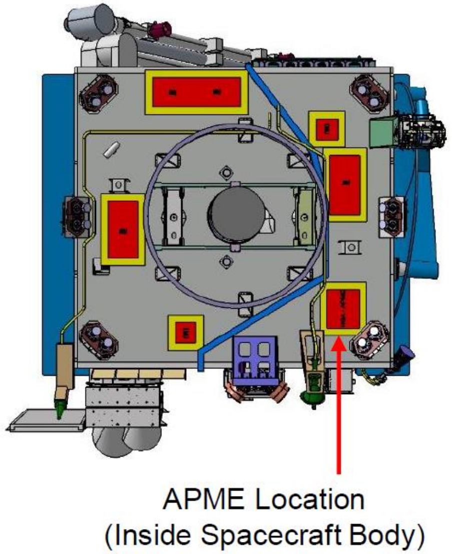


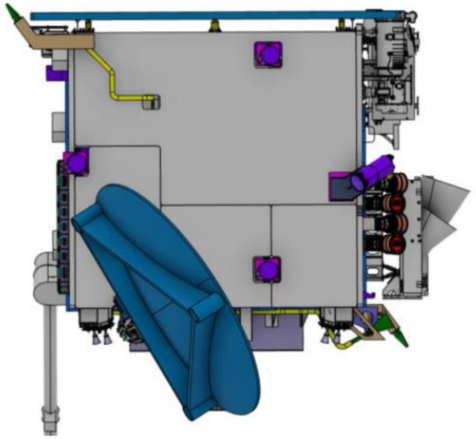


Vigil – Structures, Mechanisms Opportunities

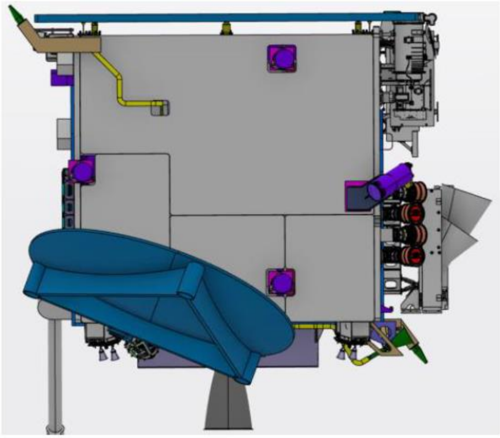
- **Antenna Pointing Subsystem (APM+APME)**
  - APM via two independent rotation axes to deploys and steers the HGA.
  - APME mounted inboard spacecraft compatible with 22V to 34V unregulated voltage, commanded and controlled via Milbus.
  - APM, Category C equipment with mi*n*imum starting TRL6.
  - APME, Category B equipment with minimum starting TRL6.
  - Delivery x1 PFM APS + x1 APME EM.
- **MLI Blankets**
  - 3 types utilised on Vigil Thermal Control:
    1. External platform MLI ~10 layers with an external conductive Black Kapton layer;
    2. Internal MLI blankets: with VDA top layer;
    3. External high temperature MLI blankets titanium top layer.
  - Category C equipment with minimum starting TRL7, to TRL9 in constituent elements. .
  - Delivery x1 PFM MLI, batch for Core Platform and batch for Spacecraft Remainder.







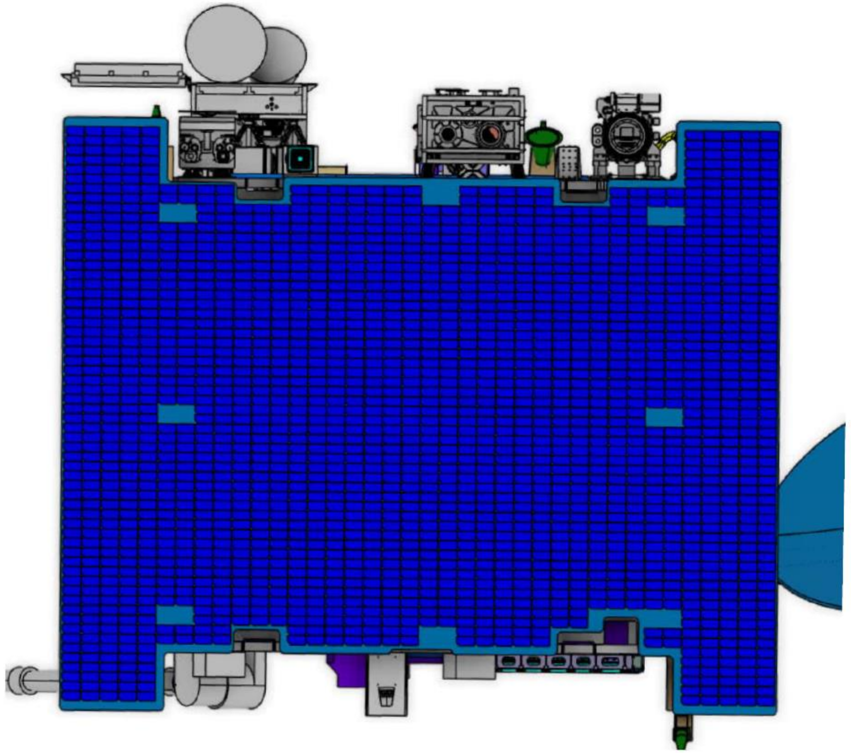
Reflector steered to
25 Deg Azimuth

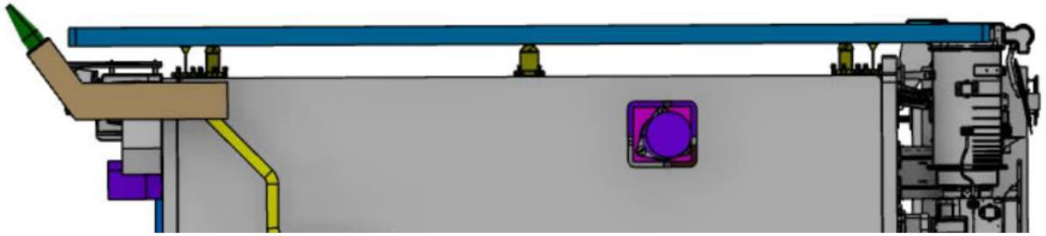


Reflector steered to
70 Deg Azimuth

Vigil Power, Electrical and Avionics Equipment Overview

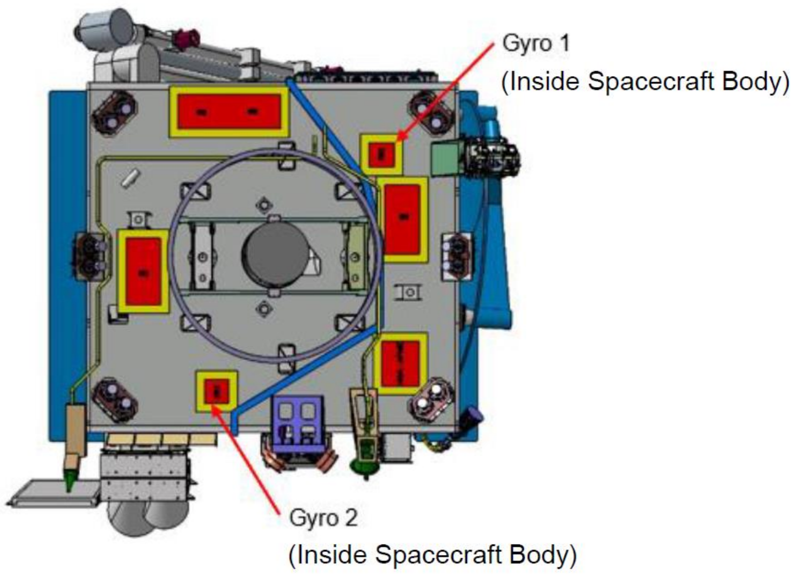
- **Solar Array**
  - Fixed top floor solar array located on +Z surface of spacecraft, that at least when on station is in constant Sun illumination.
  - Operated with optimum solar incidence angle perpendicular to Solar Array surface of approximately 6.6m².
  - Operated with shunt regulator at 29V bus voltage, about 1070W min power.
  - During S/C manoeuvres operation bus voltage between 27V (tbc) and 34V, about 1000W min power.
  - Expected use of 3G30C solar cell, and where string lengths are adjusted for optimised EOL performance.
  - Mounted via ~100m length blade mounts, mechanical decoupling.
  - Category C equipment with minimum starting TRL7, to TRL9 in constituent elements.
  - Expected to comprise of existing design of qualified components or are off the shelf with full qualification to the necessary Vigil environment.
  - Delivery of x1 PFM.

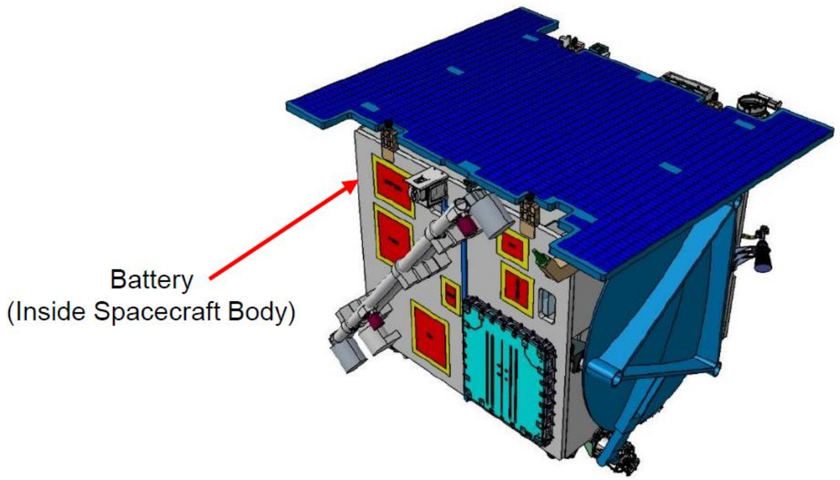




Vigil Power, Electrical and Avionics Equipment Overview

- **Spacecraft Harness**
  - Linking 6 instruments plus boom electrical interfaces to spacecraft platform including OBC, RIU, RF COMMS, EPS, AOCS and propulsion equipment.
  - – Category C equipment with minimum starting TRL6.
  - SpaceWire (SpW) interfaces, Milbus and RS422 data links used for communication between payload and platform units.
  - – Delivery of x1 PFM Harness.
- **Battery**
  - – Non regulated bus voltage range 22V to 34V with nominal operation at 29V and during S/C manoeuvres operation at between 27V (tbc) and 34V.
  - – One module with energy of approximately 3.3 kWh (tbc).
  - – Category B equipment with minimum starting TRL6.
  - – Delivery of x1 PFM.
- **Gyro**
  - – Medium performance Gyro required.
  - – Category A equipment with minimum starting TRL7.
  - – Delivery of x2 PFM.





Vigil Current GSE Requirements

MGSE*	EGSE	FGSE / Others
Spacecraft Interface Adaptor*	RF SCOE	Purge Equipment
Trollies, Lifting and Access Equipment*	Star Tracker SCOE	X-Band RF Suitcase
Spacecraft Container*	CSS	EFM Test Bench & Harness
Spacecraft Handling Frames*	TM-TC SCOE	Software Loader
	Power SCOE	Environmental Test Facilities
		Independent Software Verification and Validation (ISVV)

* Includes Original Equipment Manufacture Refurbishment as required in case of re-use.

Thank you

RAMSES

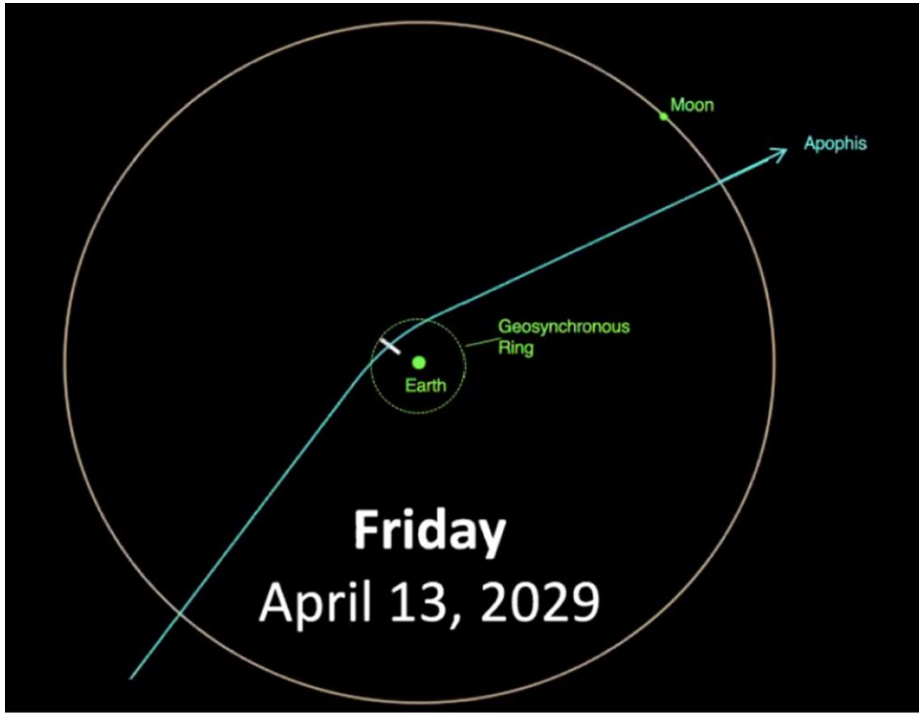
Apophis

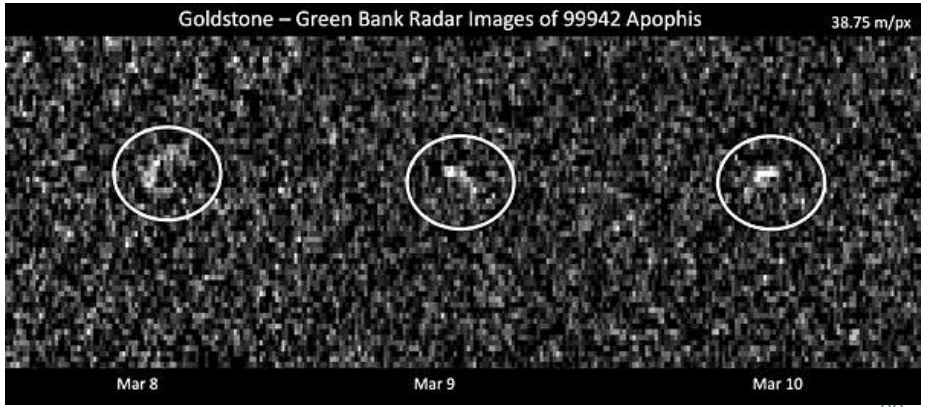
- Asteroid Apophis (~370 m) will have a **very close encounter with Earth** in April 2029, transiting closer than the GEO ring.
- The encounter is a **unique planetary defence opportunity:**
  - expected **physical properties change of Apophis** due to the interactions with Earth's gravity.
  - Extremely **rare** event (1-in-1000s years, cf.T-5 communique)
  - Full-scale tidal experiment that can **revolutionize our understanding** of dangerous asteroids
- The global Planetary Defence community strongly **recommends a pre-encounter Apophis mission**.
  - Apophis T-5 WS [Cf. Annex to PB-SSA Chair report C(2024)/60]
  - UN's SMPAG [Cf. Summary of SMPAG #22, Jan 2024, online]
  - NASA's SBAG [Cf. Findings from SBAG #29, Jul 2023, online]

APOPHIS T-5 YEARS: Knowledge Opportunities for the Science of Planetary Defense

SBAG SMALL BODIES ASSESSMENT GROUP

UNITED NATIONS Office for Outer Space Affairs





RAMSES Mission objectives

RAMSES is the new (candidate) Planetary Defense cornerstone after Hera for the characterization of Apophis during its close encounter in April 2029

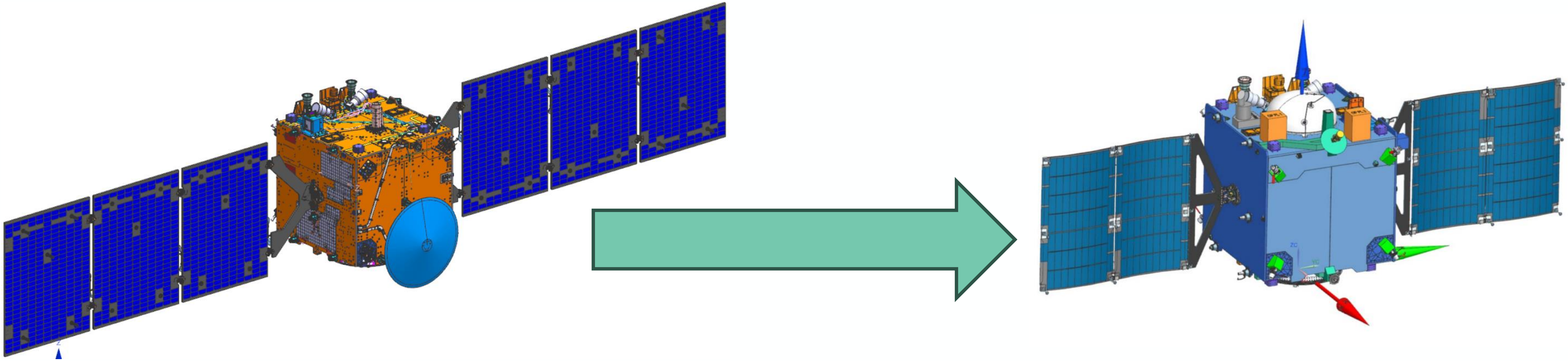
High-level mission objectives

1. Characterize Apophis with **high-resolution before** (and after) the encounter:
   - Orbit
   - Spin state and orientation (1%)
   - Shape and surface changes (**10 cm** resolution)
   - Interior structure
   - Presence of dust <1mm
   - Cohesion
   - Mass, density and porosity (1%)

2. Monitor Apophis with high temporal resolution (1min) **during** the encounter

RAMSES Technical overview – Evolution w.r.t. Hera

Main adaptations	
System level	**Single String approach for lower mass, schedule and cost** Reliability still >0.9 thanks to short mission (18 months)
Structure	Central Tube: attachment points shift Asteroid deck cutout, panels manufacturer
Power	SAW: NEC SAW Lighter PCDU (less units to “feed” due to single string)
Propulsion	Larger Tanks (331 l)
COMMS	No need for large HGA. MGAs / smaller dish



Mission Payload

Similar to Hera, as key to secure the schedule the notion of **Core** and **Opportunity** is applied, both to the mission objectives and to the embarked instruments.

Core Payload

Guarantees the achievement of the core mission objectives, Mandatory

Opportunity Payloads

Achievement of Opportunity mission objective // Further contribution to the Core mission objectives

- Do not drive the schedule critical path and the launch date / Must guarantee no risk of failure propagation to the S/C “core”. Current baseline: TIRI, MAPCAM, Altimeter (PALTH)
- **Limited resources for additional O-P/L – Several expressions of interest (20+ from MS and IP)**
- Final selection based on following criteria/preconditions:
    - Development maturity and credibility (incl. EM availability and flight heritage)
    - Full compatibility with spacecraft IRD
    - Level of commitment towards funding at CM25
    - Scientific interest and relevance for Planetary Defence (assessed with SMB)

RAMSES : International context

JAXA

- Infrared Camera (TIRI re-build)
- Lightweight Solar Array (NEC SAP)
- Launch opportunities (Possibly on H3)
- **DG – JP Government meeting in Japan on 20 Nov**

NASA

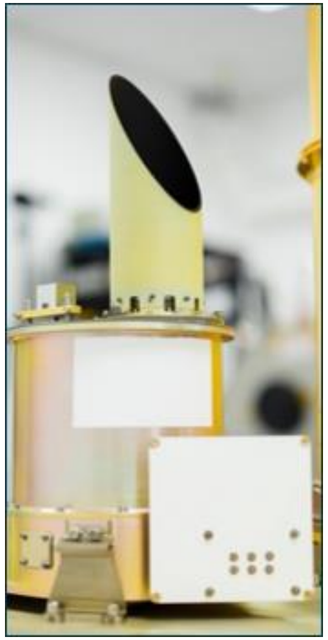
- Possible MAPCAM rebuilt (OSIRIS-APEX)
- Participating Scientist Program
- Synergy with OSIRIS-APEX operations after the close encounter

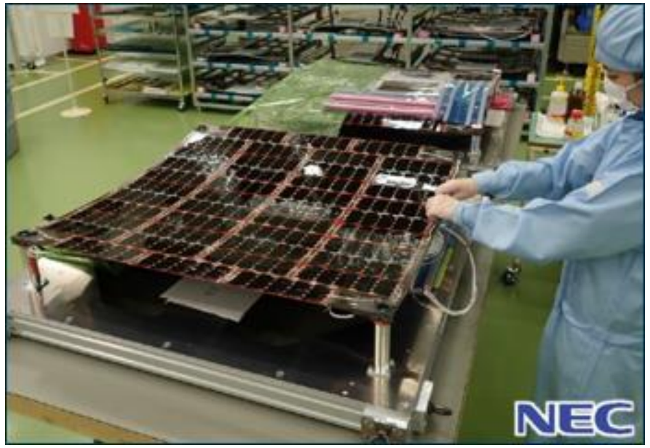
ISRO, KASI

- Potential payloads
- Possible ground stations support

European National Agencies

- Potential CNES small fly-by probe rideshare





Master Schedule – Key Dates

- PDR: **25 Nov 24 – 16 Jan 25**
- Final additional opportunity payload confirmation: mid-25
- CDR: Oct-Dec 25 (Across CM25)
- Equipment FM delivery: Jul-Sep 26
- S/C Integration: up to Dec 2026 (Latest PL integration)
- Functional tests: Nov 26 – Apr 27
- Environmental Test Campaign: May - Nov 2027
- QAR: Jan 2028
- Margin on S/C shipment: 3 months
- S/C shipment: Mar 28
- **Launch: Apr 28**

Hera reference

PDR Sep 20

CDR Jul 22

Prop Module assembly & Test: Mag 21 – Feb 22

Core module Integration: Jan –Jun 23

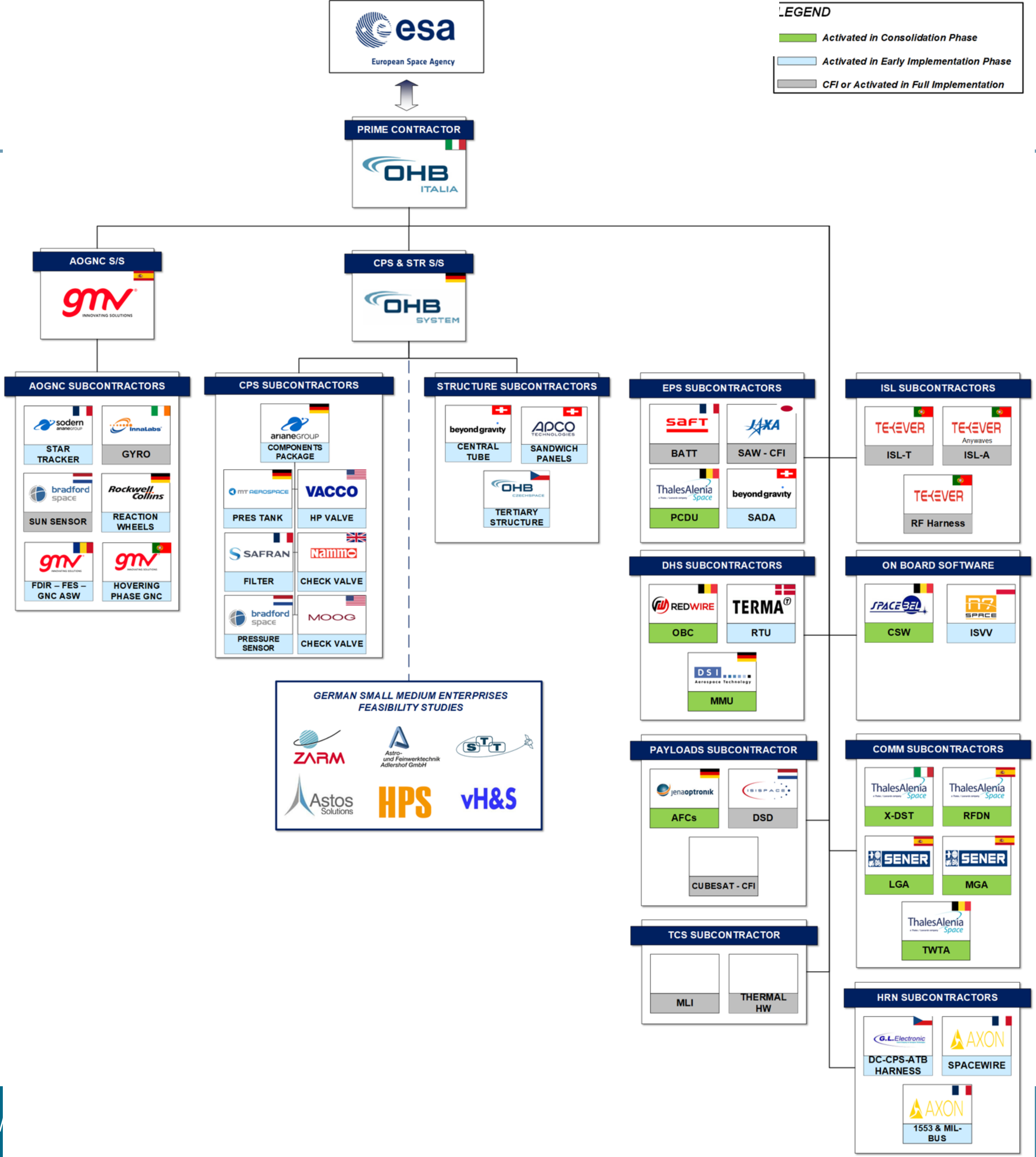
S/C mating Jun 23

Shipment to ETS: Aug 23

Environmental tests: 6 months (net)

Shipment to launch site: Aug 24

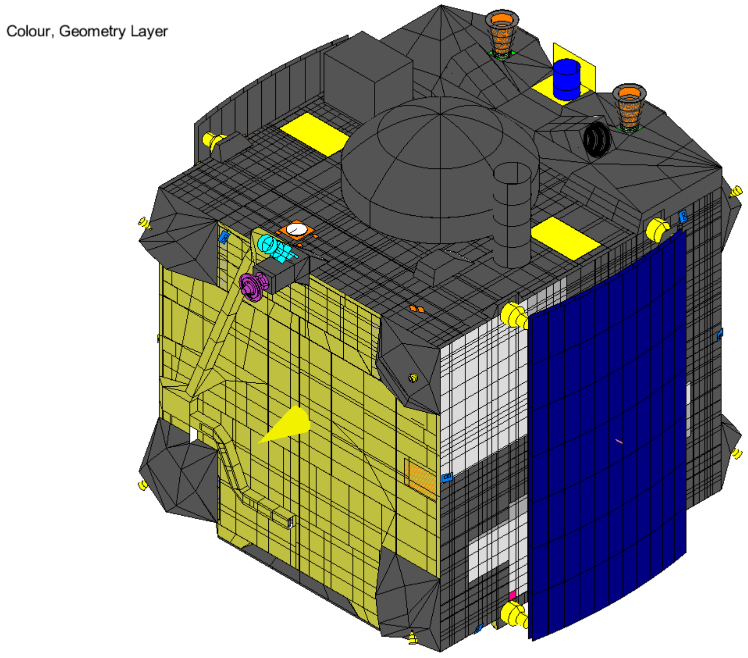
INDUSTRIAL CONSORTIUM



Thermal Control Subsystem (2/10)

MLI and thermal hrn to be procured (mission dependent)

In particular the exposed tank shall be correctly dimensioned

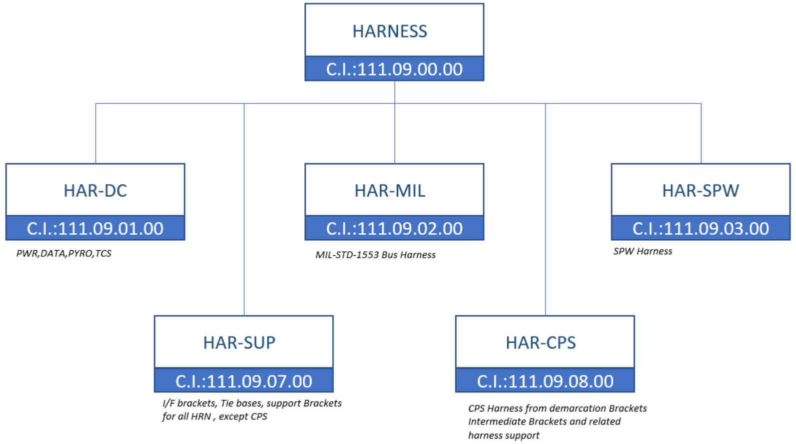


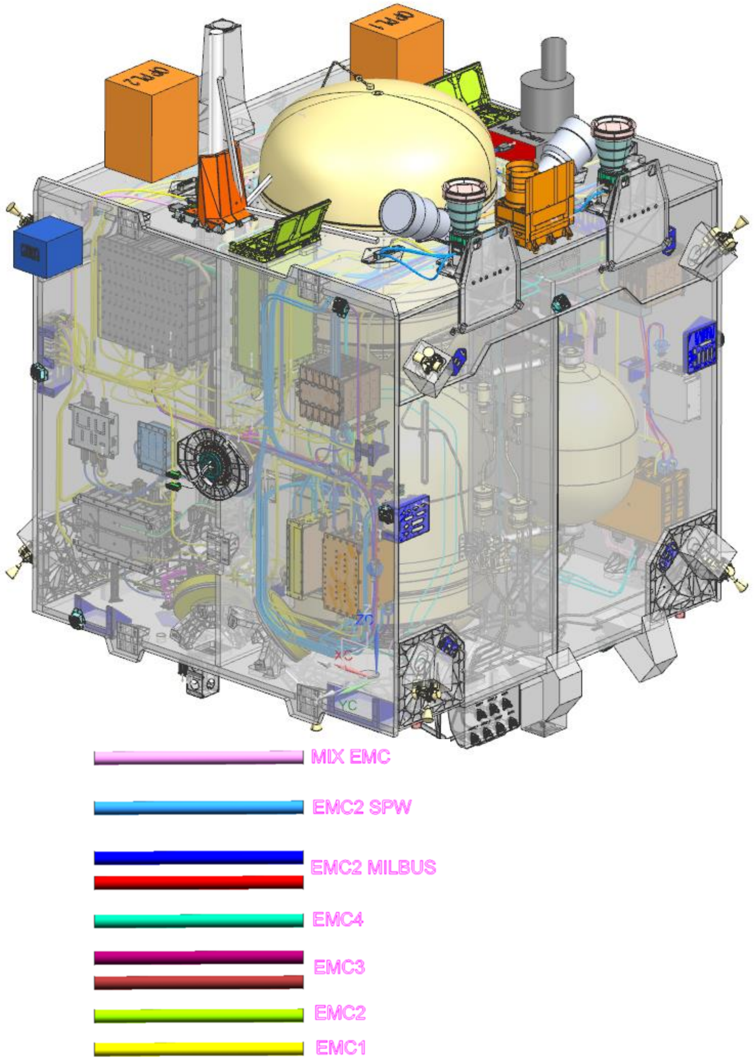
RAMSES GMM in stowed configuration

RAMSES : Harness FM

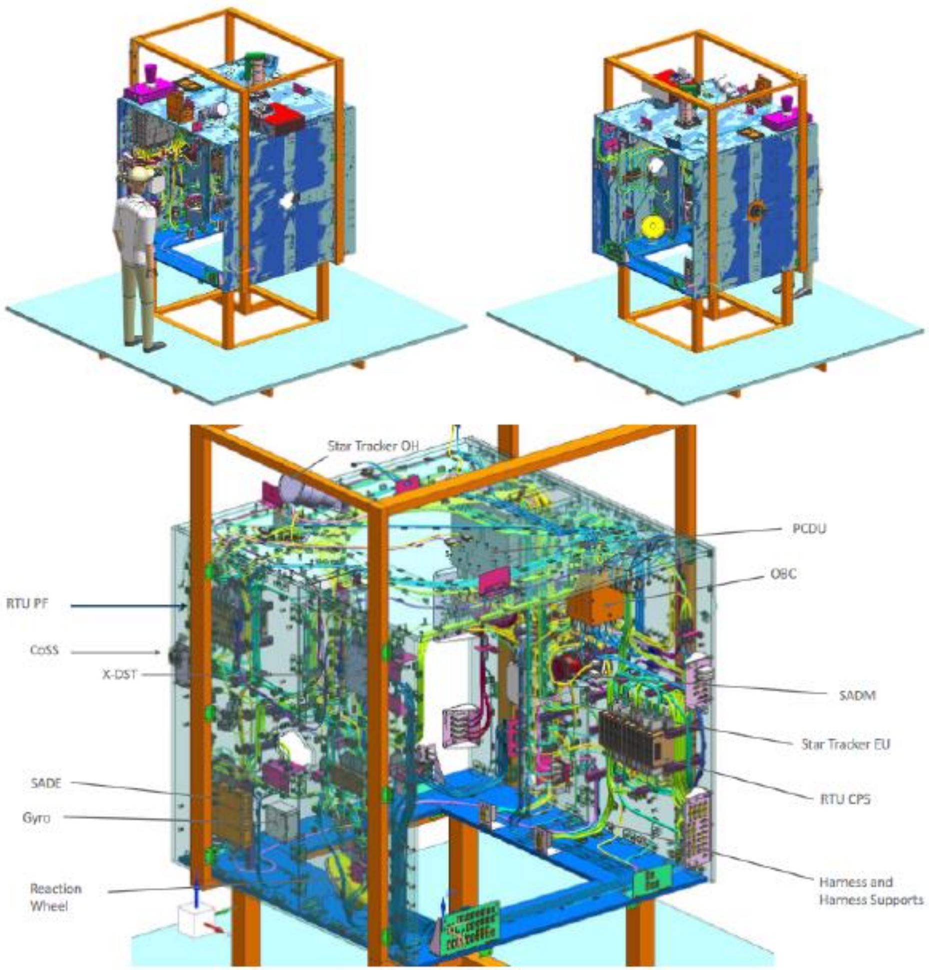
Harness description highlighting differences respect final review

- RAMSES harness design is based on HERA . Changes are foreseen only due to:
  - New unit design
  - Single string adaptation
  - Different ACCOMMODATION





ATB Harness – RAMSES



A massive use of ATB HERA harness is foresee.
preliminary Estimation of only a 30% of new harness dedicated to RAMSES ATB

Ground Support Equipment - MGSE

- MGSE inherited from HERA and potentially useable for RAMSES PFM, but in overlap with COMET-I PFM / SARAH:
  - PM Hoisting Brackets
  - PM LD Stiffeners
  - Payload Deck Dummy
  - Support Washers
  - Rolling Table for PM integration (SARAH)

- MGSE to be refurbished / replaced:
  - ITC with MPT → HERA items are quite uncomfortable to handle. Possibility to replace them with alternative solutions (new procurement, adaptation of already available items)
  - PMTC → procurement of a dedicated item could be evaluated, including PM integration stand
  - S/C Hoisting Brackets
  - Panel Integration Device – Cage (TBC)

No.	Item	to be used for:
1	S/C Transport Conainer	
2	S/C Integration Stand SN01	
3	S/C Integration Stand SN02	
4	Handling Clamp Band (HCB)	
5	AIT Handling Adapter (AITHA)	
6	PM Hoisting Brackets	Comet-I
7	S/C Vertical Hoisting Device	
8	Working Platform	
9	S/C Hoisting Bracket	
10	Payload Deck Dummy	Comet-I
11	Rolling Table for PM integeration	Sarah
12	Intermediate Plate for Rolling Table SN02	
13	Panel Integration Table	
14	Panel Integration Spacers	
15	PM LD Stiffener	Comet-I
16	Panel Integration Device - Cage	
17	OSR Protection Covers	
18	Stiffener for small Closure Panels	
19	Stiffener for RCT panels (lower)	
20	Support Washers	Comet-I
21	Mass Property Measurement Adapter	
22	Vibration Test Adapter	
23	SC Mass Dummy	
24	Core Module Central Tube Dummy	
25	2x Bottom Deck Stiffeners	
26	Intermediate Plate for SCIS 02	
31	Hoisting Beam CT	
32	(Wooden)Transport Box for the PM	
33	SA Deployment rig	
34	Calrod Grid	
33	Intermediate Plate for Electra MPT SN03	Not needed

Ground Support Equipment - EGSE

- EGSE inherited from HERA and potentially useable for RAMSES PFM, but in overlap with COMET-I PFM:
  - CCS
  - EPS SCOE (SA Simulator, Battery Simulator)
  - Battery Conditioning Unit
  - TM/TC FE

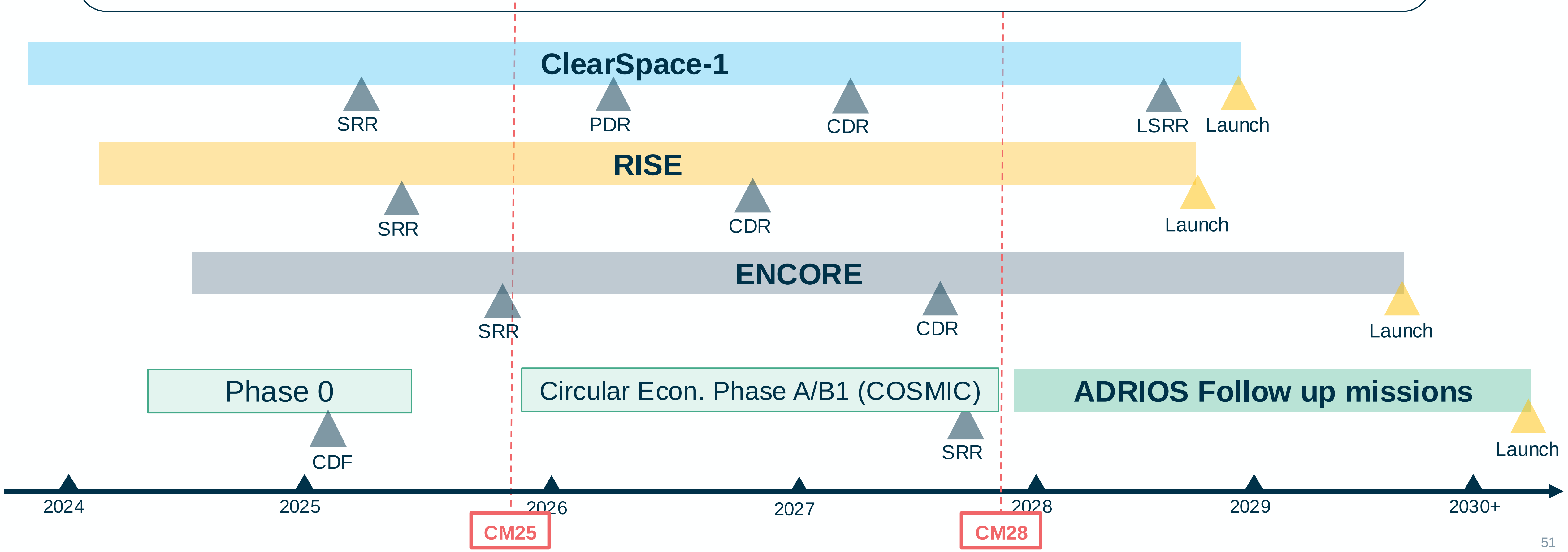
- EGSE to be refurbished / replaced:
  - X-band RF SCOE (only one available, to be shared between ATB and PFM → one more could be needed?)
  - Launch COTE (not exiting on HERA)
  - GNC SCOE updates

No.	Item	Part of ATB (ESA property)	to be used for:
1	Central Check-out System (x4)	x	Comet-I
2	CCS Clients (x2)	x	
3	Direct Bus Power Supply	x	
4	EPS SCOE (BS+SAS) Set 1		Comet-I
5	EPS SCOE (BS+SAS) Set 2	x	
6	TK and Pyro/HDRM (Release Mechanism Jig) Set 1		
7	TK and Pyro/HDRM (Release Mechanism Jig) Set 2		
9	TCS (Thermal Control Jig)		
8	BUCD (Battery Conditioning Unit)		Comet-I
9	Inter-Satellite Link SCOE	x	
10	COMMS X-Band RF SCOE		
11	Payload Interface Checkout Unit		
12	Guidance, Navigation & Control SCOE (TEMIS)	x	
13	Guidance, Navigation & Control SCOE (GMV)		
14	STS Closed Loop EGSE (PC+Optics)		
15	DHS SCOE (PC Redwire + Box)		
16	Milbus Analyser		
17	Separation Strap Box (SEPA) Set 1		
18	Separation Strap Box (SEPA) Set 2		
21	ISL Test Caps		
22	Telecommand/Telemetry Front-End Equipment (with RF) Set 1	x	
23	Telecommand/Telemetry Front-End Equipment (with RF) Set 2		Comet-I
24	S/C Simulator (for H-Checks)		
25	Telecommand/Telemetry Front-End Equipment Baseband Bypass		
26	NDIU		
27	Meinberg		

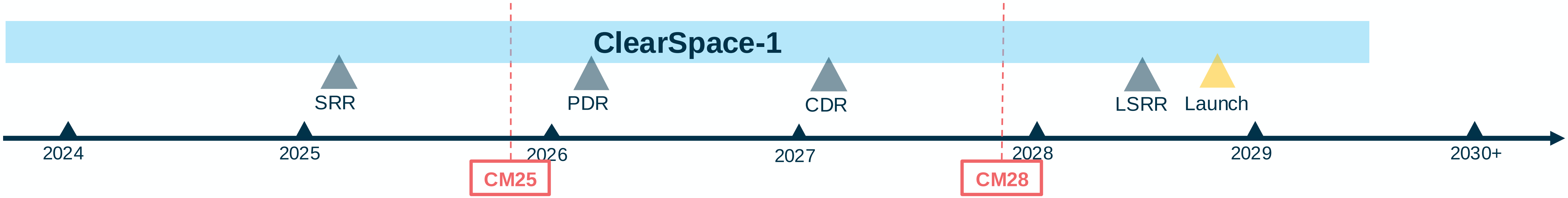
ADRIOS

ADRIOS Cornerstone overview

- Demonstrate and consolidate European leadership on ADR and IOS
- Enable development of ADR and IOS markets
- Capacity building in support of the development of a Circular Economy in Space



ClearSpace-1 Overview



- The CS1 mission will demonstrate the functionalities required to safely approach a space object in low Earth orbit into close proximity
- Industry team lead by OHB System AG with ClearSpace SA and OHB Sweden as subcontractors
- Mission is fully funded
- Launch target 2028
- Phase A/B1 being completed

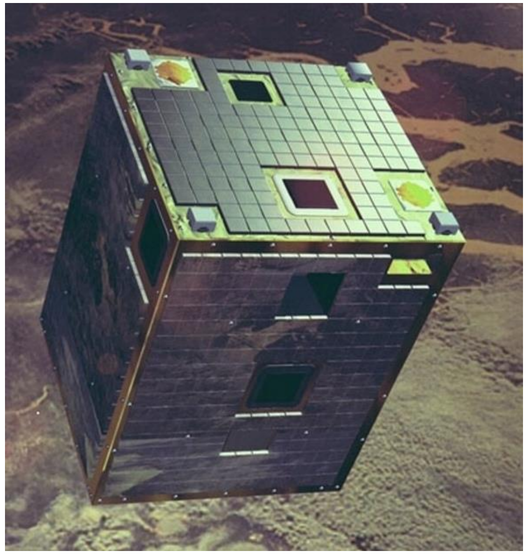
OHB

clearspace today

ClearSpace-1 Mission Baseline

- Originally, ClearSpace-1 was aiming at capturing and removing a VESPA launch vehicle adapter
- Collision of space debris with VESPA in August 2023 increased risk for original ClearSpace-1 mission to unacceptable level
- ClearSpace-1 mission major re-orientation based on results of joint ESA / ClearSpace exercise
    - Object to be removed is now PROBA-1 satellite
    - Direct injection by European micro-satellite launcher
    - Mission duration 1 year
    - Uncontrolled re-entry of the stack
    - Use of available COTS platform components for spacecraft
    - Use of ClearSpace-1 Legacy phase developments by ClearSpace adjusted for the new client spacecraft

proba-1



SPACENEWS 35 YEARS

Civil

Target of European debris removal mission hit by other debris

Jeff Foust August 22, 2023

An artistic impression of ClearSpace-1 approaching its target, the upper part of a Vespa (Vega Secondary Payload Adapter) left after a 2013 launch. Credit: ClearSpace

WASHINGTON — A payload adapter that is the target of a European debris cleanup mission may have itself been damaged by a debris impact.

The European Space Agency said Aug. 22 that it was informed 12 days earlier by the U.S. Space Force's 18th Space Defense Squadron, responsible for space domain awareness activities, that it had identified several pieces of debris in the vicinity of a larger payload adapter called Vespa that has been in low Earth orbit since a Vega launch a decade ago.

The new debris, ESA said, likely originated from Vespa after a collision with a piece of debris too small to be tracked. Follow-up tracking by the 18th Space Defense Squadron as well as European facilities indicates that the payload adapter remains intact. ESA did not state how many pieces of debris from Vespa were bring tracked.

The incident is ironic because the Vespa adapter is the target of an ESA-backed mission to remove it from orbit. ESA selected Swiss startup ClearSpace in 2020 to fly a mission that would grapple the 113-kilogram adapter and remove it from orbit, awarding it a contract worth 86 million euros ($93 million).

ClearSpace-1 Operations Concept

Closing:

Servicer approaches the client on passively safe relative orbit, slowly reducing relative semi-major axis in spiralling approach

Fly-around:

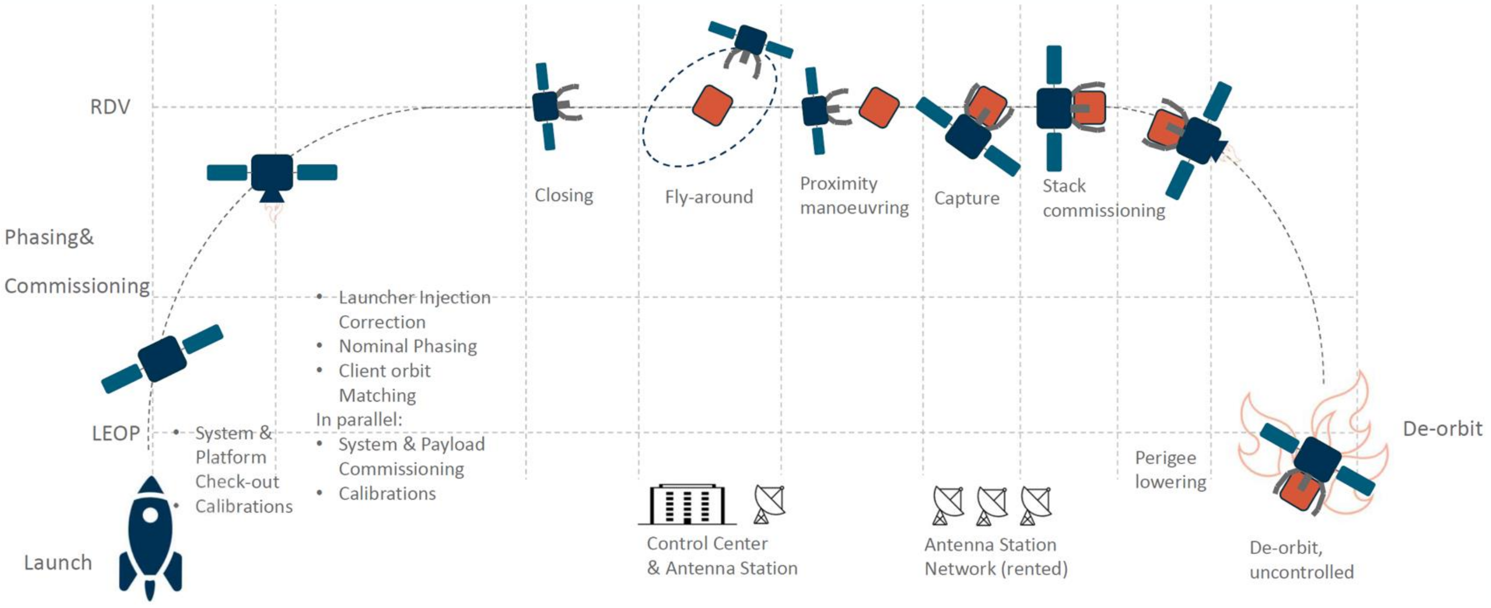
Multiple waypoints centred on the client object at gradually decreasing ranges will be passed until the working range of each sensor is reached.

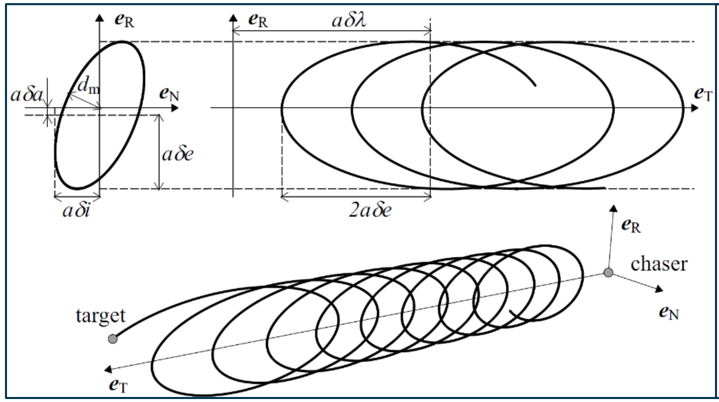
Proximity Manoeuvring:

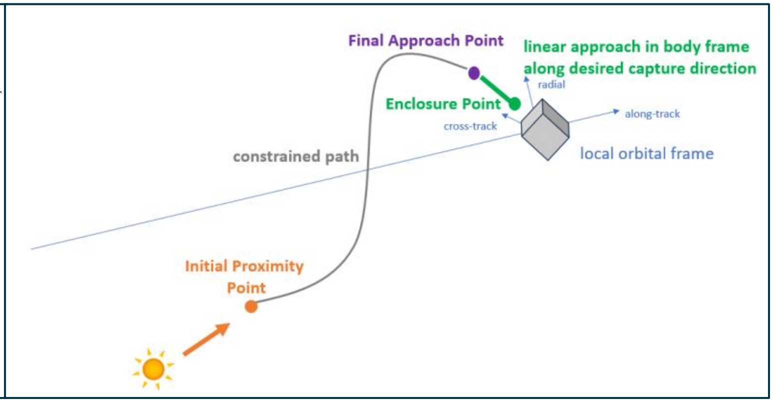
Transition from Formation Keeping Point (FKP) to Initial Proximity Point (IPP), followed by forced motion trajectories with relative orbit no longer passively safe, keep out zone around the client protected by Collision Avoidance Manoeuvre function, back to FKP at the end.

Capture:

Final approach to client from FKP to IPP station keeping with relative pose estimation in the loop, from IPP to Final Approach Point (FAP) and to proximity trigger, enclosure and capture operations. Capture confirmation and stack stabilisation to achieve a stable sun-pointing attitude.

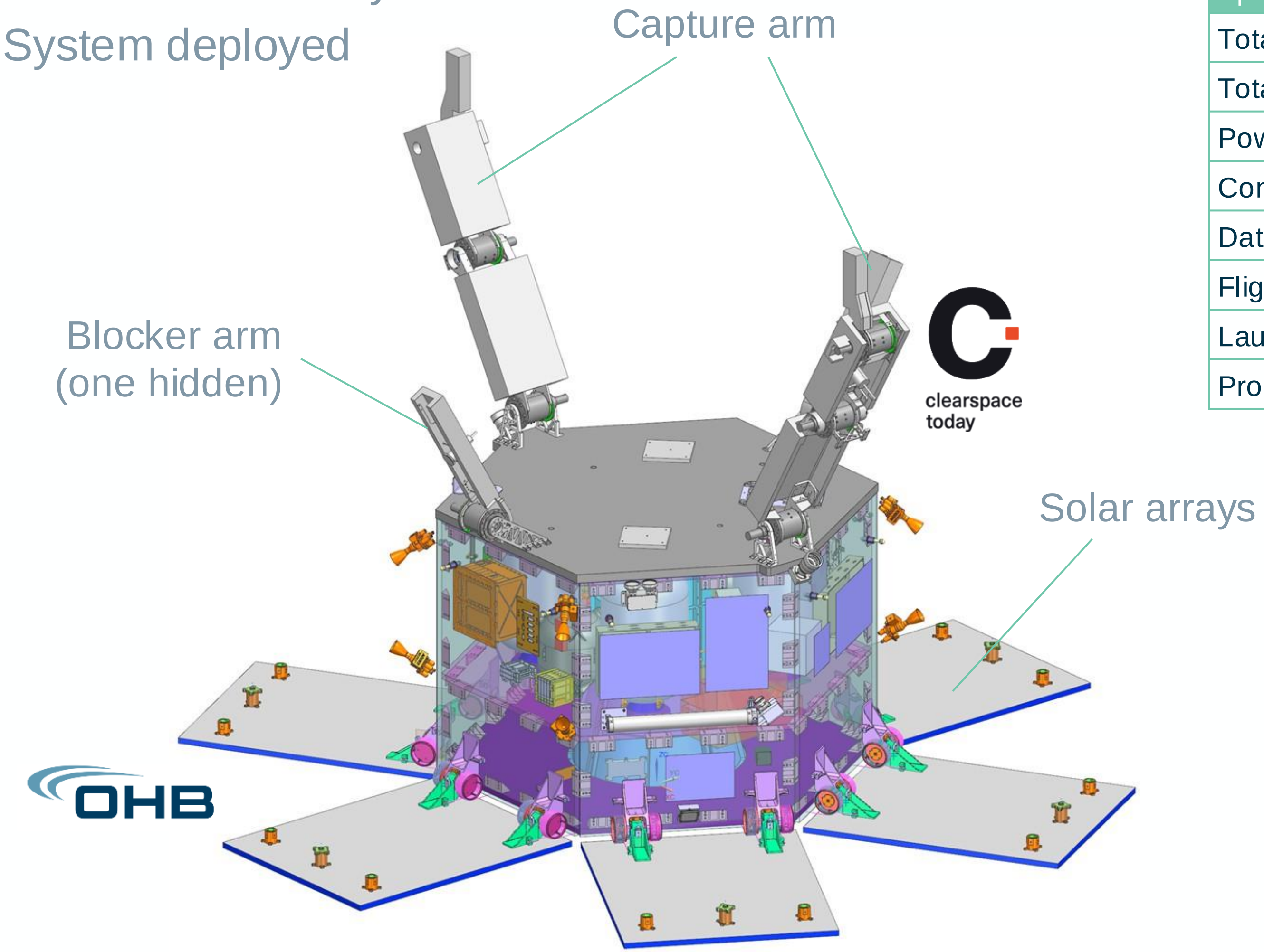






ClearSpace-1 System Design

CS1 Spacecraft with Solar Arrays and Capture System deployed

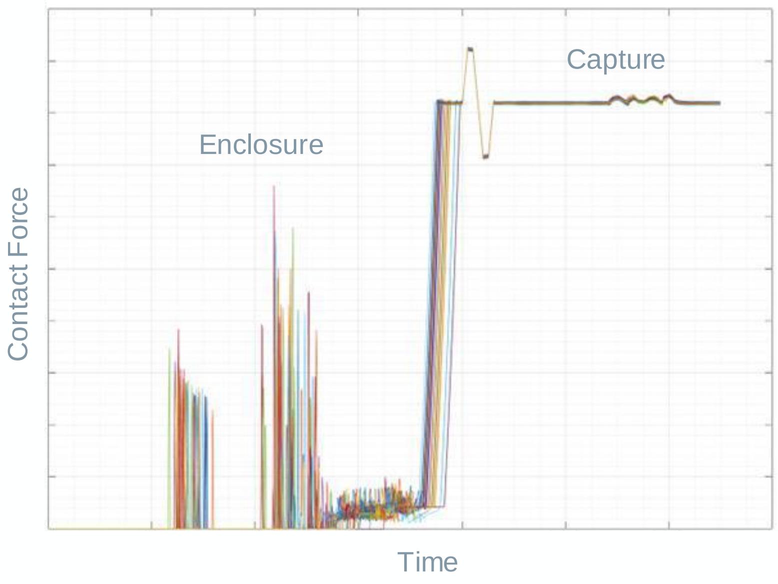


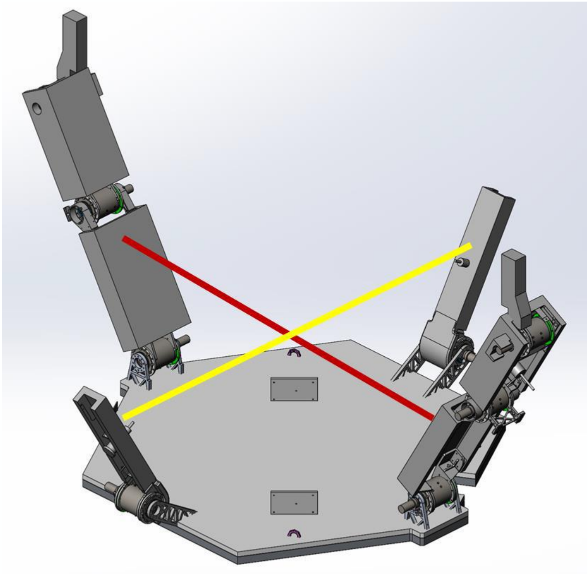
Spacecraft Parameters	
Total mass	580 kg wet, including SRR margin
Total volume	1600 mm (width), 1300 mm (height)
Power	850 W (peak)
Communication Links	S-band, X-band
Data Handling	Platform OBC, Payload OBC
Flight Operator	OHB / ClearSpace
Launch vehicle interface	24-inch standard
Propulsion system	Chemical, green bi-propellant

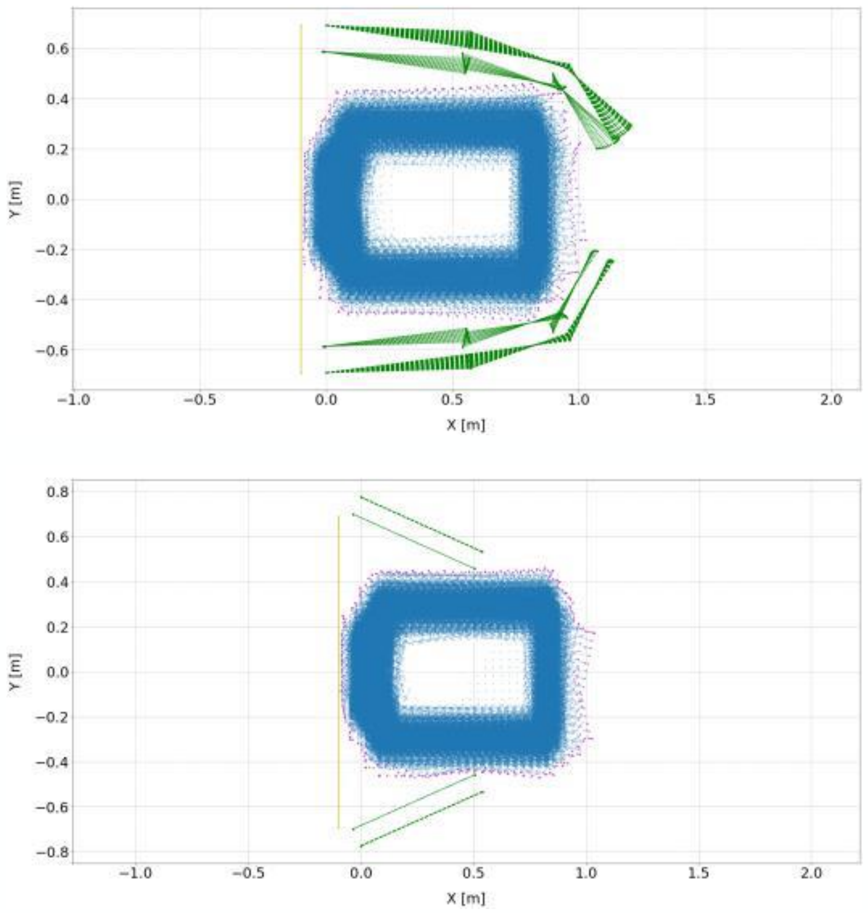
ClearSpace-1 System Design

CS1 Capture System

- Autonomous client detection within the capture envelope
- Motion of arms to enclose, grasp and securely capture the client
- Absorption of the contact loads and avoidance of damage to the client or the servicer by force limitation
- Securing of the client for stack formation







ClearSpace-1 Opportunities for Participation

Item	SME	InnoSat	Return
Radar & Antenna			
WAC & NAC			
Capture System (CSY)			
CSY Generic Control Electronics	x		
CSY Capture Arm Phalanges and damping structure			
PL Harness			
S-band Transceiver	x	x	
Magnetorquer	x	x	
Reaction Wheel	x	x	
Structure Panels	x		
Central Structure	x		
Launch Vehicle Adapter	x		
Harness	x		
Star Tracker		x	
Solar Arrays	x	x	
Folding and Latching Mechanism			
HDRM			
Battery		x	
Satellite Test Facility			
Mission Operations			

- Supplier selection ongoing at OHB System AG in preparation of the Phase B2/C/D/E proposal

Participating State	Industrial return requirements
Czech Republic	2%
Germany	23%
Hungary	1%
Poland	1%
Portugal	8%
Romania	4%
Sweden	14%
Switzerland	30%
United Kingdom	18%

ClearSpace-1 Opportunities for Participation

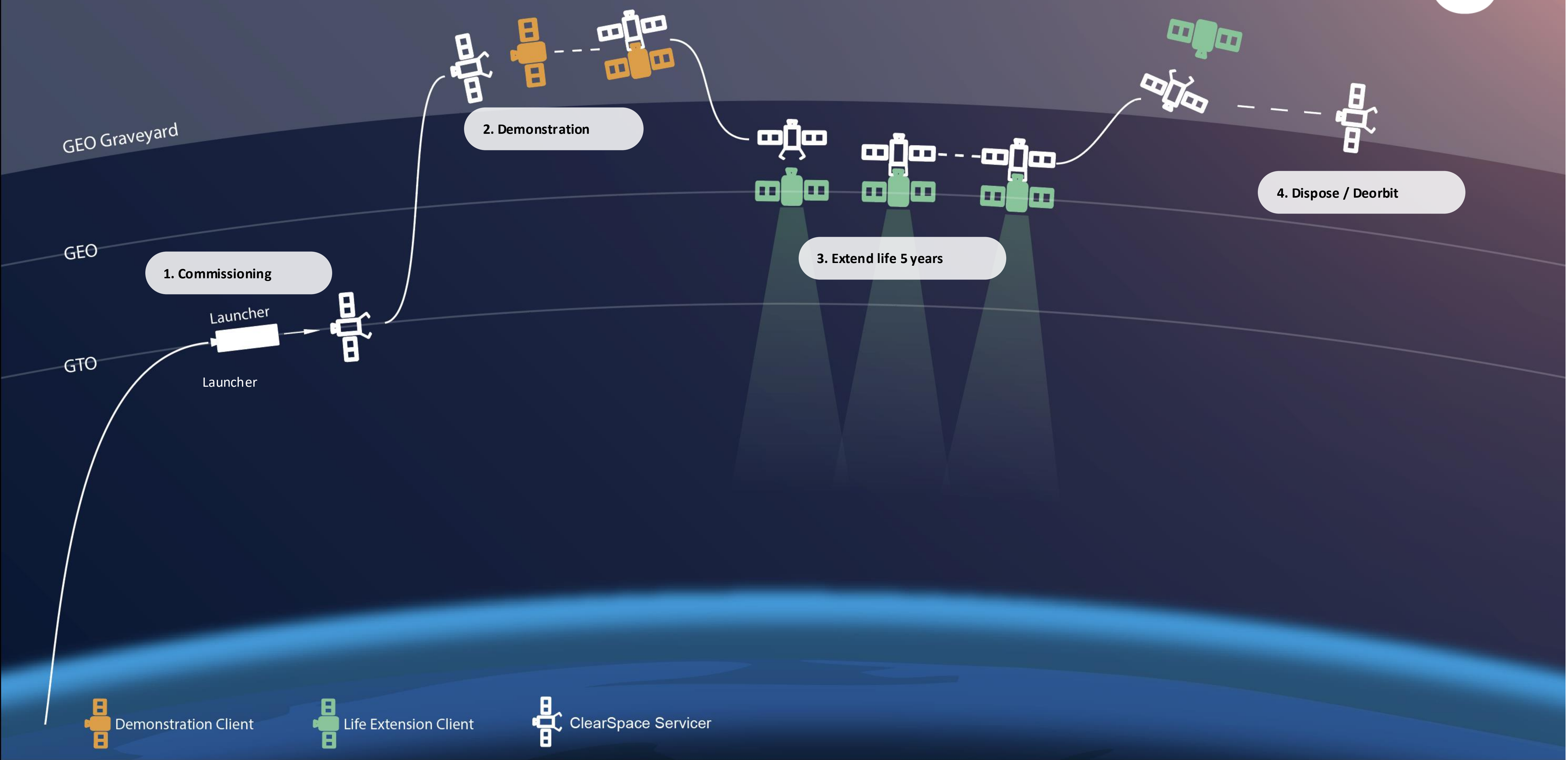
Item	SME	InnoSat	Return
S-Band Antenna	x	x	
GNSS Antenna	x	x	
Payload OBC	x		
Capture System Harness			
Chemical Propulsion System Engineering and Integration	x		
Rate Sensor (Gyro)		x	
Multi-Layer Insulation			
Rendezvous GNC development			
Payload Flight Software			
Capture System functional test GSE			
Power Control & Distribution Unit	x	x	
Platform OBC	x	x	
GNSS Receiver		x	
Sun Presence Sensor		x	
Propulsion Subsystem Management			
On Board Software Modification			
Satellite Simulator			
GNC Models for SATSIM/FES/SVF			
ATB & Test evironment set-up			
Satellite Test procedures validation on ATB			
RAMSES Flight Software			
General Support Services			
Innosat EGSE provision			
Design of PF AOCS/GNC and work in integrated Team			

- Supplier selection ongoing at OHB System AG in preparation of the Phase B2/C/D/E proposal

Participating State	Industrial return requirements
Czech Republic	2%
Germany	23%
Hungary	1%
Poland	1%
Portugal	8%
Romania	4%
Sweden	14%
Switzerland	30%
United Kingdom	18%

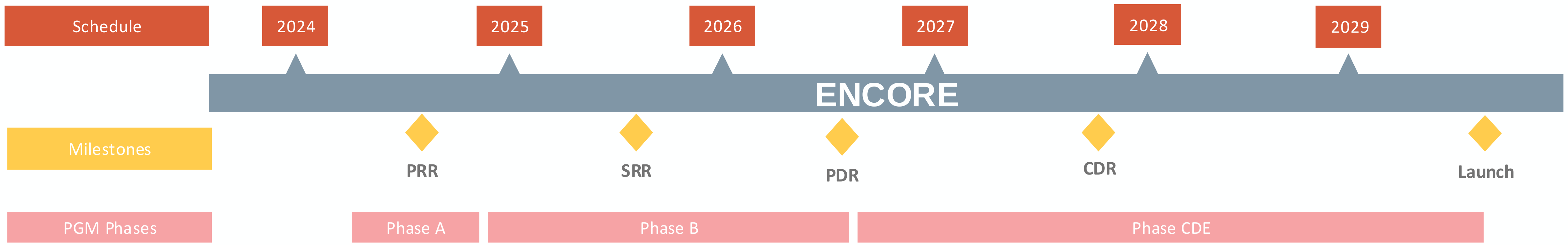
ADRIOS

ENCORE – GEO Life extension CONOPS



ENCORE – Status and Schedule

- ClearSpace-Luxembourg is the Prime
- Phase A starting in end-2024, focusing on platform and payload
- Following completion of the Phase A, follow-on activity will be prepared and ClearSpace are actively working to identify roles and responsibilities with a subcontractors



ENCORE GEO-Return

- Total Cost at Completion is 174 Meuro excluding co-funding contribution.
    - CMIN-22: 42 Meuro
    - CMIN-25: 45 Meuro
    - CMIN-28: 87 Meuro

- Several key roles and responsibilities remain open including platform support, which is reflected in the geo-return CMIN-25 request.

		S2P Period 2 (CM-22) Subscriptions	S2P Period 3 (CM-25) Estimate	S2P Period 4 (CM-28) Estimate
		Amount (Meuro)	Amount (Meuro)	Amount (Meuro)
AT	Austria		0-2	TBD
BE	Belgium		0-2	
CZ	Czech Republic			
DK	Denmark		2-4	
EE	Estonia			
FI	Finland			
FR	France		0-15	
DE	Germany		5-20	
GR	Greece			
HU	Hungary			
IE	Ireland			
IT	Italy			
LU	Luxemburg	26	15-20	
NL	Netherlands		0-2	
NO	Norway		0-3	
PL	Poland		0-5	
PT	Portugal		0-8	
RO	Romania	0.8	2-5	
ES	Spain	1.7	3-8	
SE	Sweden		2-5	
CH	Switzerland	2.5	5-10	
GB	United Kingdom	10	5-10	
CA	Canada	1	0-2	
LV	Latvia			
LT	Lithuania			
SI	Slovenia			
SK	Slovakia			
		42	45	87

RISE Mission Summary

RISE aims to bring together a service provider and a customer for the verification of life extension of a satellite through Attitude and Orbital Control Takeover (AOCS Takeover) in geosynchronous graveyard orbit (GGO).

- Industry led mission by D-Orbit-IT – industry defining the mission and system requirements
- End-to-end contract signed in Q3 2024 covering Phase A to E
- Following the verification in graveyard orbit, ESA role ends, industry to continue with commercial service
- First European Mission for AOCS Takeover in Europe
- Requires cutting edge technology for rendezvous and capture
- Depends on customer (e.g. telecom operator) participation in development, and customer satellite in GGO

ADRIOS

RISE – CONOPS

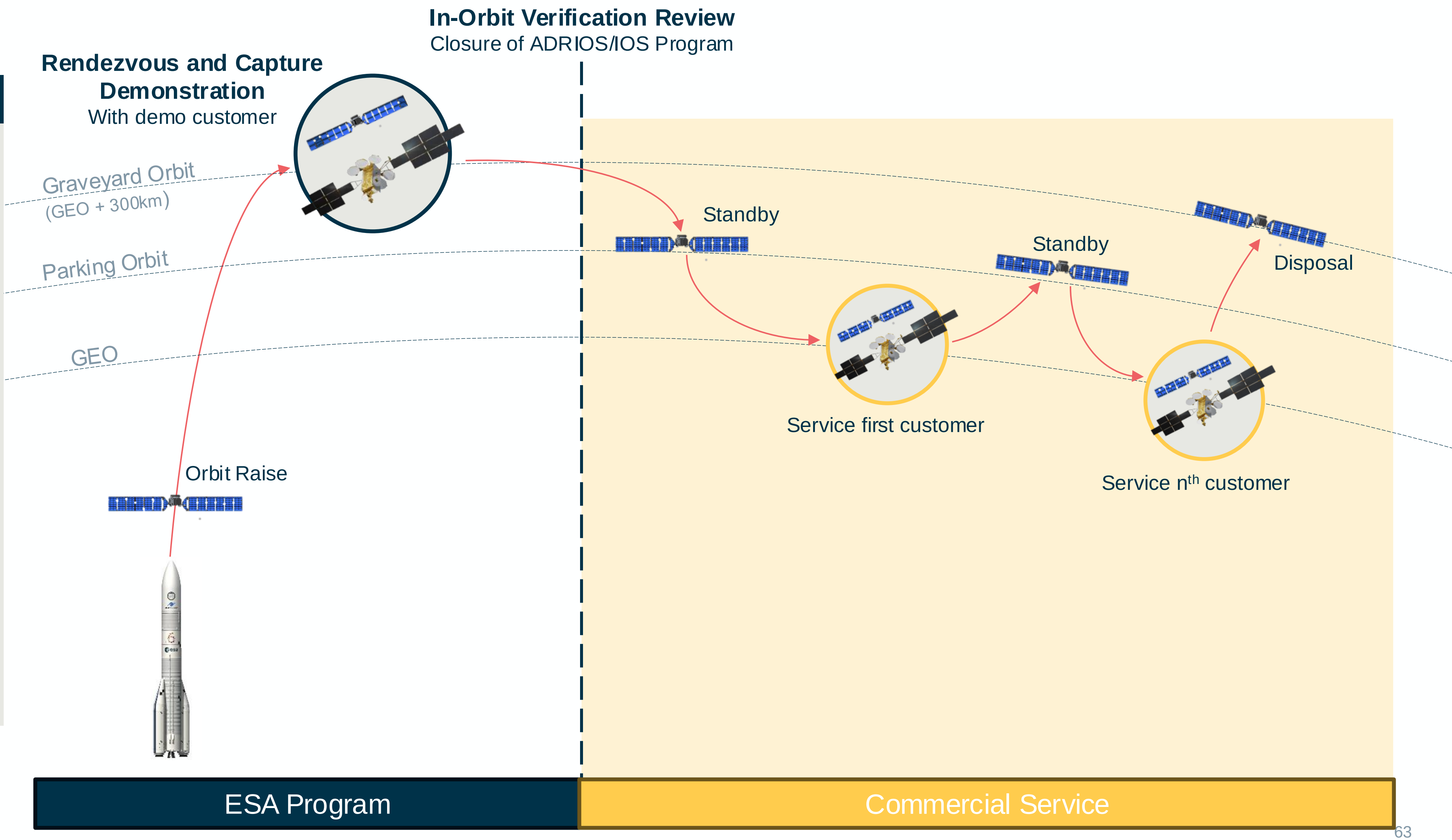
Mission Overview

ESA

1. Launch injection into Geostationary Transfer Orbit
2. Orbit Raise from GTO to GEO Graveyard Orbit
3. Rendezvous and Capture Demonstration in GGO with demo customer
4. **In Orbit Verification Review**

Commercial

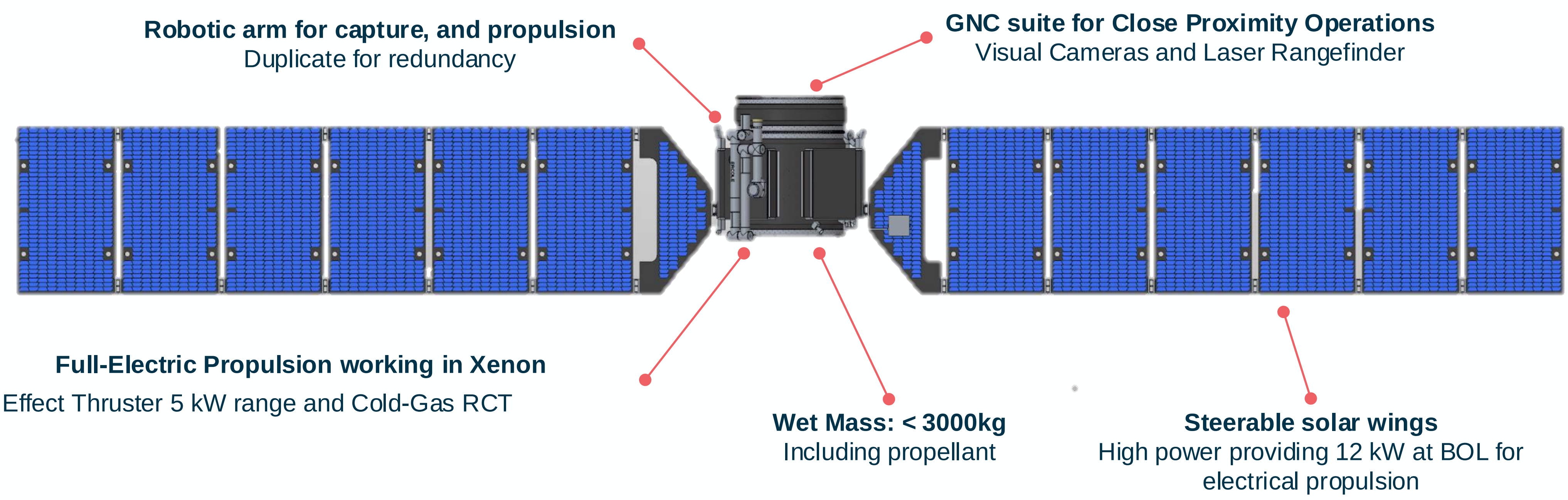
5. Standby in parking orbit until start of servicing
6. Servicing of first commercial customer
7. Disposal in GEO Graveyard Orbit



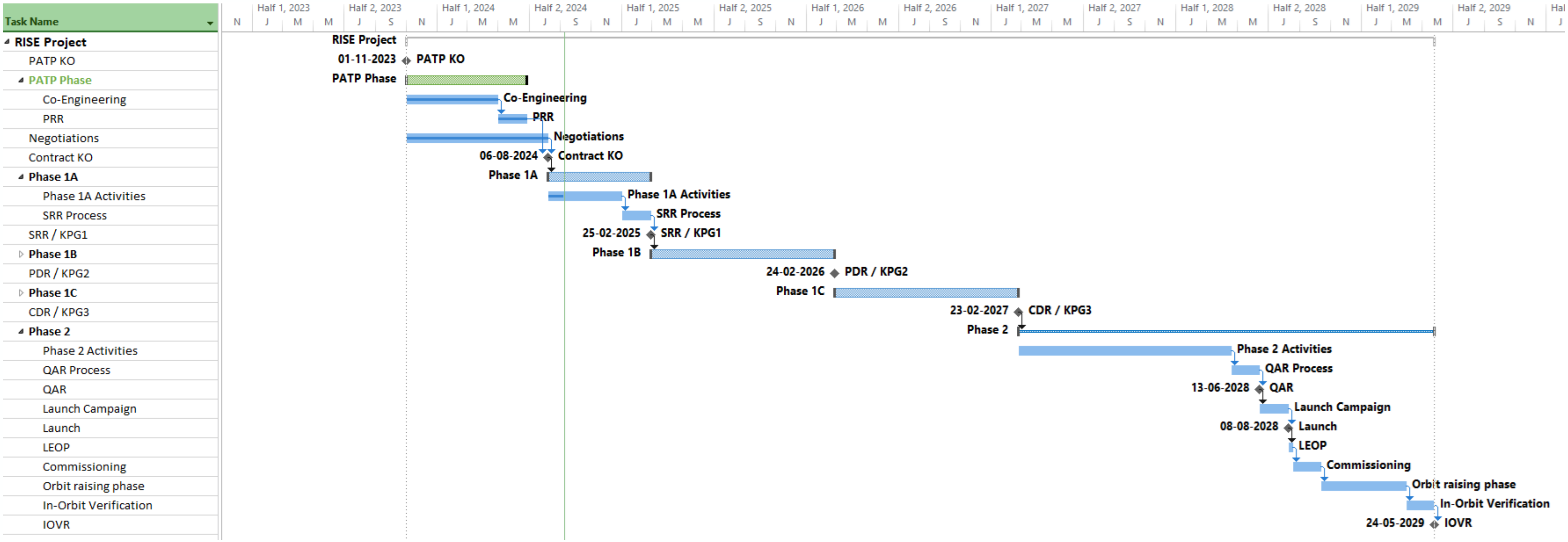
RISE – System Description

Capabilities

- GTO to GEO Transfer
- Demonstration of AOCS take-over capabilities in the GEO graveyard orbit followed by commercial GEO life extension service.
- Lifetime of 8 years
- ECSS tailoring performed by D-Orbit



Schedule and Costs



Costs:

- Cost at Completion (CaC) is 210 Meuro plus co-funding from D-Orbit
- 128Meuro is requested at CMIN-25

RISE Geo-Return

		S2P Period 2 (CM-22) Subscriptions	S2P Period 3 (CM-25) Estimate
		Amount (Meuro)	Amount (Meuro)
AT	Austria		0-2
BE	Belgium		2 - 5
CZ	Czech Republic		
DK	Denmark		1 - 3
EE	Estonia		
FI	Finland		
FR	France		0 - 5
DE	Germany	10	15 - 25
GR	Greece		
HU	Hungary		
IE	Ireland		
IT	Italy	60	50 - 80
LU	Luxemburg		
NL	Netherlands		
NO	Norway		
PL	Poland		3 - 10
PT	Portugal		2 - 5
RO	Romania	0.8	1 - 3
ES	Spain	3.3	5 - 20
SE	Sweden		0 - 3
CH	Switzerland	2.5	5 - 10
GB	United Kingdom	6	5 - 10
CA	Canada	0.5	0 - 2
LV	Latvia		
LT	Lithuania		
SI	Slovenia		
SK	Slovakia		
		83	128

RISE Consortium to-date (Phase B1):

Italy:
- DOrbit (Prime, System Enginereing..)
- Telespazio (Ground segment infrastructure)

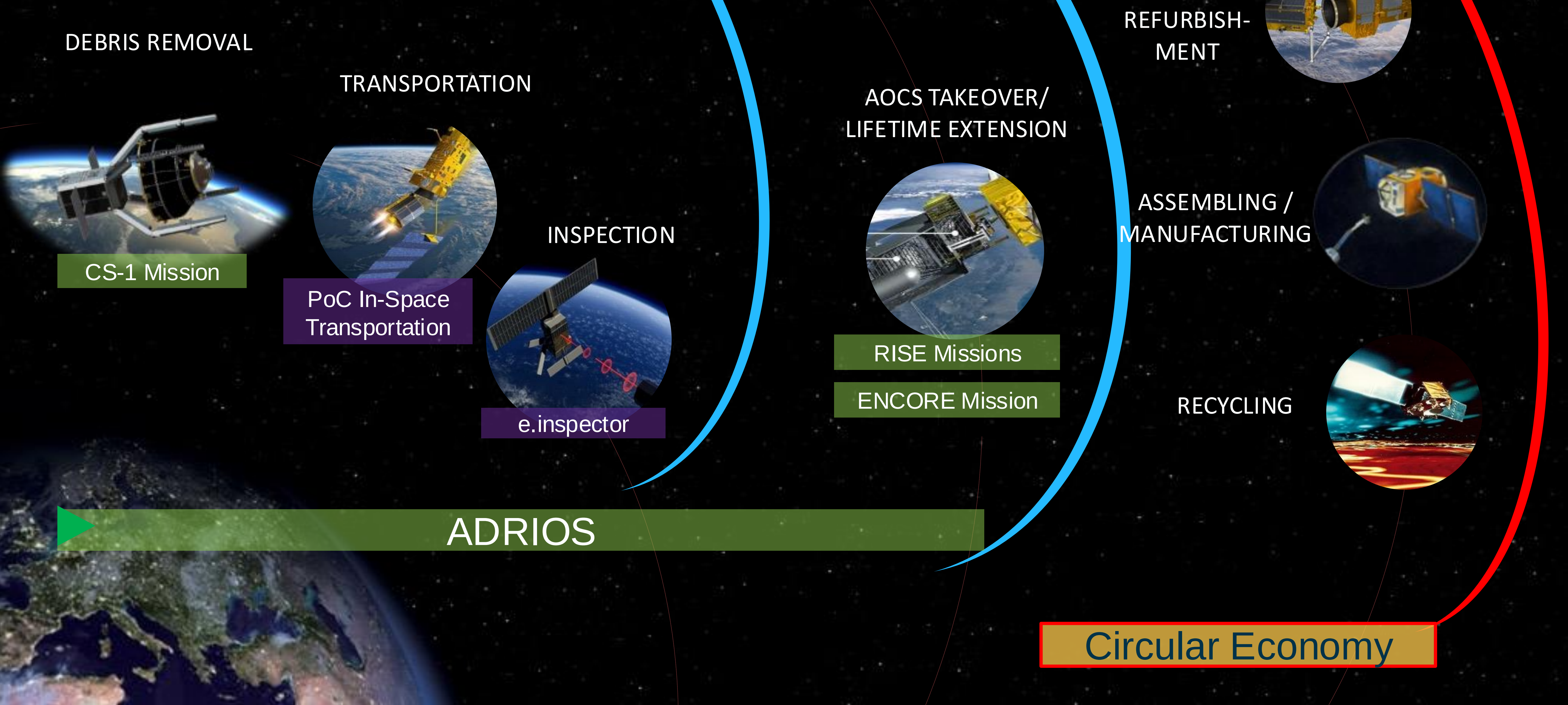
Germany
- DLR(ERCOLE Robot Arm Analysis)
- KINETIK (ERCOLE Robot Arm)
- iBOSS (Robotic Interfaces)

United Kingdom
- D-Orbit (UK) (Customer acquisition and market analysis)
- LMO (Close Proximity Operations sensor selection and analysis)

Spain
- GMV (Relative Proximity Operations verification)

Several roles remain open, this is reflected in the S2P Period 3 Subscription uncertainty!

ADRIOS Future Vision



ADRIOS Follow-up - Circular Economy for Space

Concepts for future circular economy space systems capable of providing on-orbit **refurbishment**, **manufacturing**, and **recycling** in Earth orbit.

Refurbishment is the servicing of an existing satellite by replacing current aged or non-functional parts by new equivalent ones.

Manufacturing is the manufacture of s/c parts on-orbit starting from raw material and/or basic components coming from Earth and/or from on-orbit recycling.

Recycling is the capacity to process materials/parts already in space, from old spacecraft or space debris, into usable raw material for the manufacturing of new equipment/parts

Selection Criteria

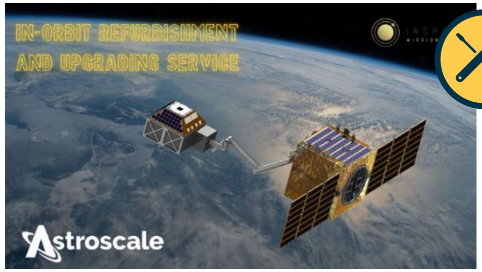
Relevance for circular economy in space

Novelty and disruptive potential

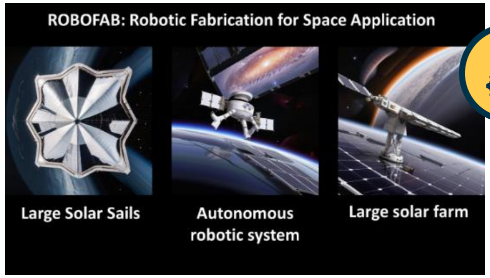
Technical and programmatic feasibility

CM25 : 2 phase A/B1 ADRIOS follow-up missions + technology maturation – 2 x 10M€
CM28 : phase B2 - E mission proposal

Circular Economy for Space Call - Shortlisted Ideas



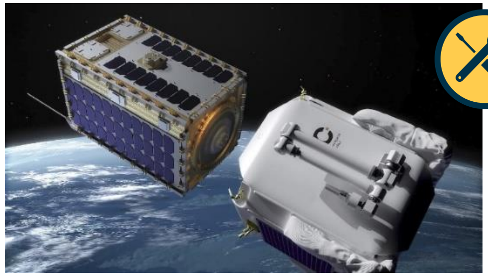
Astroscale (UK)
Satellite Refurbishment and Upgrading Services for Orbital Sustainability



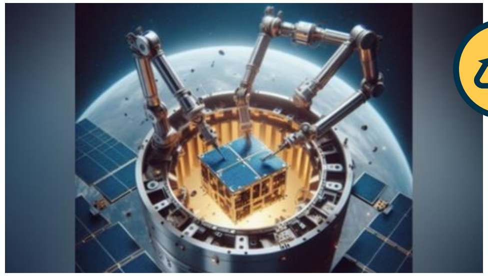
KINETIK Space (D)
Robotic Fabrication for Space Applications

Space scAvengers (SV)
Managed Recycling Orbit operated as a Multi-Agent System

TU Berlin (D)
Salvage - Targeting a European GTO object for cis-lunar recycling stations

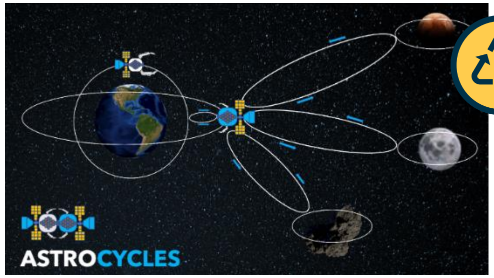


ClearSpace (CH)
Sustainable Cosmic Swap



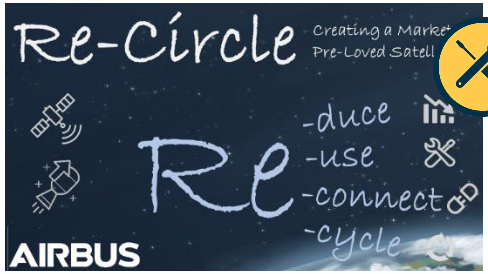
OHB (D)
SCRAP-IOD: SpaceCraft Removal And Processing - In Orbit Demonstration

Thales Alenia Space (FR)
Recycling Space Plant



Columbiad Launch Services (CA)
Recycling and Orbital Circular Lifecycle Engineering Solutions

AirBus (FR)
Re-Circle: Creating a Market for "Pre-Loved" Satellites



Growbotics (UK)
LOOP: commercial refurbishment mission of a spacecraft in GEO

COSMIC – Enhancing Space Weather System

Space Weather – Objectives

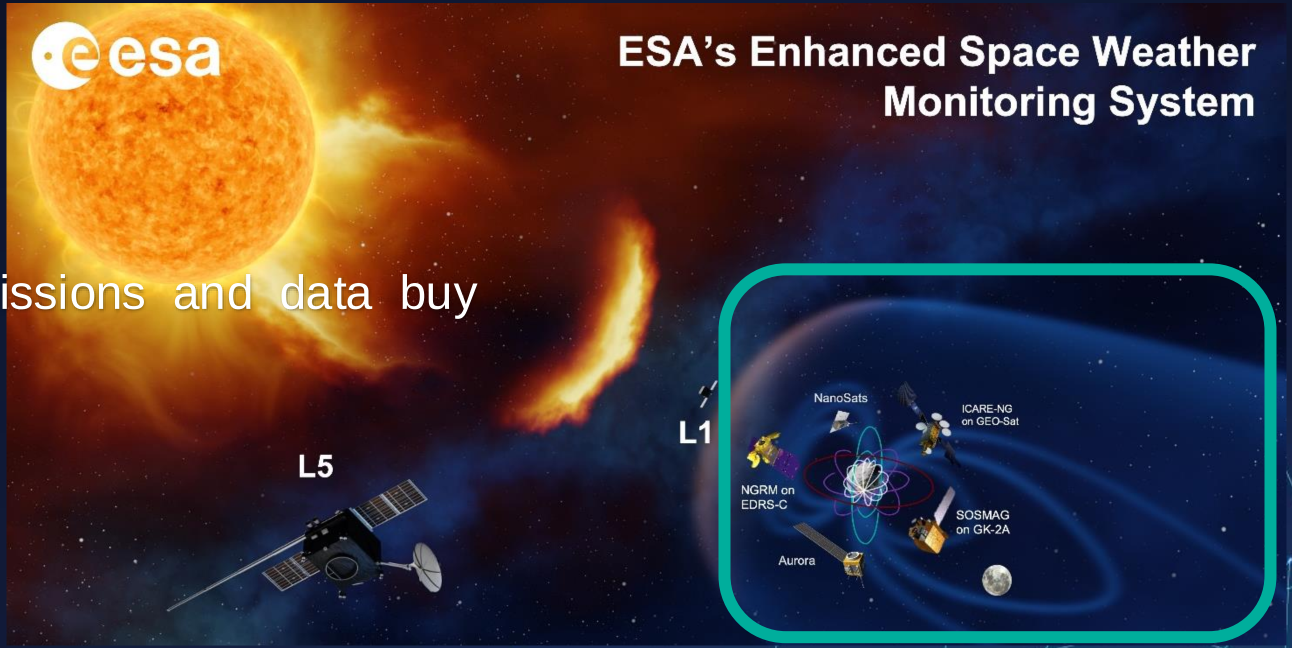
ESA will contribute in a coordinated European context to:

- Development of an operational **space weather monitoring system**
- Development of **capability to provide services tailored to European user needs**
- Definition of **long term maintenance and enhancement plan**
- Implementation of **tested and exercised early warning system** enabling prompt responses
- Development of **world class R2O/O2R framework**

Space Weather – Distributed Space Weather Sensor System D3S

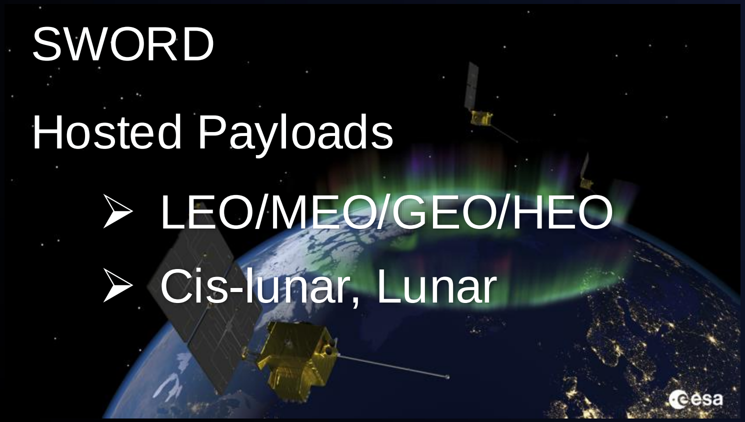
Objective

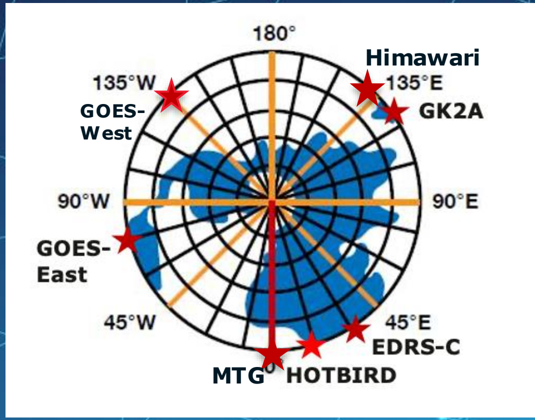
- Monitoring of the ”Earth space” environment
- Near-real time data for operational applications
- Cost effective implementation through small missions and data buy from commercial actors



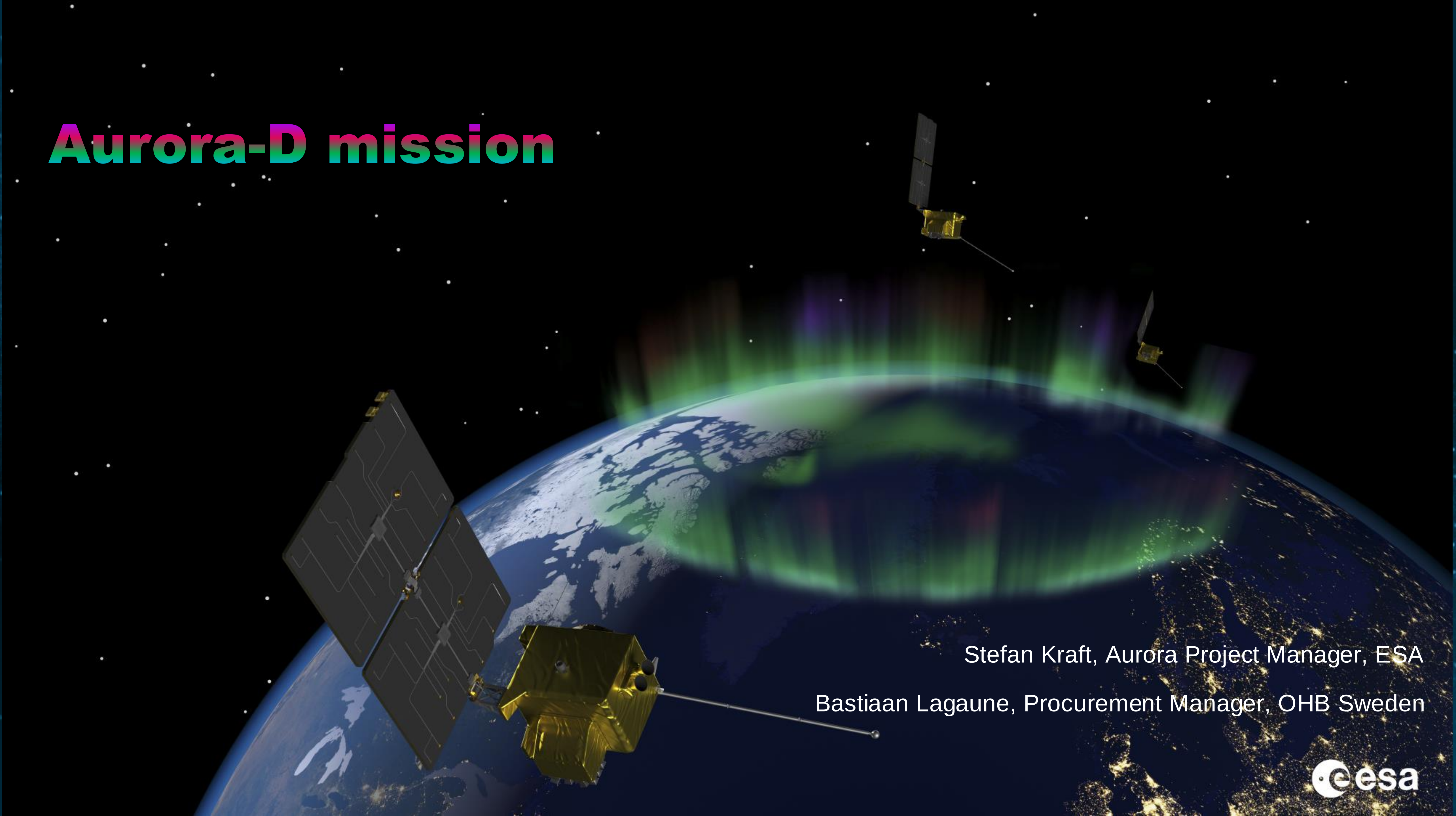
Missions:

- Aurora
- Nanosat constellations
- SWORD
- Hosted Payloads
  - ➢ LEO/MEO/GEO/HEO
  - ➢ Cis-lunar, Lunar





Aurora-D mission



Stefan Kraft, Aurora Project Manager, ESA

Bastiaan Lagaune, Procurement Manager, OHB Sweden

Aurora high-level mission objectives

- Continuous observation of Aurora Borealis and Australis to monitor the impact of solar wind and Coronal Mass Ejections on the terrestrial system.
  - Imaging of Aurora performed by optical and far UV imaging.
  - Electron precipitation to be derived by conversion of imaging data into electron flux and energy
- Provide imaging data of day and night side of the Auroral Oval to determine strength, dynamics, location, and extent of the auroral region.
- Spatial sampling distance: between 30 km and ~100 to 200 km.
- Identification, monitoring and nowcasting of geo-magnetic storms and as a goal perform monitoring of sub-storms.
- Improve magnetospheric and ionospheric modelling for space weather nowcasting and forecasting, develop and provide new services.
- Secondary objective: provide magnetic field, radiation, particle flow, and electron density measurements → radiation monitor and magnetometer.

Aurora-D main characteristics

Continuous monitoring of the Auroral Oval

- Small Satellite demonstration mission (Aurora-D) in preparation of constellation (Aurora-C)
- Aurora-C: 4-satellites with 90 degree phasing
- Aurora-D: Mission Class IV (Gamma)

Mission orbit & satellites

- Medium Earth Orbit @ ~6500 km, circular, drifting
- ~210 kg incl. instrument
- ~350 W nominal operation (TBC)
- S-band communication, ~360 kbps downlink rate

Instruments

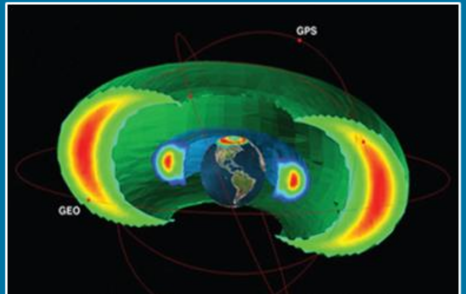
- Auroral Optical Spectral Imager (AOSI)
- Aurora far UV Imager (AUI)
- Radiation Monitor and Magnetometer (RadMag)

Launch Vehicle & Launch date

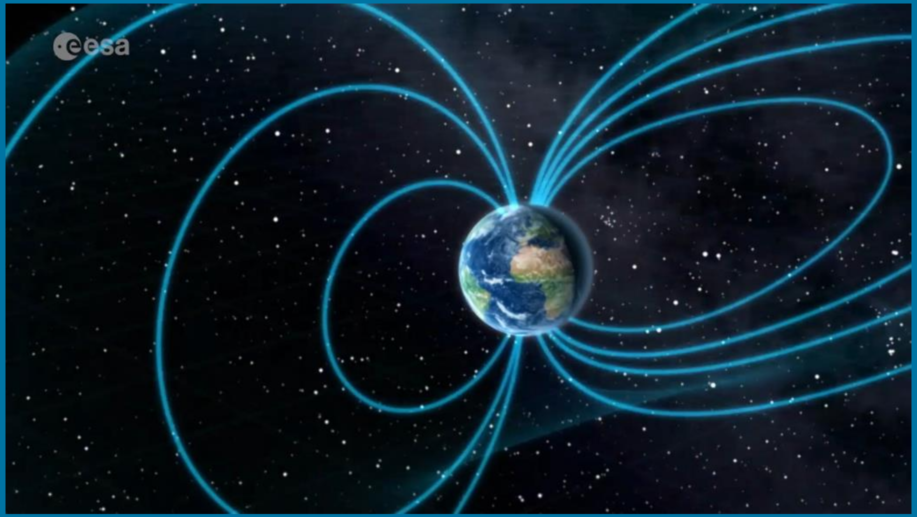
- Micro-launcher baselined

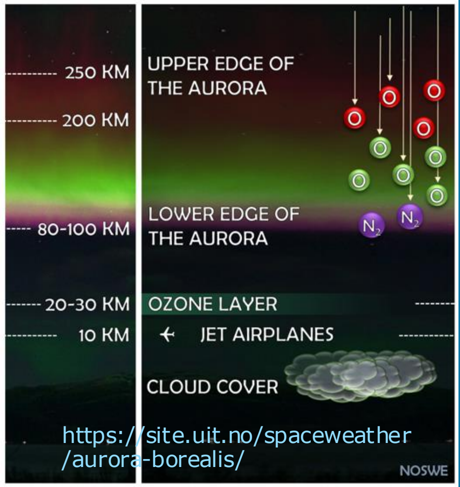
Flight Operators and payload data processing

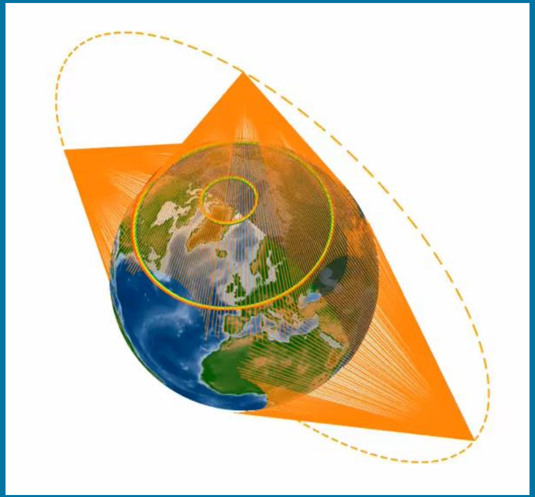
- Operation, ground segment and launch service managed by mission prime
- Level 1 processing at ESOC SWE PDC

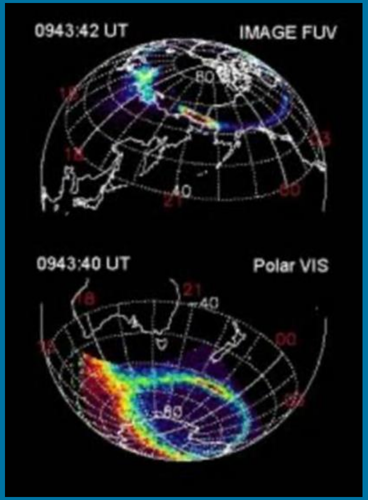


http://nap.edu/1306
0









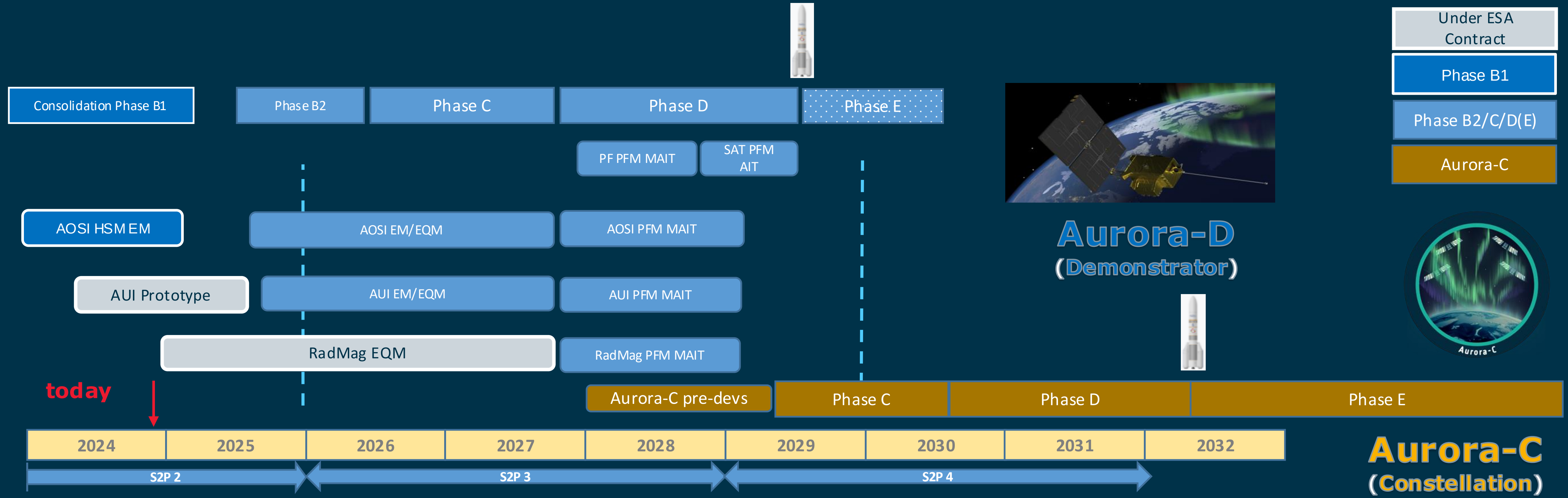
Aurora-C ROM cost and Aurora development timeline

esa

Phase B1 underway with OHB Sweden as mission prime, SRR planned for Q1 2025

RFQ for Phase B2/C/D to be released immediately after SRR in Q2 2025, Phase E to be initiated later

Preparation of Aurora-C expected to start in Space Safety Period 3 (S2P3)



Opportunities for Aurora-D Phases B2/C/D/E

In general, the Aurora-D consortium is nearly complete and an RFI round is already ongoing, a few open items still exist. OHB Sweden intends to close the final selection at SRR (Q1 2025).

All potential bidders (from the participating member states*) are requested to contact the following responsible entities to be considered as a supplier to Aurora-D:

1. **System/Mission aspects: OHB Sweden - Bastiaan Lagaune (bastiaan.lagaune@ohb-sweden.se)**
2. **Platform aspects (**): OHB Sweden - Bastiaan Lagaune (bastiaan.lagaune@ohb-sweden.se)**
3. **Instrument aspects:**
   - AOSI – Absolut System: Juana Rodrigo (juana.rodrigo@absolut-system.com)
   - AUI – CSL: Jérémy Brisbois (jbrisbois@uliege.be)
   - Radmag – EK-CER: Attila Hirn (hirn.attila@ek.hun-ren.hu)
4. **Ground Segment aspects: OHB Sweden (bastiaan.lagaune@ohb-sweden.se)**
5. **Launch Segment: OHB Sweden (bastiaan.lagaune@ohb-sweden.se)**

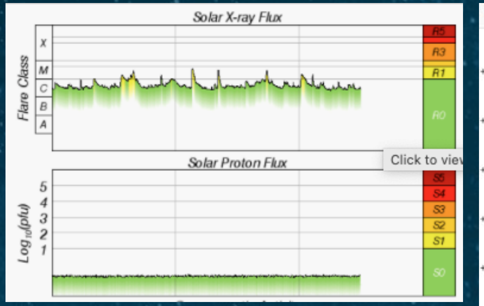
***Main contributors: BE, FR, DE, HU, NO, PL, ES, SE, UK, SK, CA, not to be excluded: CH, DK, GR, PT**

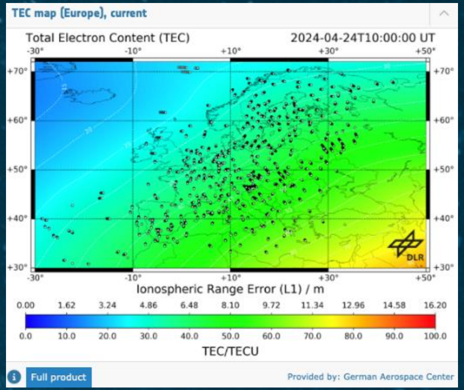
**** Largely based on heritage InnoSat platform. Minor deviations from standard supply chain might exist.**

Space Weather – D3S – 1st Nanosat - SWING

- Under French lead (platform, instruments, mission operations) with FI, NO contributing instruments and IT supporting the ground segment
    - Prime: Hemeria (FR),
    - sub-cos: Eidel (NO), Isaware (FI), Syntony (FR), Planetek (IT)
- Addressing the needs of ionospheric space weather services
- Mission design:
    - LEO SSO, local time TBD, 3 years lifetime, high reliability & availability, low latency
    - Instruments: Radiation monitor, Langmuir probe, GNSS radio occultation, X-ray flux monitor
    - Service to become available early 2027
    - First year of service contracted, then possible yearly extensions

hemeria





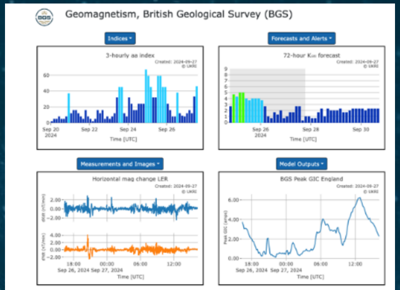
- Business case demonstration for a commercial constellation with ESA as anchor customer

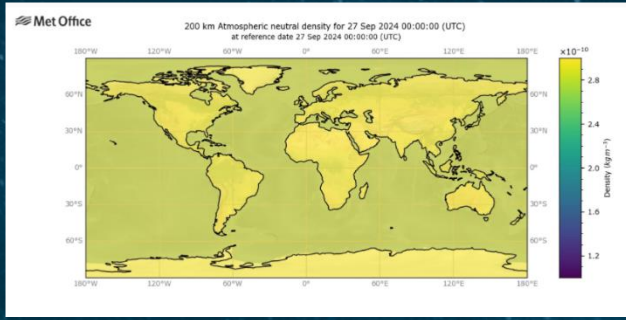
Space Weather – D3S – 2nd Nanosat

- **Enabled by additional Polish subscription**
- **Phase 0/A1 study contract signed:**
  - **Prime: Creotech Instruments SA (PL)**
  - **Subs: CBK PAN (PL), WUST (PL)**

creotech

- **Addressing space weather data <u>complementary</u> to 1st mission, e.g.:**
  - **LEO magnetic field,**
  - **Radiowaves**
  - **Plasma / neutrals density**

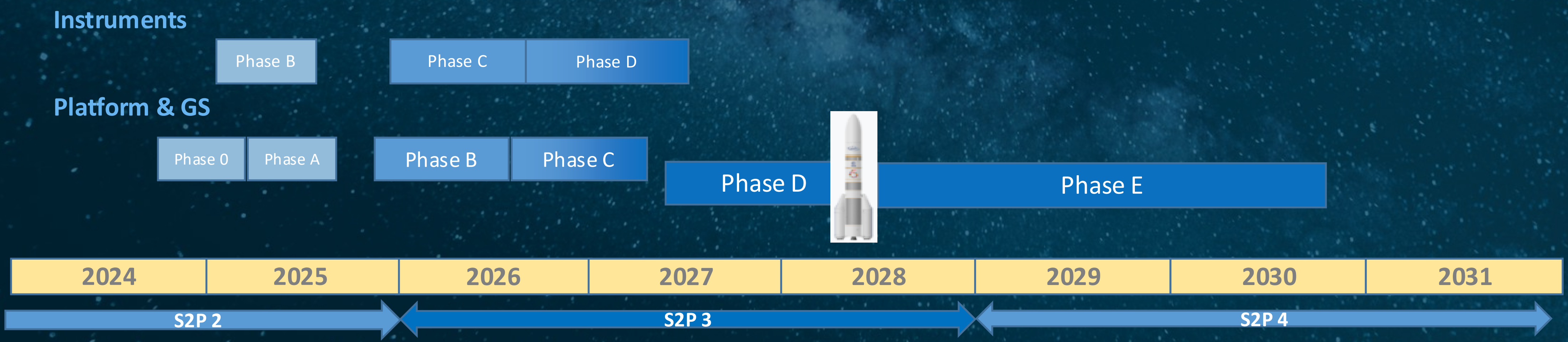




- **Instrument baseline proposed, but still to be consolidated!**

Space Weather – D3S – 2nd Nanosat

- **Implementation plan:**
  - **Baseline:**
    - **Phase A2/B and instrument Phase C budget ROM: 4.8 MEuro (PL,** HU + NO, FI, IT**)**
    - **Phase C/D/E (including FM, launch, IOV, and one year of operation) ROM: 6.8 MEuro (PL+X)**
  - **PoC: Melanie.Heil@esa.int**



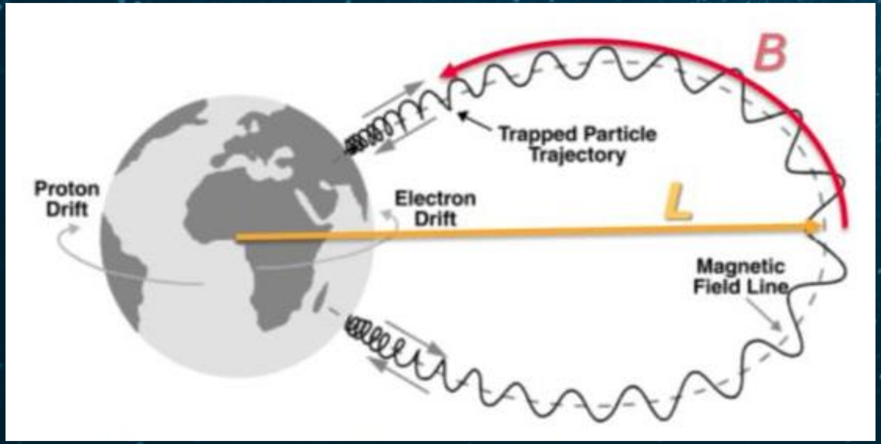
Space Weather – D3S – SWORD

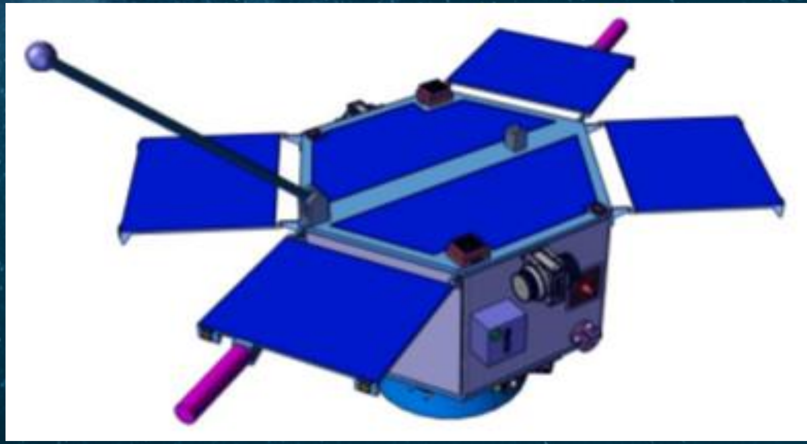
New!

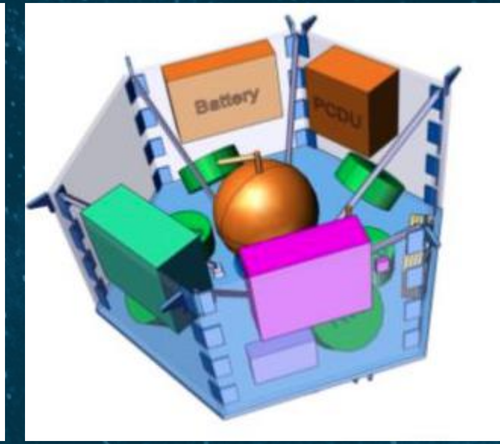
- Dedicated mission to provide **nowcasts of the radiation belts**
- ESA internal CDF performed end 2023, currently **two parallel pre-Phase A studies** ongoing, primed by **1) Redwire (BE) and 2) Airbus DS SAU (ES)**
- Mission Design:
  - GTO-type orbit, **2 satellites** equally distributed, slowly rotating to sample pitch angle distribution, 2-3 years lifetime, commercial GS network, high reliability, low latency
  - Instruments: **radiation monitors** covering a very wide energy range, **plasma monitor, Langmuir probe, and magnetometer** as baseline (descoping possibly needed)


esa

CDF Study Report
SWORD
Space Weather Orbital Radiation Detector



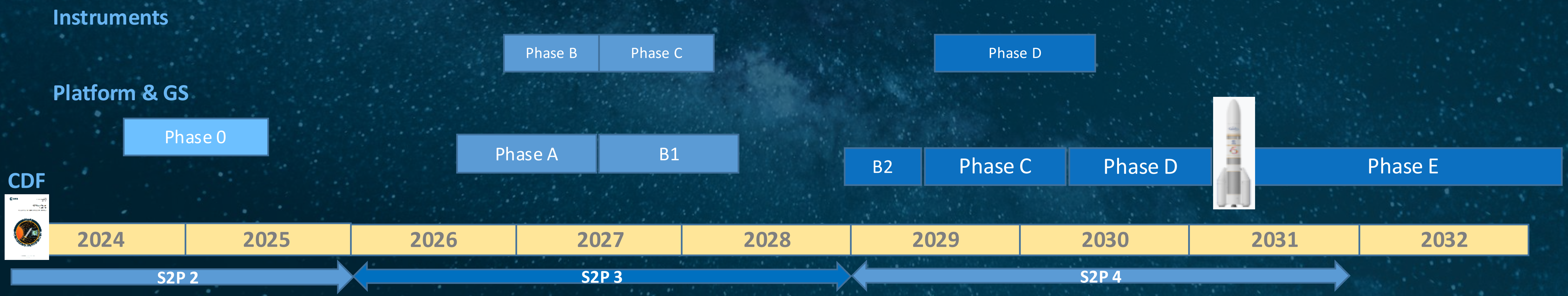




Space Weather – D3S – SWORD

- Implementation foreseen as mission-as-a-service, high industry responsibility
- ROM CaC: 75 MEuro

- <u>Implementation Plan:</u>
  - Mission Phase A/B1 (open ITT) and instrument pre-development: ~3 MEuro
  - Remaining budget for Phase B2/C/D/E requested at CM28



- *Regular replenishment foreseen for an operational Space Weather System*

Space Weather – D3S – Hosted Payloads

- *Wealth of data is openly available through SWE Portal!*

Future plans:

- Operations of ongoing and upcoming HP missions
- Data processing preparation and commissioning of upcoming missions (NGRMs, next ICARE-NG,…)
- Continued cooperation with KMA on GEO space weather suite: SOSMAG-II to fly on GK5 in 2029/30
- Instrument pipeline => continuous instrument development and procurement for future missions

Always looking for synergetic flight opportunities!

Instrument	Hosting flight	Orbit (altitude in km / longitude in °)	Launch Date	Mission Lifetime
SOSMAG	GK-2A	GEO (128° East)	2018	10 years
NGRM	EDRS-C	GEO (31° East)	2019	10 years
NGRM	Sentinel-6	LEO (1336 km, 66° incl)	2020	7 years
ICARE-NG	HB 13F	GEO (13° East)	2022	10 years
ICARE-NG	HB 13G	GEO (13° East)	2022	10 years
NGRM	*MTG-I1*	*GEO (0°)*	*2022*	*8.5 years*
NGRM	MTG-S1	GEO (0°)	2025 (planned)	8.5 years
NGRM	MOS A1	LEO (~830 km, SSO)	2025 (planned)	7 years
NGRM	MOS B1	LEO (~830 km, SSO)	2026 (planned)	7 years
NGRM	MTG-I2	GEO (0°)	2026 (planned)	8.5 years
MiniRMU	Lunar Pathfinder	Lunar (elliptical)	2026 (planned)	8 years
ERSA (SREM, NGRM, ICARE-NG, MAGIC)	Lunar Gateway	Lunar (NRHO)	2027 (planned)	5+ years
***SOSMAG-II,* next ICARE-NG, NGRMs…**	***GK5, MTGs, MOSs, and TBDs***	***GEO, LEO, and TBDs***	***2026+***	

COSMIC – Towards Enhanced Space Weather Services

SWE Service Network : World Class R2O(2R) Framework Targeting End User Needs

- Demonstration and testing space weather service capabilities with end users: pre-operational service model
- Continuous evolution with opportunities to include new and improved products every 3 months
- Continuous reliable provision with user in the loop enables:
  - Understanding of user workflows and terminology
  - Feedback on products and tools, understanding of highest priorities for users (O2R process)
  - Identification of promising business cases
- **Performance assessment** establishing community standards
- Fostering commercial solutions

- Tailored to use cases or domain on request
- How to navigate & utilise key tools
- At users premises or online webinars

- Bespoke dashboards
- Content tailored together with test users
- Individual product adaptation

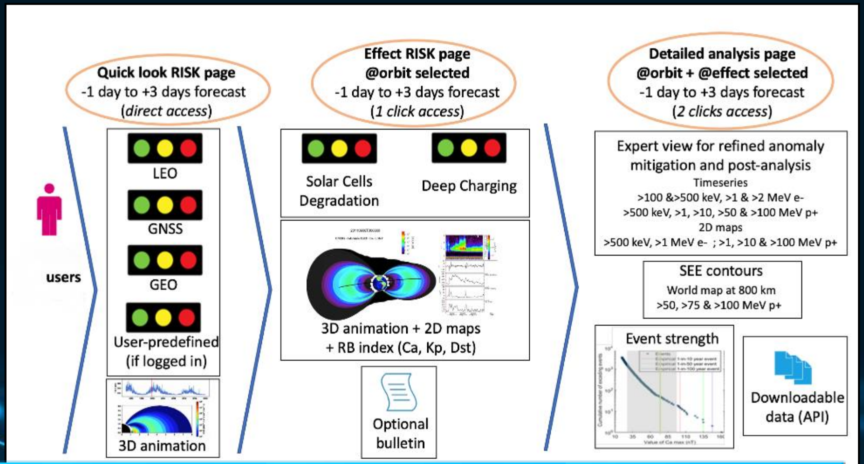
- Outreach to registered user community
- Feedback on service content and presentation

- At users' premises or part of a conference or workshop e.g. European Space Weather Week

SWE Service Portal Evolution and Targeted Application Developments

SWE portal evolution

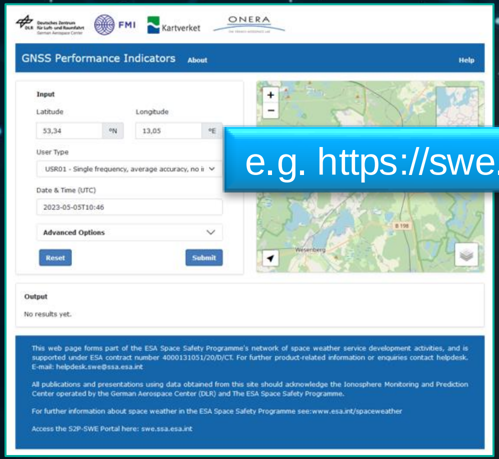
- Layered approach portal-wide catering for different levels of user expertise
- Technology upgrade enabling interactive, customisable presentation
- Leverage underpinning data system improvements for API data access
- Improved SWE Portal navigation and search for better usability



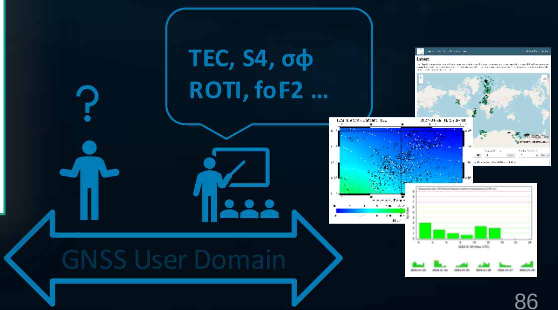
e.g. https://swe.ssa.esa.int/onera-rb-fan-federated

Targeted Application & Tool Development

- Combining individual products into overarching user-driven consolidated product/applications.
  - Target domains including Spacecraft Operators, GNSS, electricity transmission grid operators & others.
- SWE Data Utilisation: advanced Level-2 processing pipelines and toolkits including preparation for Vigil.



e.g. https://swe.ssa.esa.int/GPI-federated



Space Weather Core – Enhancements and New Technologies

Virtual Space Weather Modelling Centre (VSWMC)

- End-to-end Space Weather modelling, simulation and NRT data processing
- Verification and validation of end-to-end simulation with further models
- Support for OSSEs and OSEs
- Advanced user interfacing and data visualisation

Software development

- Phase 2 of the Space Weather Payload Data Centre
  - Implementation of Vigil Level 1 data processing
  - Enhancement of the Data Hub
- One-stop-shop for space weather data

Enhancement of space weather models

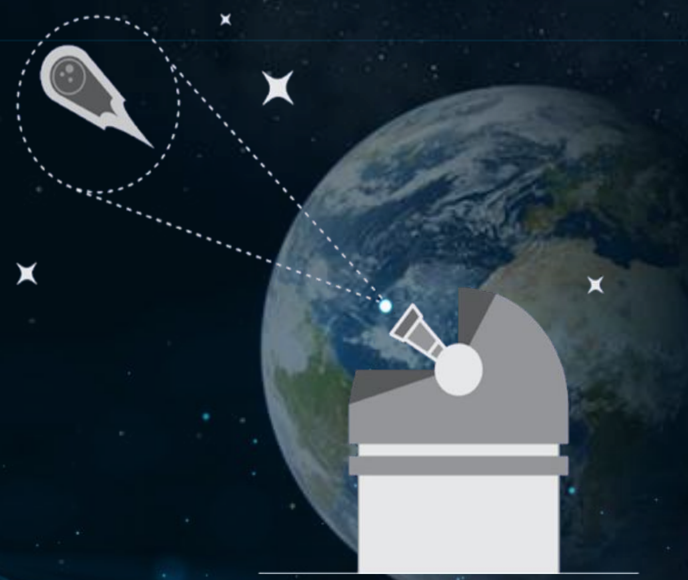
- Empirical, physics based, DL, AI and combined models
- Utilisation of data from space weather system
- Advanced onboard data processing
- Feasibility studies for new technologies

Instruments and mission studies

- New instrument developments/procurements
  => instrument pipeline
  => utilisation of advances in sensor technology
- OSSEs and OSEs
- Operationalisation of ground based observations

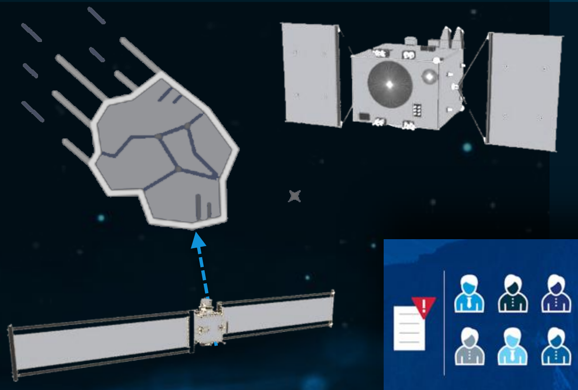
COSMIC – Predicting Asteroid Impacts

Planetary Defence - Objectives



Observations
- Establishment of a high cadence full-sky asteroid survey (Flyeye) network
- Closing global observational gaps (i.e. NEOMIR)
- Further improvements to NEO follow-up capabilities (Observation Network) and development of new technology and methodologies

Assessment:
- Upscaling and performance improvement of our Orbit determination and impact morintoring system (Aegis), maintaining full complementarity with our international partners
- Evolution of our quick-assessment system (Meerkat) towards higher performance and emergent technologies
- Improving the understanding and modelling of impact effects



Mitigation:
- Support and strengthening of UN mandated entities (IAWN, SMPAG)
- Secure provision of reliable information to international partners and the general public
- Strengthening the collaboration with international partners for optimal and resilient impact threat responses
- Developing Fast Asteroid Reconnaisance (FAR) and contactless deflection capabilities

The Near Earth Oject Coordination Centre (NEOCC)

Operations Base for Planetary Defence activities:

- Coordination of the Observation Network
- Development, testing and initial operations of the NEO Survey network
- Coordination, maintenance and evolution of the Assessment Pillar activities (Aegis, Meerkat, etc.)
- Driving development, maintenance and evolution of information infrastructure (Systems, Portal, Interfaces)
- Driving innovation through coordination of all PD core related industrial contracts
- Safeguarding information, data and expertise in the present and for the future (SecOps, Archives)
- Coordination and execution of all mitigation activities
- Driving mission sudies and preparing the ground segments for future space missions

NEO Survey - Activities for Period 3

Flyeye-2 finalisation

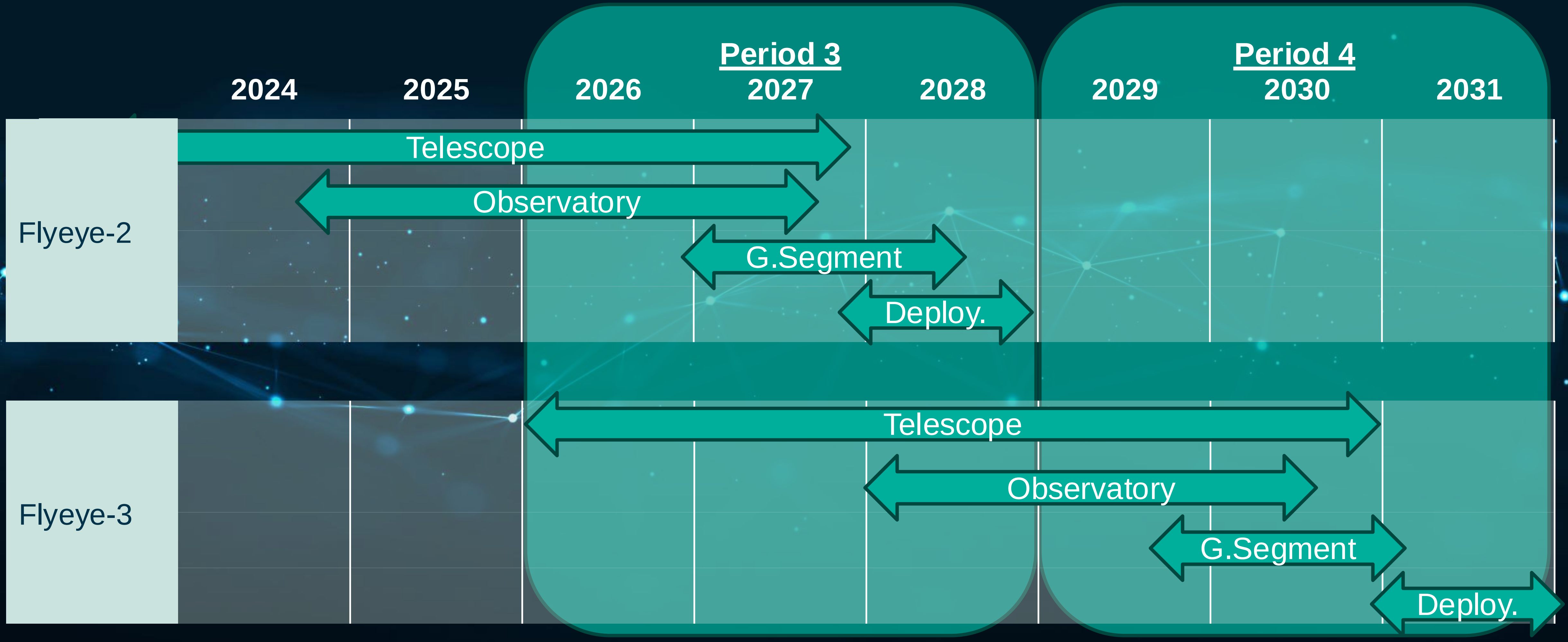
- **Observatory**
  - Site development and acceptance
- **Ground Segment**
  - Design and implementation
- **Telescope**
  - Transport to site, installation, acceptance and commissioning

Flyeye-3

- **Telescope**
  - Design updates
  - Long-lead item procurement (Primary Mirror, Cameras, Secondary Optical Tubes)
- **Observatory**
  - Site design

Flyeye-1 Telescope Equatorial Mount (Matera, Nov'2024)

NEO Survey - Timeline



NEOMIR

IR Telescope at L1

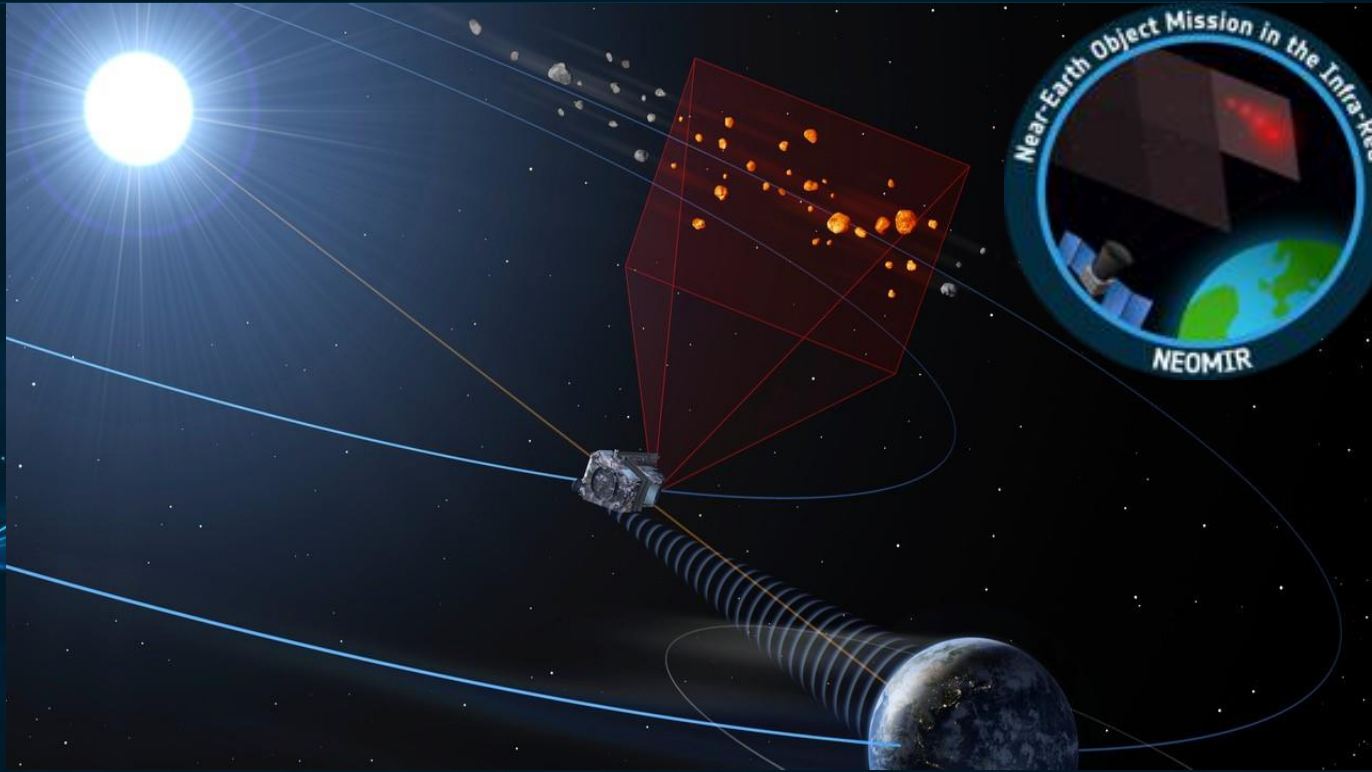
- Concentric scans around Sun down to minimum elongation
- High-rate revisits to detect small and fast-moving objects
- Main Challenges:
  - High detector sensitivity and precision
  - Cooling system

Period 2 Status (GSTP):

- System level study Currently in Phase A2
- Detector Study in parallel
- Starting Phase B1 at the end of Period 2

Period 3 activities (S2P):

- Focus on critical technologies (detectors, thermal design) as separate actaivity
- Adapt Phase B2/C Budget and pacing to Apophis mission implementation



Satis/Fast Asteroid Reconnaisance (FAR) Demonstrator

Strategic Objective:

- Achieve and demonstrate FAR capability at minimum budget and maximum repeatability
- Integrate into coordinated response approach with international partners

System design:

- Lightweight S/C Bus (12U-XL or 16U CubeSat format)
- Minimum viable instrumentation (Multispectral Camera System, Thermal IR)
- Compatibility with wide range of launchers (including microlaunchers)

Current status:

- Phase A concluded successfully at PRR level
- Phase B starting in February 2025

Ion-Beam Deflection Studies

Strategic Objective:

- Alternative deflection method to Kinetic Impactor with no risk of (partial) disruption of the target
- Cooperation with international partners

System design parameters:

- Based on solar Electric propulsion modules
- Autonomous station keeping
- Long-term operation capability
- Scaleable

Current status:

- CDR study on demonstrator mission under the name **P**recise **A**steroid **N**udging (PAN) in collaboration with JPL scheduled for 2025
- Phase A/B Study via GSTP anticipated for Period 3

COSMIC – Technologies for a growing Space Traffic

COSMIC – Technologies for a growing Space Traffic
Ground Lasers for S2P

Ground-based Laser Technology could enable innovative services:

1. On-demand Ephemeris Provision
Providing precise space debris orbit data to better analyse the dynamics of predicted conjunctions, triggering escalation only if the collision probability is confirmed to be significant.

2. Laser-Based Collision avoidance manoeuvres
Altering orbits of space debris involved in conjunctions with satellites, increasing miss distance between conjunction partners and thereby reducing the probability of collision.

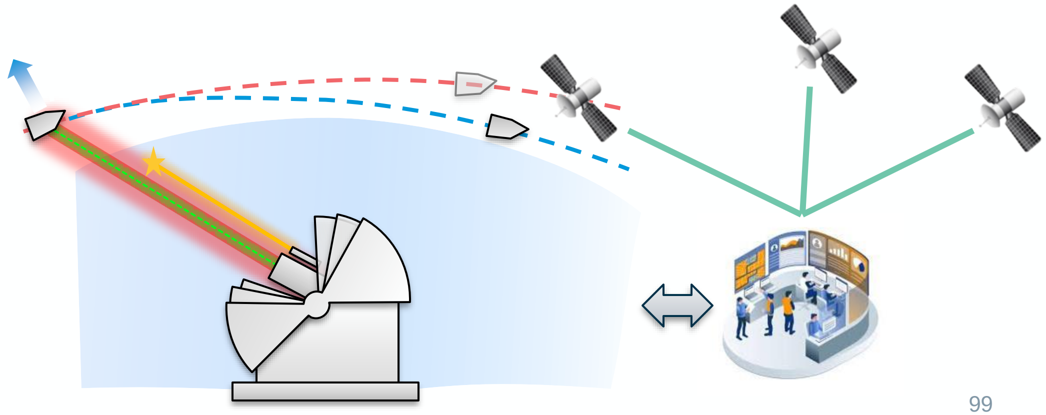
Two development streams consolidated into a unified program:

OMLET

Orbital **M**aintenance via **L**aser mom**E**ntum **T**ransfer

Currently tackling technical challenges → targeting industrially operated services
Ensuring that European industry is ready and aligned with the demands arising from the sector of services powered by space technologies for everyday users

Opportunity for a business-oriented framework in Europe
Evolve with dynamic sustainability needs of the space environment.



Market / Values
- Satellite operators, Service providers
- Minimize propellant usage for CAM → extending operational life of satellites
- Reducing operational efforts

COSMIC – Technologies for a growing Space Traffic

OMLET Services for End Users

1. On-demand Ephemeris Provision

- Technology for Space Debris Laser Ranging
- Proof-of-Concept Tracking Network

Towards Commercialization

Development Areas
- Daylight tracking
- Accuracy
- Legal aspects

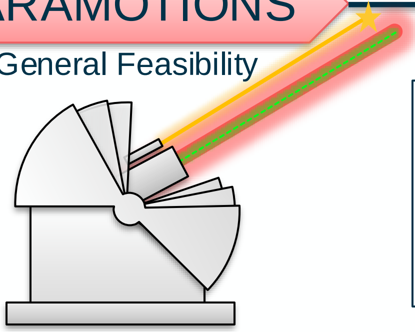
Networks
- Interfaces
- Optimization
- Scalability

Integration
- End-user involvement
- Market Entry
- Ecosystem Development

2. Laser-based Collision Avoidance Manoeuvres

LMT Engineering Station

LARAMOTIONS — General Feasibility



Phase A/B1 — 2024/2025
- Requirements Consolidation
- Advanced LMT studies
- Legal aspects
- Flow-down to Subsystems

Phase B2 — 2026/2027
- Solid Baseline Design (Preliminary Design Review)
- De-Risk High Priority Areas through testing/prototyping

LMT in-orbit demo mission phase A, B1

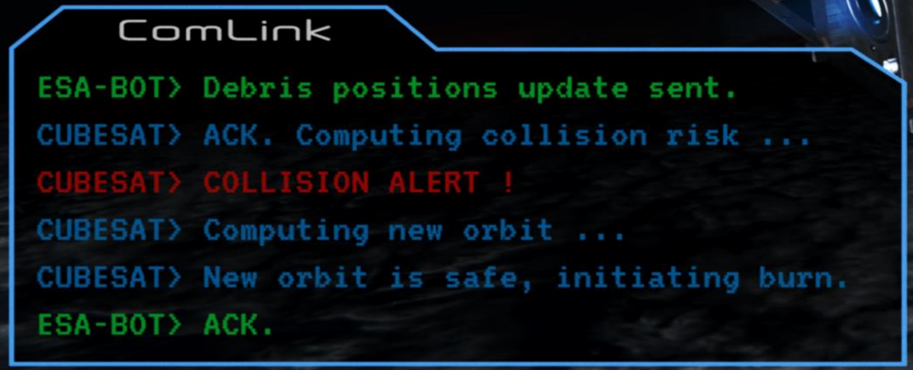
Phase C

Laser sources (40 kW), Power scalability, Beam combining, Adaptive optics, Operational Concepts

COSMIC – Technologies for a growing Space Traffic

CREAM (Collision Risk Estimation and Automated Mitigation)

Key objective: Reduce human effort for collision avoidance ensuring mission safety.



Further maturation, enhanced pilot usage and in-orbit demonstration

- Ground systems
  - **Test operations, rollout further and expand**
    - Decision support functionality
    - Avoidance manoeuvre design
    - Platform supporting operator coordination
    - Platform monitoring system
  - **Test operations and expand expert facility**
- In-orbit demonstration
  - Dedicated **IOD mission phase B to F** (launch readiness end of P3)
  - **Piggy-back demonstrations** for different platforms
- Late access /decisions
  - Develop use of Galileo for **late commanding**
- Future criteria
  - Mature **decision criteria** beyond probability

Budget: 10M (CM25), 10M (CM28)

SAILOR (Sail Array for Impact Logging in ORbit)

Key objective: Improve space environment knowledge on least observed size range (sub-mm to cm)

Damage caused by small object are mission critical, but hard to sample in large quantities.

Retrieved data will help improve models, which are used to assess the risk for missions.

<u>*Pre-phase A*</u>

Completed in 2022, 2 x 100m^2 sails, cameras on rigid rotating boom

<u>*Phase A/B1*</u>

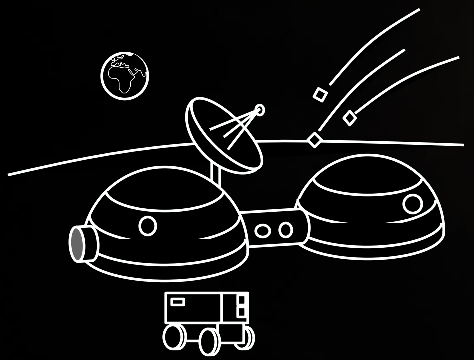
On-going, prime C3S

- Multiple satellites with each 2 x 25m^2 sails, with PVDF sensors
- Cameras on rigid rotating boom

COSMIC – Technologies for a growing Space Traffic

LUMOS – Cislunar monitoring

Impact prediction



Collision Avoidance

Disposal Assessment

Current concept:

- Optical payload
- “Moon-shield” straylight reduction
- Distant-retrograde orbit (~40.000 km around Moon)

Feasibillity & Concept

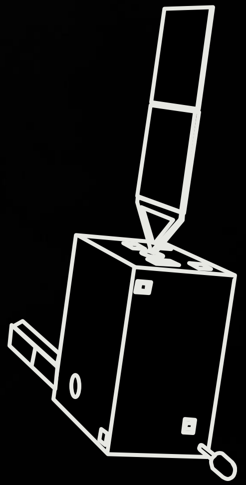
CDF Q1/24

Prepare

Phase A
Q4/24

Build & Fly

Phase B-EF
CM25/CM28



COSMIC – Technologies for a growing Space Traffic

DRACO (Destructive Re-entry Assessment Container Object)

Current baseline (S2P P2):

- Platform prime DEIMOS (ES)
- Re-entry capsule leads FGE (UK) and VKI (BE)
- Finish development and qualification by end 2026
- Execute launch and operations in 2027

Continuation under P3:

- *Return on investment:* Complete flight rebuild in a ground facility to demonstrate end-to-end demise designs. Flight campaign.
- *Commercialisation:* Exploit the capsule’s technology push for return from space applications; Enable State-of-the-Art Computation model for design and safety.
- *Innovation:* Derive the design for demise environment for structures and launchers.

Core

Towards a Zero Debris Future: Understanding the Space Debris Environment and technologies for space traffic coordination

→ Supporting the preparation and return of data from mission concepts

→ Enabling key technology developments from proof-of-concept to demonstration

Risk management technologies

Driving the state-of-the art risks management methods and models in sync with hardware development and operational concepts

Capacity monitoring technologies

Evolving towards holistic space environment capacity models for space sustainability

Observation technologies

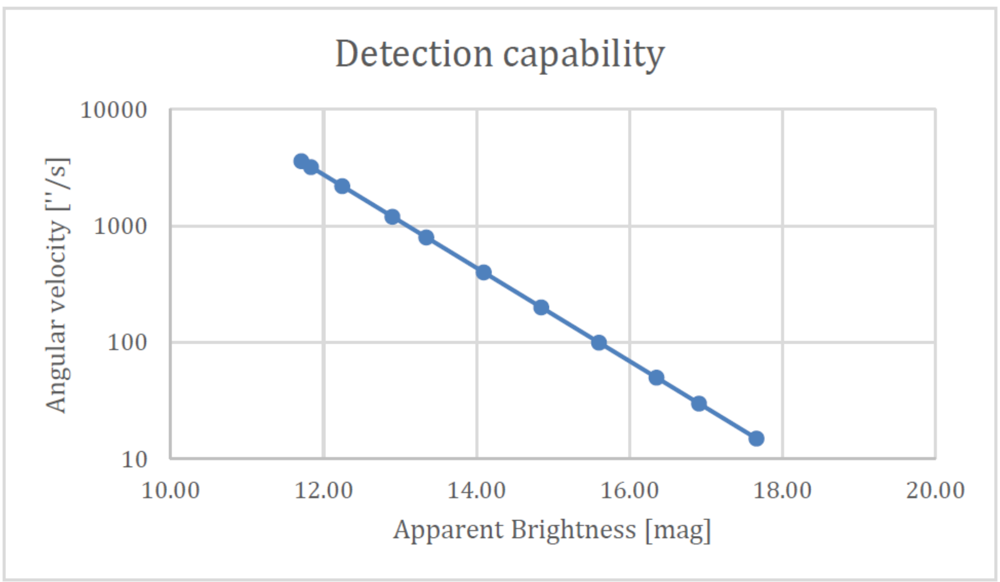
Extending observational and processing capabilities to understand the space debris environment

Zero Debris enabling technologies

Space debris consequence and technology readiness raising activities to support space and ground-based projects

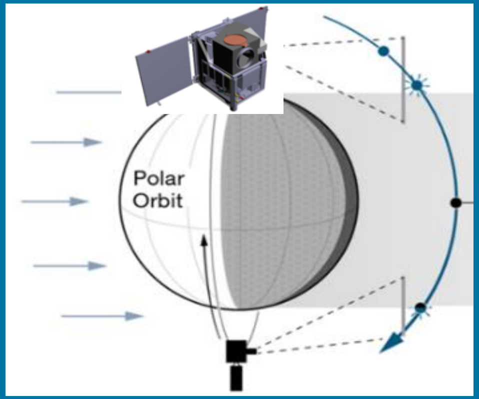
VISDOMS Mission Objectives

- Demonstrate capability of statistical monitoring of sub-catalogue sized objects in LEO (and beyond).
- Perform a first assessment of the population density of objects in the mm- to cm sized objects domain.
- Demonstrate the mission performance, the efficiency of the detection methods, the onboard processing capability, and the establishment of the on-ground processing chain based on real observational data.
- Demonstrate the observational capabilities in real environmental and light conditions.
- Explore tracking capabilities of objects less than 1 m located at larger distance such as in GEO.
- Develop observational schemes and observation patterns and pave the way towards a future optimised operational system.



VISDOMS key characteristics

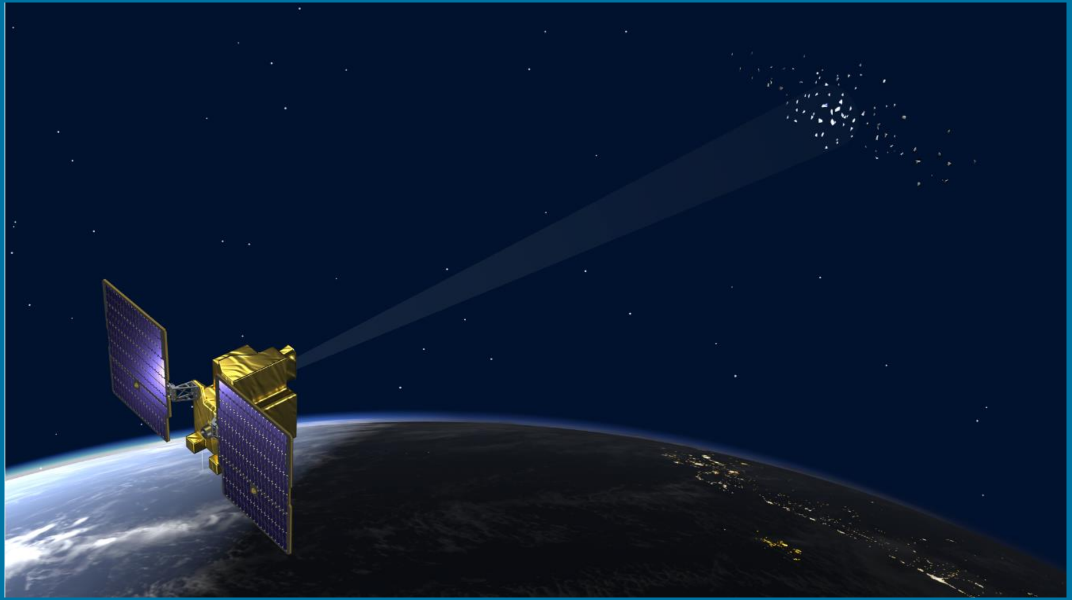
Verification of In-Situ Debris Optical Monitoring in Space



- Small satellite space debris monitoring demonstration mission
- Detect objects in LEO (<1 cm), MEO and GEO (<1 m)
- Mission Class IV (Gamma)

Mission orbit & satellites

- Low Earth Orbit, 600 to 900 km
- Dawn dusk, sun synchronous
- 1 satellite, ~200 kg, ~300 W
- X-band transmission



Mission Duration

- 1 year minimum + extension
- Operational after 1 month

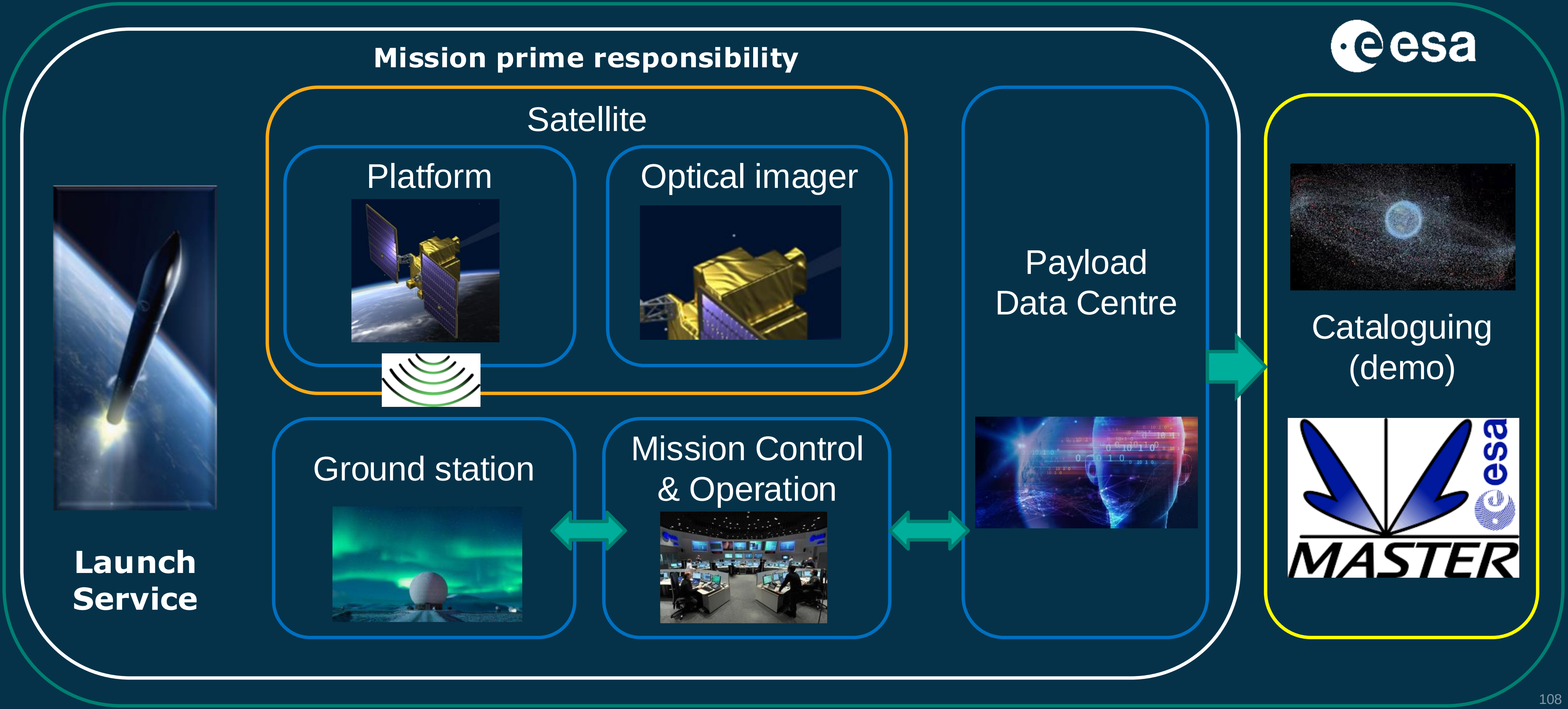
Instrument

- Optical telescope, ~50 kg, ~100 W class
- Dimensions commensurate with small satellite platform
- Aperture ~20 cm, angular resolution 5”

Launch Vehicle & launch date

- Micro-launcher or VEGA SSPM, target 2029

VISDOMS Mission architecture



COSMIC – Towards a Zero Debris Future

COSMIC – Towards a Clean and Zero Debris future

CORE element : Strategic Technology Areas

Techno-Enablers for Zero Debris

Design for Demise, In-flight failure prediction and mitigation, Space Debris Impact shielding, Robust passivation, mitigate visual brightness

Understanding environmental impacts

environmental impacts assessment from production to atmospheric re-entry, supporting European industry transition

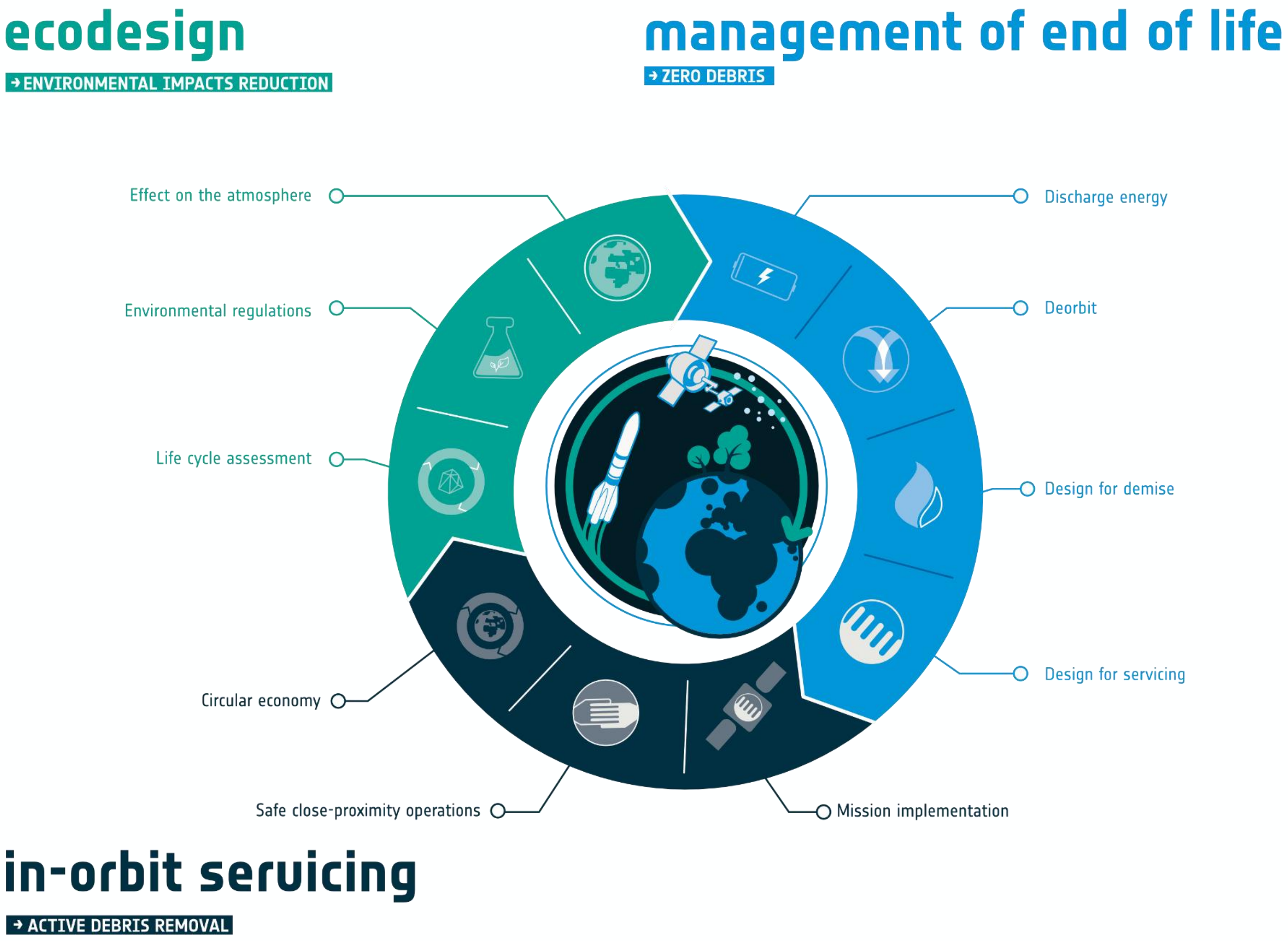
Paving the way for Circular Economy in Space

Maturation of enabling technology for in-orbit manufacturing, refurbishing and recycling

Derisking for Active Debris Removal

Rendezvous Test Facility,
2nd Generation standardized interfaces,
CPO maturation and risk assessment,
ADR mechanisms maturation

Clean Space overview

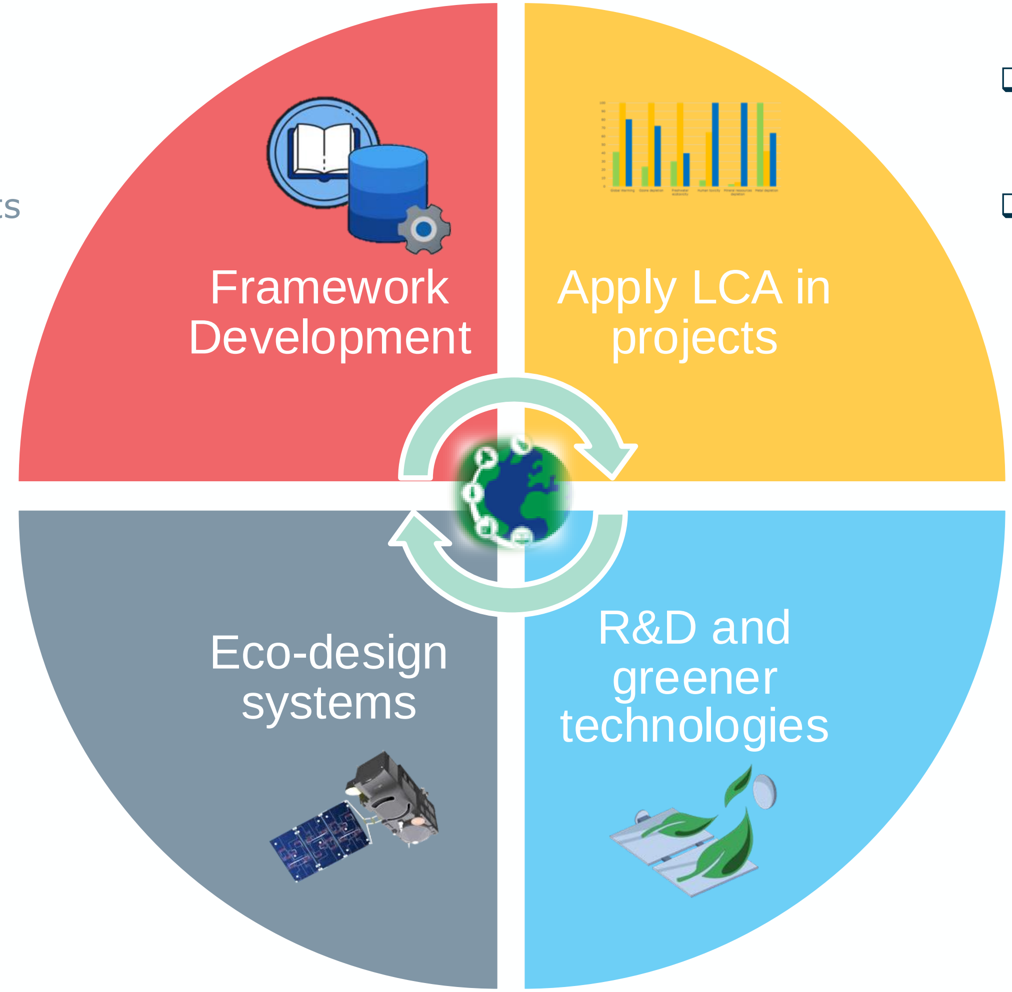


Ecodesign overview

Programmatic and Technical framework: Ecodesign WGs

- **ESA LCA Database:**
  - Release of a new version!
  - Web: Space Debris Portal
  - Development of Generic Datasets
- **Handbook Update:**
  - Alignment to other Standards
  - Inclusion of feedback
  - DQR, questionnaires, etc
- **Simplified LCA**
  - 10 ESA study cases with LCA

- **System:**
  - EcoStar SysNova Campaign
- **Technologies:**
  - Toward Greener MAIT



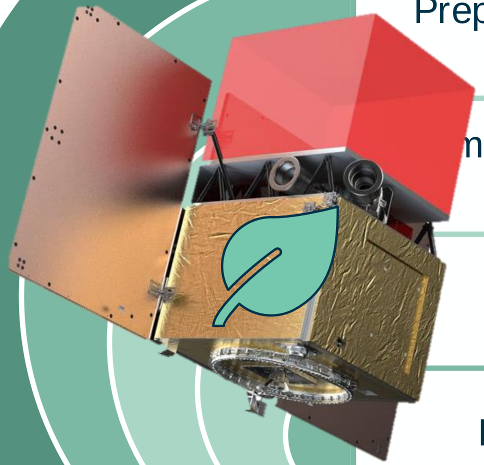
- **Systematic application:**
  - All directorates
  - Early and later phases
- **Lessons learned and feedback:**
  - Lessons Learned CDF
  - Ecodesign taskforce
  - PM forum consultation

- **Atmospheric impacts:**
  - OSIP campaign
  - Dedicated Workshops
  - Roadmaps
- **Data gaps:**
  - Impacts of testing
  - Impacts of sat constellations
- **Greener Technologies**
  - Greener propulsion system

EcoSat IOD

Ecodesign

Objective	Breakthrough in development, integration and demonstration of green technology in European space product-lines



Enable ESA Green Agenda objectives	•-46.2% GHG emissions by 2030
Preparing industry to transition toward a sustainable economy	•Environmental KPIs and criteria in Agency's procurement •Raise competitiveness of sustainable proposals
mall satellite platform for commercial purposes	•Maximise re-use of the platform and environmental benefit •Systems studies avoid burden shifting and ensure a lean development plan
Co-funding with industry	•ESA co-funds a mission below 50M Euro
Boost green space technologies	•Bring technologies at TRL 9

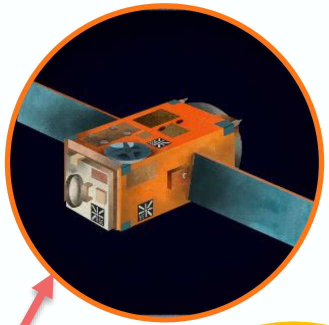
2024	•Phase 0 •4 x 150 k€ contracts
CM25	•Phase A/B1 ITT •Green technologies validation
2026-2028	•Phase A/B1 •Phase B2
CM28	•Co-funding Phase C/D/E
2030	•Launch!

CM25 : 2 parallel phase A/B1 + technology maturation – 2 x 4 M€
CM28 : IOD through co-funding of mission (<20M€)

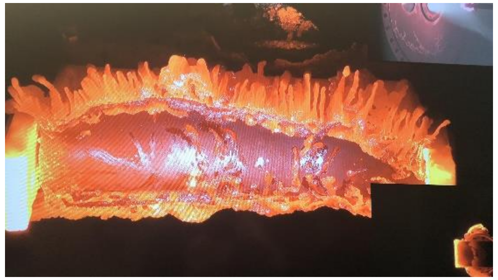
Towards a Zero Debris Future

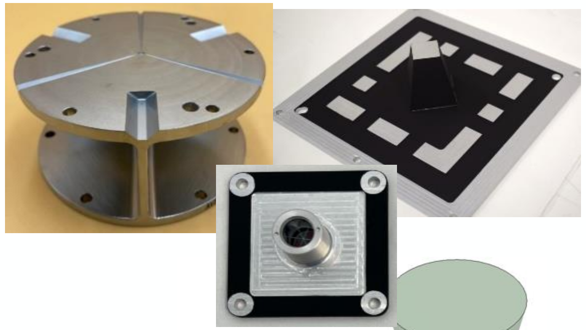
ESA Zero Debris implementation for future missions relies on key technical developments:

Policy Evolution



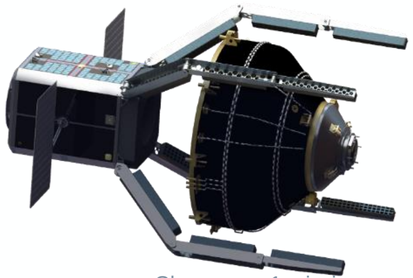
Zero Debris compliant spacecraft platforms



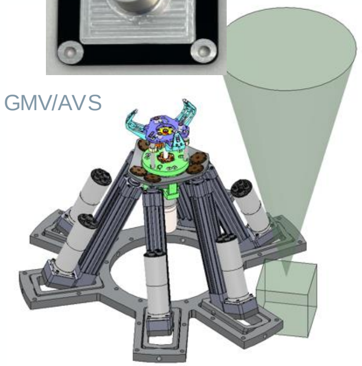


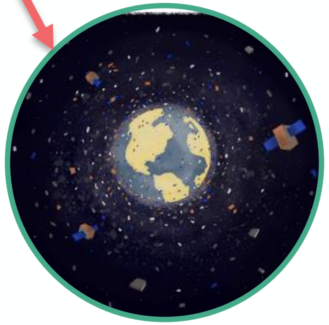
Credits: GMV/AVS

Development & Demonstration of In-Orbit Services



Clearspace-1 mission





Technology improvement for SST and collision avoidance

Scope of platforms evolution

Zero Debris

For these 3 goals, 5 objectives were identified:

Zero Debris Platforms

1 Simplify End of Life

2 Understand & avoid failure

3 If failure, reduce risk

Fully demisable LEO platforms (LEO)

Reduce the on-ground casualty risk and simplify EoL management

Reliable disposal strategy (LEO, MEO, GEO, Lunar)

Deorbiting strategy to comply with 5 years (LEO)

Modular implementations of controlled re-entry (LEO)

System resilience (LEO, MEO, GEO)

Anticipate and avoid spacecraft failure in-orbit and support decision making

Platform robustness to debris impacts

Mitigatory operations (LEO, MEO, GEO)

Collision avoidance manoeuvring procedures and capabilities

Limit debris generation in case of failure in-orbit (e.g. passivation)

Design for Removal (LEO, MEO, GEO)

Ease removal by external servicer and decrease associated costs

+ Dark & Quiet skies design solutions

Zero Debris Platform activities

Funded | Funding TBD CMIN25

Zero Debris

Large LEO platforms

Phase 1 — RR — SRR

Phase 2 (2026-28) — PDR

Platform design and development by the integrators

Maturation and adaptation of key technologies
Subcontractors' involvement: RFI, RFQ, TDA

2024 — 2025 — 2026 — 2027

Zero Debris Large Platforms: LSI & Supplier Workshop Registration Form

- **3 parallel contracts with the LSIs**
- **2.7M** co-funded by **OPS – S2P COSMIC**, and **by EOP**
- **Scope:**
  - Definition of platform design evolution up to SRR
  - Preliminary trade-offs
  - Preliminary suppliers consultation and development of roadmap for phase 2

- **3 parallel contracts with the LSIs**
- **~10 M€ per contract**
  - **50%** of the budget: **work with subcontractors** for maturation and adaptation of **key technologies**
- **Scope:**
  - Implementation of platform design evolution up to PDR
  - Technical developments and technology adaptation/maturation

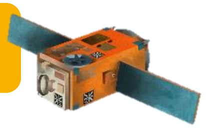
Zero Debris Platform activities

Funded

Funding TBD CMIN25

Zero Debris

Small platforms



Scope:

- **50-500kg** satellites
- Assess Impacts of Zero Debris on small satellites in Earth Orbits
  - Evolution of platform up to PDR
  - Identification and development of building blocks for smallsats

Phase 1 (Dec 24 – 25)

Phase 2 (2026-27)

PDR

Platform design and development by the integrators

Maturation and adaptation of key technologies
Subcontractors' involvement: RFI, RFQ, TDA

- **Up to 3 parallel contracts – open competition**
- **1.2 M** co-funded by **OPS – S2P COSMIC**, and **by EOP**

2-3 parallel contracts 4 M each

(w/ EOP co-funding)

- **~ 50%** of the budget: **work with subcontractors** for maturation and adaptation of **key technologies**

Cubesat IOD

Scope:

- Zero Debris system concepts for **1-16U Cubesats in LEO**
- Demonstration of **Zero Debris capabilities for Cubesats**
- **Commercial opportunity for IOD –** identification of customer

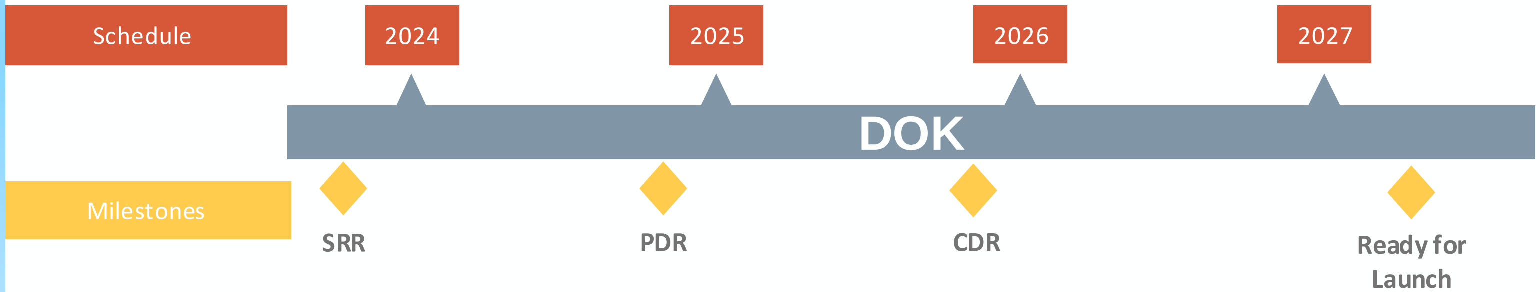
SysNova studies	IOD Phase A	IOD Mission (phase A – F)
5 studies 100k each	2 contracts 250k each	2 x IOD missions 2 x 1.5-2 M for IOD co-funding by ESA

2025 2026 2027

De-orbiting Kit

Project Status

- SRR completed in December 2022 - Changes since SRR
    - Propulsion subsystem – Propene/N2O “green” (D-Orbit)
    - Avionics and SW – AVH3 based on ION heritage (D-Orbit)
    - Interfaces with VESPA+R
- Phase C/D/E
    - RFP preparation – to be issued end May 2024
    - Target data pack delivery is Mid September 2024



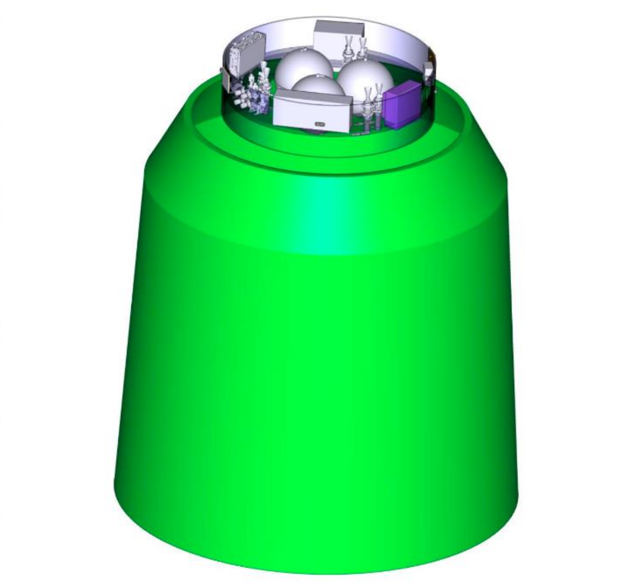
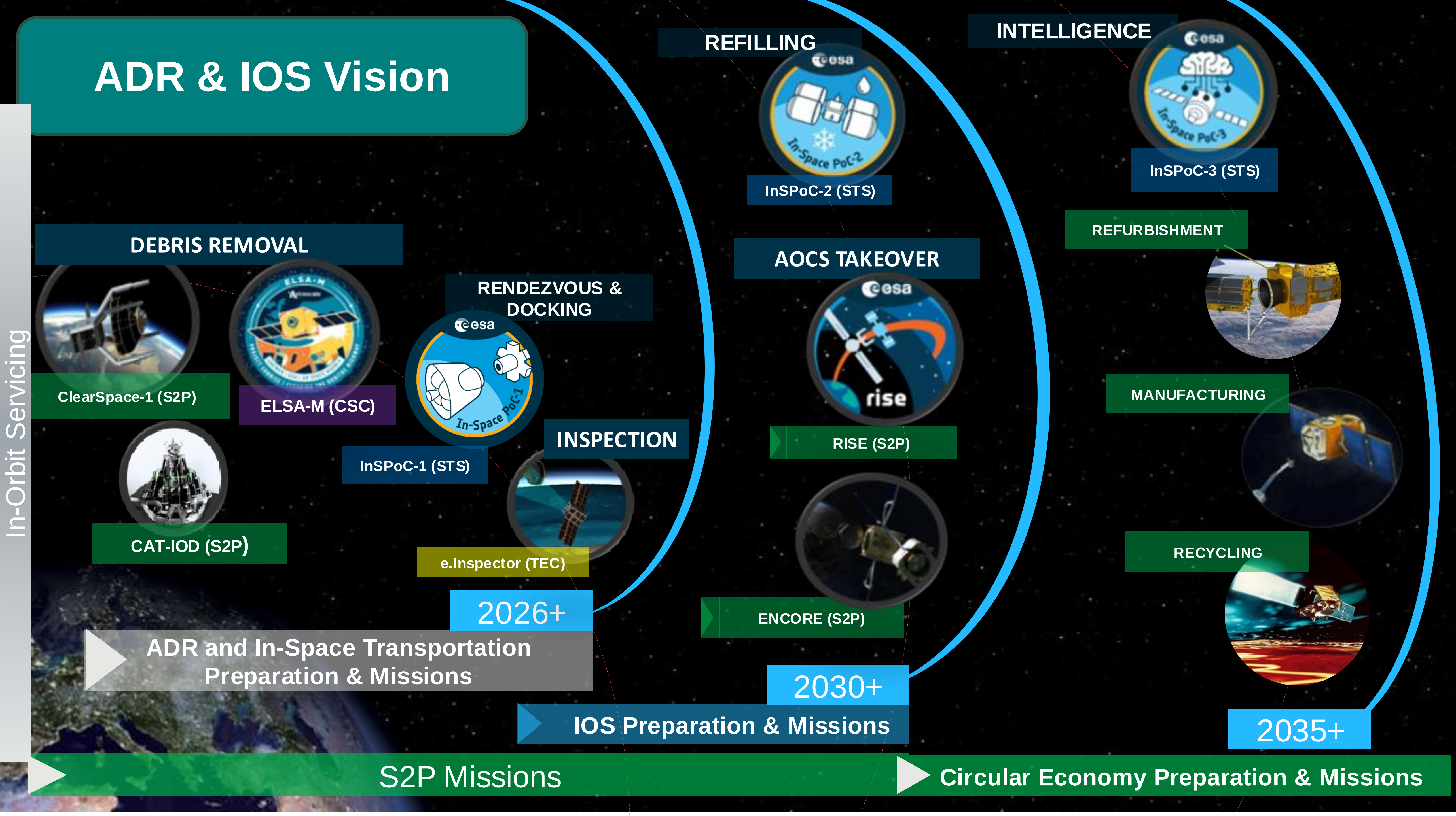


Figure 9: Deorbit Kit CAD model attached to possible target (VESPA).

Credit: D-Orbit

Funding Overview		
CaC	**13.5 M€**	*Excluding industrial contribution*
CM22	8 M€	
CM25	5.5 M€	TBC propulsion delta qual. needs and launcher/AVIO costs

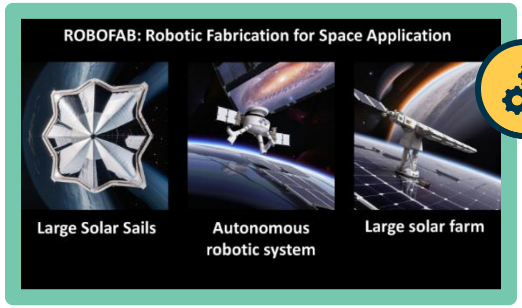

ADR & IOS Vision
In-Orbit Servicing
DEBRIS REMOVAL
ClearSpace-1 (S2P)
ELSA-M (CSC)
CAT-IOD (S2P)
RENDEZVOUS & DOCKING
esa
In-Space PoC-1
InSPoC-1 (STS)
INSPECTION
e.Inspector (TEC)
2026+
ADR and In-Space Transportation Preparation & Missions
REFILLING
esa
In-Space PoC-2
InSPoC-2 (STS)
AOCS TAKEOVER
esa
rise
RISE (S2P)
ENCORE (S2P)
2030+
IOS Preparation & Missions
INTELLIGENCE
esa
In-Space PoC-3
InSPoC-3 (STS)
REFURBISHMENT
MANUFACTURING
RECYCLING
2035+
S2P Missions
Circular Economy Preparation & Missions

Current Activities on the Space Circular Economy

In-Orbit Servicing

Present: 4 on-going mission and system studies (6 months, 100k) started in September 2024.

Astroscale (UK)
Satellite Refurbishment and Upgrading Services for Orbital Sustainability



KINETIK Space (DE)
Robotic Fabrication for Space Applications

Growbotics (UK)
LOOP: commercial refurbishment mission of a spacecraft in GEO

Thales Alenia Space (FR)
Recycling Space Plant

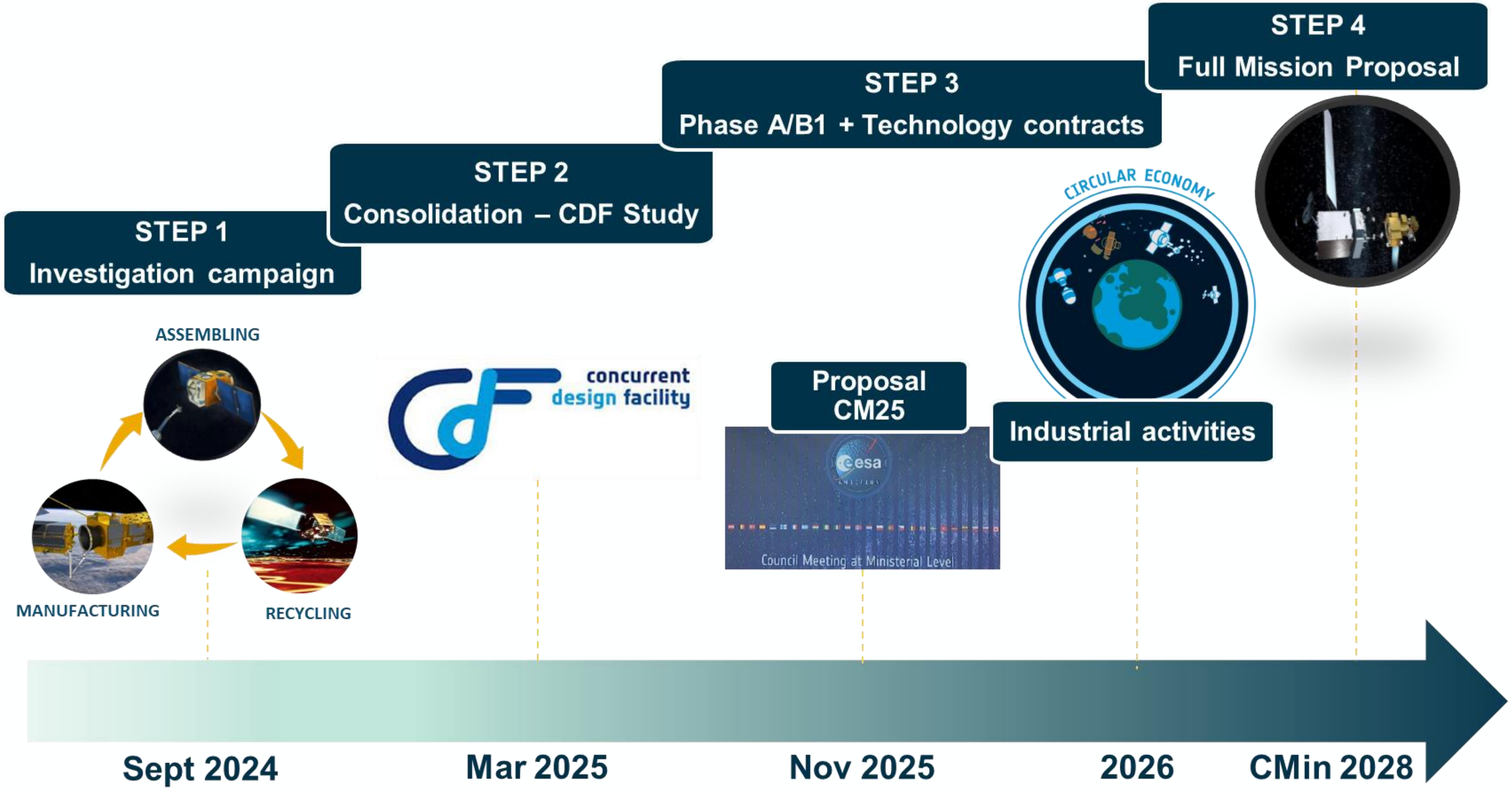
Refurbishment

Manufacturing

Recycling

Roadmap for Space Circular Economy

In-Orbit Servicing



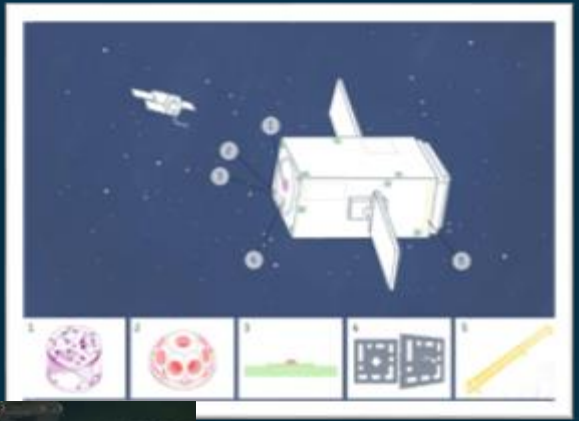
CM25 : 2 phase A/B1 ADRIOS follow-up missions + technology maturation – 5-10M€
CM28 : phase B2 - E mission proposal

COSMIC – Towards a Zero Debris Future

CAT-IOD

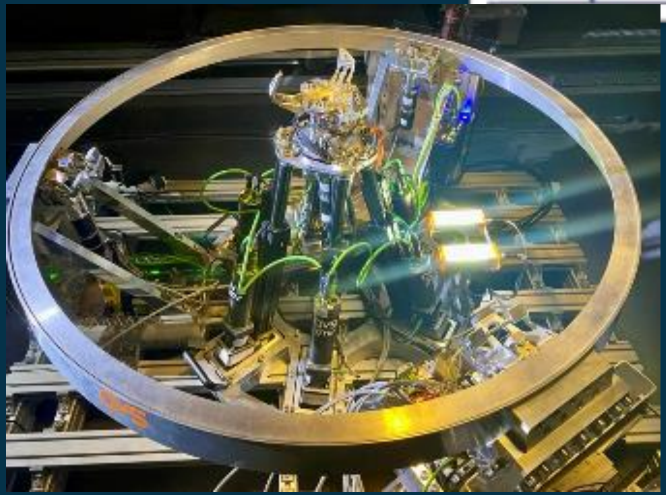
CAT Mission Objectives

- Rendering ADR reliable, safe and affordable is essential for the implementation of the Zero Debris Approach
- ESA Standardized Removal Interfaces on board of its future LEO missions, e.g. Copernicus Expansion.
- CAT payload bay developed in parallel to allow validation of interfaces



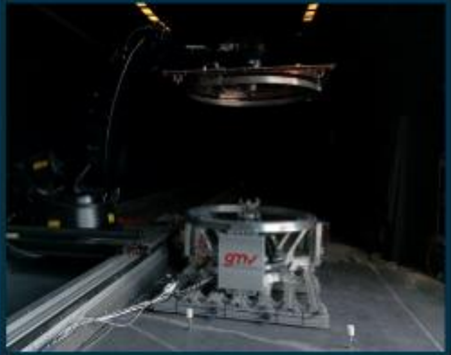
- An **In-Orbit Demonstration** mission to fully verify and validate **Capture Payload Bay** (CAT) and **ESA Removal Interfaces**
  - End-to-end CAT system design and operational concept demonstration in:
    - cooperative
    - uncooperative scenarios

- Demonstration is safe orbit guaranteeing fast reentry in case of failure

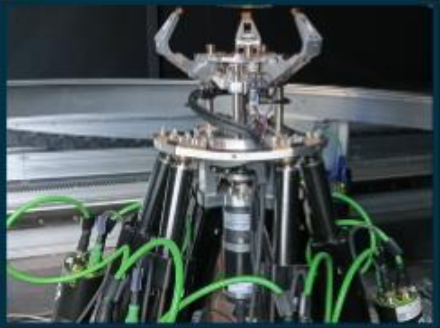


CAT Payload Bay

- Total mass with margin: 38.4 kg
- Peak power consumption: 360W
- Integrated visual navigation
- Capturing robotics assembly including:
  - Gough-Stewart platform with contact compliance
  - Gripper end-effector mechanism performing capture and rigidization



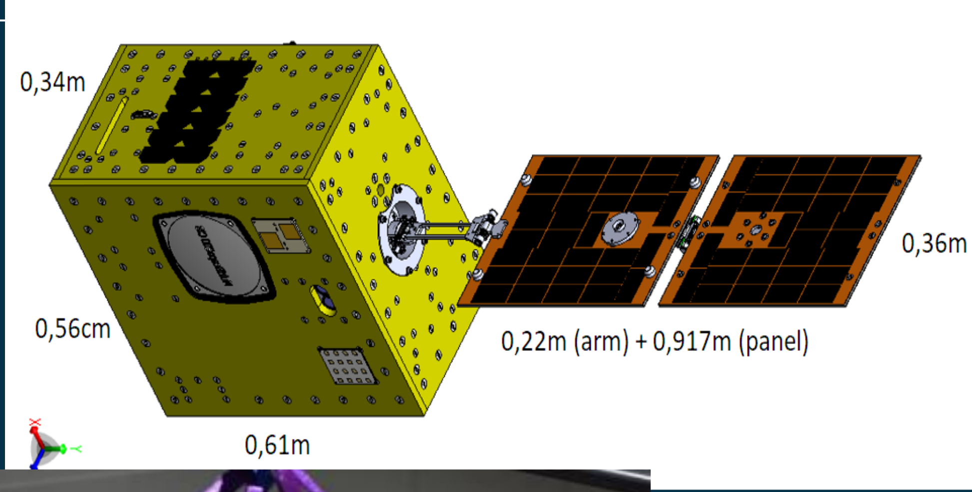
1. RDV tracking	2. Robotics tracking	3. Close Approach	4. Capture	5. Compliance

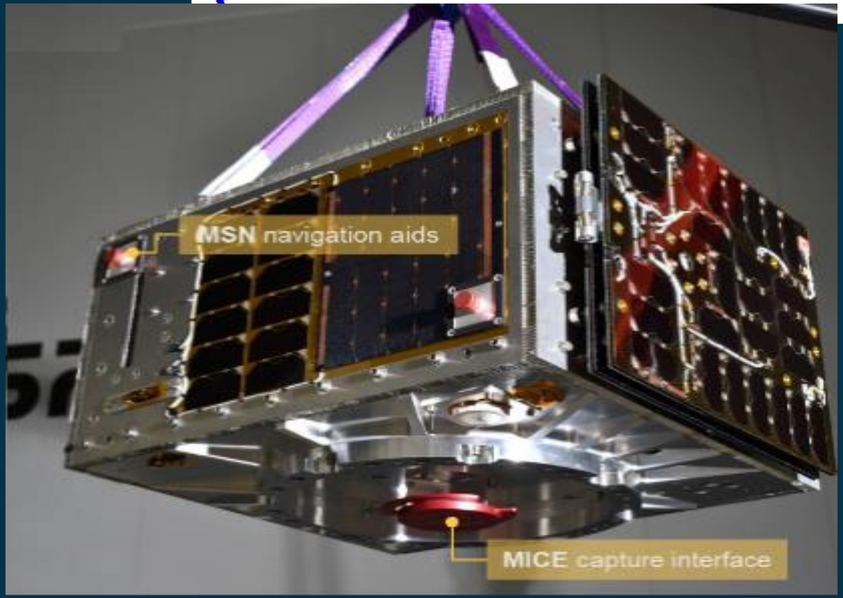


Credits: GMV

Potential Target Description

- LUR-1 Spanish national satellite
  - Launched August 2024
- Wet mass: 57 kg
- Low Earth Orbit ~510 km, SSO 10:30 p.m.
- Prepared with ESA Removal Interfaces:
  - Mechanical Interface for Capture (MICE) and
  - Rendezvous Markers to Support Navigation (MSN)
- 3 Axis Stabilised allowing to demonstrate cooperative and uncooperative scenarios
  - E.g. simulate different tumbling motions for rendezvous

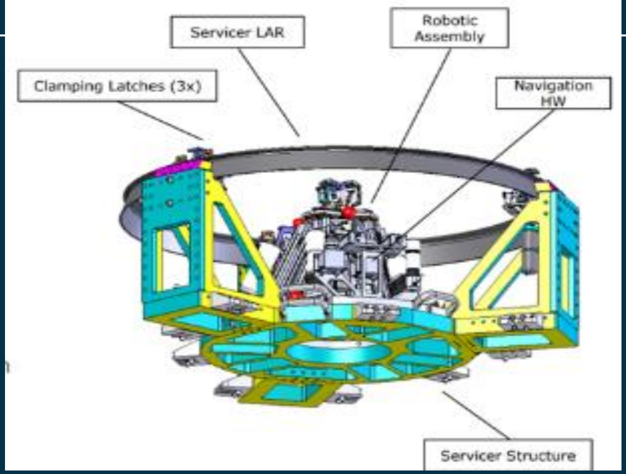


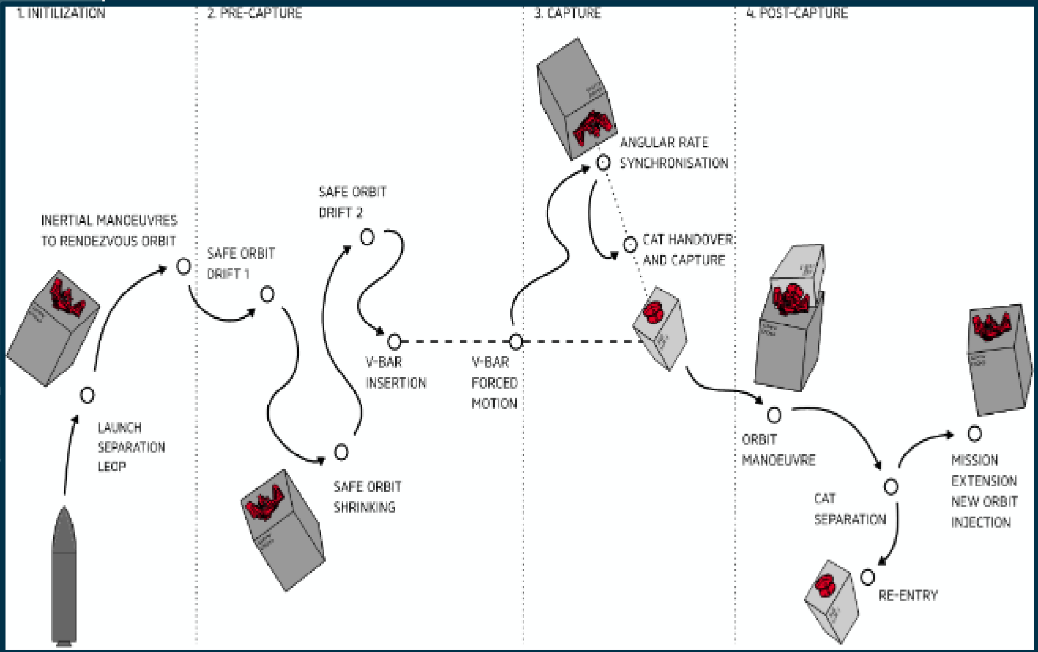


Credits: AVS

Mission Key Characteristics

Mission orbit & satellites	Mass
Mission orbit & satellites - Low Earth Orbit ~510 km nominal altitude - SSO orbit 10:30 p.m - Small Satellite platform with heritage LEO platform - Dimensions: 80x80x120 cm (x, y, z) **Launch Vehicle** - Micro launcher, or - multiple launch service (e.g. Vega)	**Mass** - Wet mass: ~150 kg incl. Capture Payload Bay **Mission Duration** - < 1 year **Power** - ~420 W max. Capture mode **Delta V budget** - ~50-100 m/s
Launch date: 2029	





CAT IOD Planning and Financial Overview

2022 2023 2024 2025 CM25 2026 2027+

CAT Capture Payload Bay Breadboard

CAT Capture Payload Bay EM

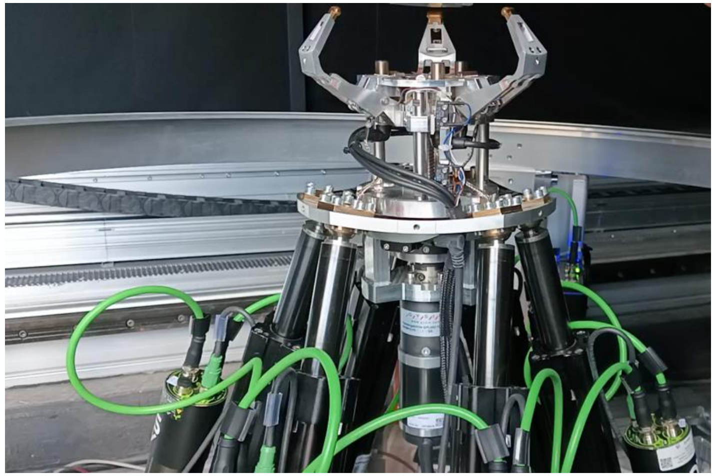
CAT IOD Phase B/C/D

2 x CAT IOD Phase A

PRR

S2P

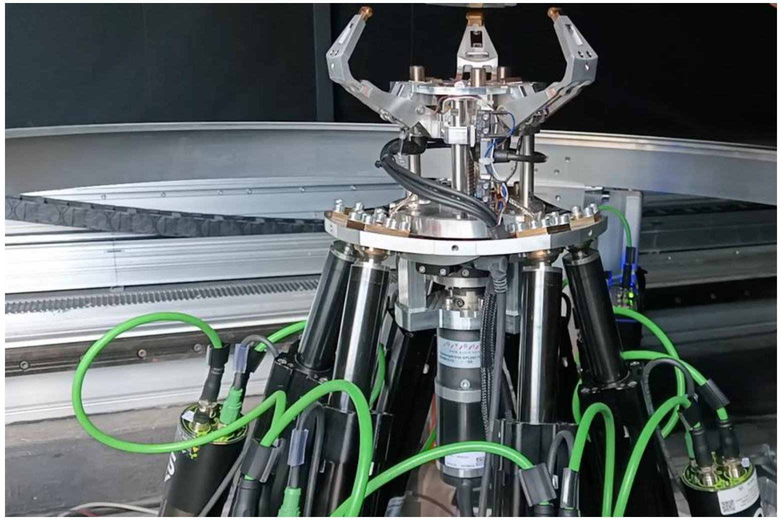
Preparatory Activities



Credits: GMV

Funding Overview		
CaC	75 M€ (TBC)	*To be confirmed by PRR*
CM25	75 M€	*Full funding in CM25 for launch in 2029*

CAT IOD Planning and Financial Overview



Credits: GMV

		S2P Period 3 (CM-25) Estimate
		Amount (Meuro)
AT	Austria	0 - 2
BE	Belgium	2 - 15
CZ	Czech Republic	0 - 2
DK	Denmark	2 - 8
EE	Estonia	
FI	Finland	
FR	France	0 - 5
DE	Germany	2 - 10
GR	Greece	
HU	Hungary	2 - 5
IE	Ireland	
IT	Italy	2 - 10
LU	Luxemburg	5 - 15
NL	Netherlands	0 - 2
NO	Norway	
PL	Poland	5 - 10
PT	Portugal	2 - 8
RO	Romania	2 - 8
ES	Spain	20 - 40
SE	Sweden	0 - 2
CH	Switzerland	5 - 10
GB	United Kingdom	15 - 35
CA	Canada	0 - 5
LV	Latvia	
LT	Lithuania	
SI	Slovenia	
SK	Slovakia	
Total		75

COSMIC – Competitiveness

COSMIC – Competitiveness

The competitiveness segment in ESA's Space Safety Programme aims at developing the space safety market and at exploiting commercialisation dimensions.

➔ ***Use of a novel, two-staged industry-driven procurement process via Call for Proposals (CfP)***

<u>Status Fall 2024 (rolling approach)</u>

11 outline proposals were timely iterated

10 outline proposals were positively evaluated

9 activities have implementation recommended

8 activities have been kicked-off

- Overall Volume in S2P2 total 8.4M
- Intended Volume in S2P3: 10M

COSMIC – Competitiveness

Further planned evolution of Competitiveness Segment in S2P

- Keep the **efficient CfP approach**, remain open for all areas of S2P, keep wide spectra of possible activities
- Keep the **flexible evaluation process** that allows for fast feedback on Outline proposals
- **Shorten further the time to kick-off** and reduce the observed ~5months from Accepted Outline Proposal to Kick-Off (target is 3-4 months)
- **Extend scope** from “Partnering” to also support “Enabling”
- **Assess market success** of supported activities that near completion

Logistics

Logistics Guidelines

Follow all safety instructions from our Space Safety YGT team.

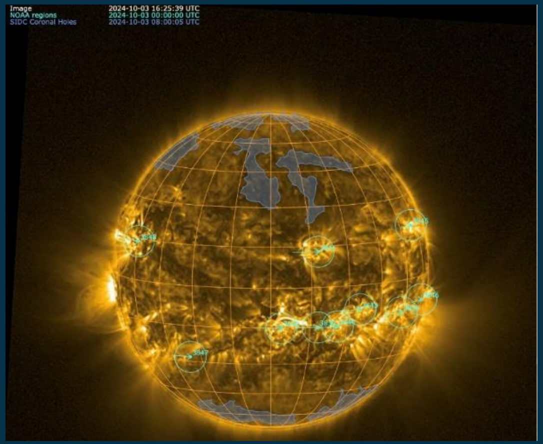
Do not leave the building without an ESA badge holder.

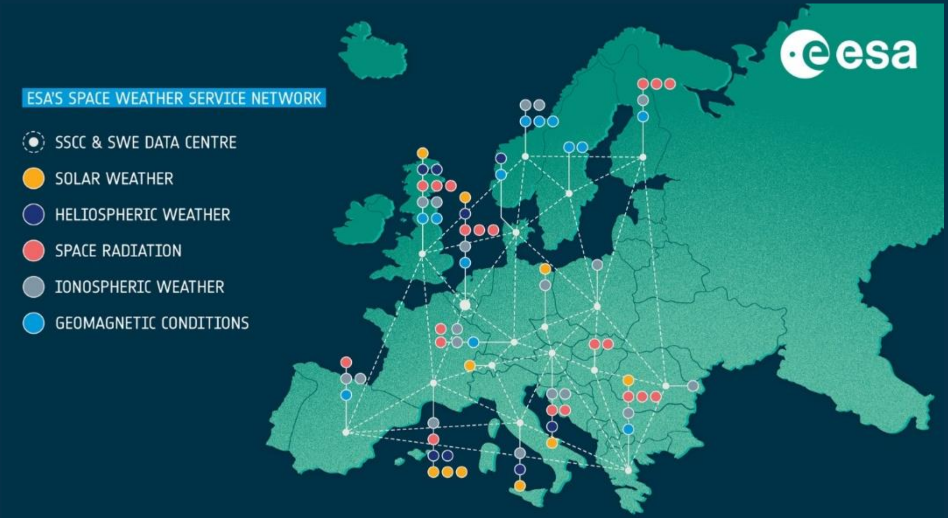
B2B meetings should last 20-25 minutes. Stick to this schedule to ensure a smooth afternoon, as many have flights to catch.

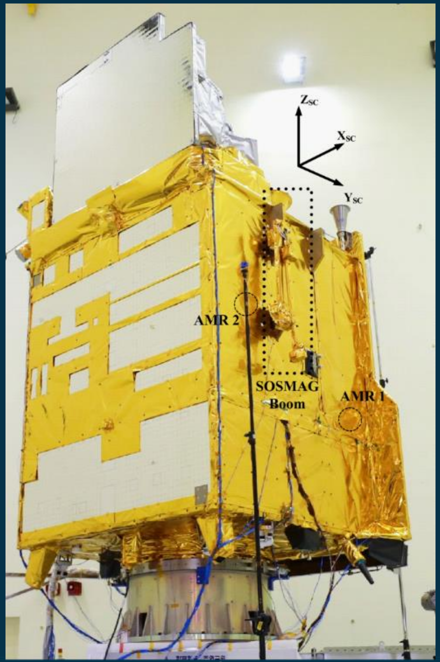
Return your badge when leaving the facilities.

Space Safety Achievements 2024

Space Weather - Achievements

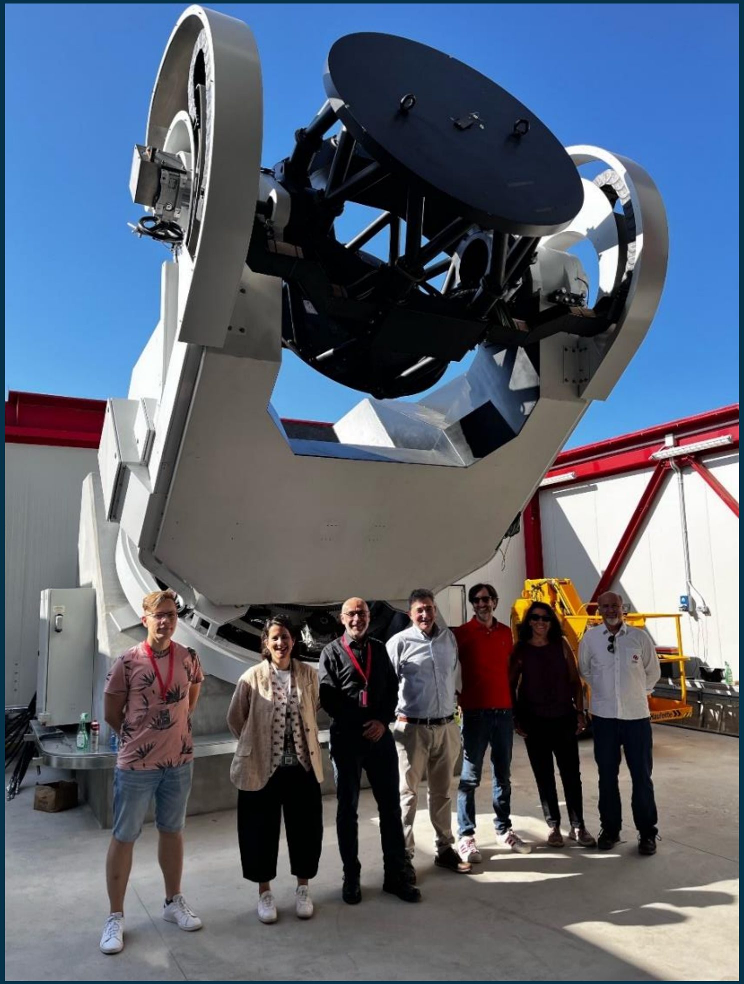




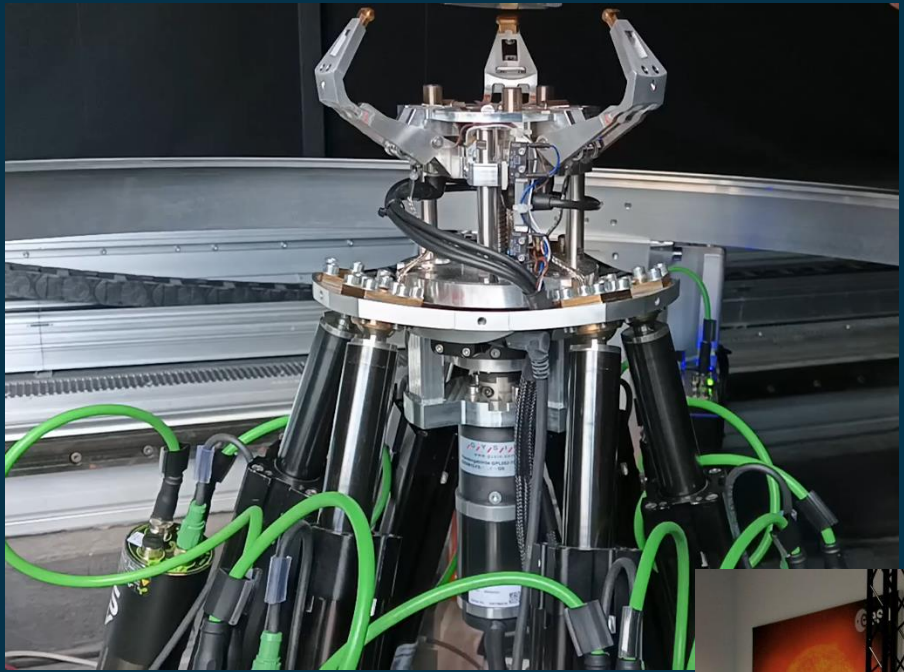


→ THE EUROPEAN SPACE AGENCY

Planetary Defence - Achievements



Space Debris & Cleanspace - Achievements



THANK YOU!

Contact Details

Name and Position	Emails
Holger Krag, Head of ESA's Space Safety Programme	Holger.Krag@esa.int
Christian Steimle, Clearspace-1 Project Manager	Christian.Steimle@esa.int
Andrew Wolahan, Rise Project Manager	Andrew.Wolahan@esa.int
Giuseppe Mandorlo, Vigil Project Manager	Giuseppe.Mandorlo@esa.int
Paolo Martino, Ramses Project Manager	Paolo.Martino@esa.int
Juha-Pekka Luntama, head of ESA's Space Weather office	Juha-Pekka.Luntama@esa.int
Stefan Kraft, Aurora's project manager	stefan.kraft@esa.int
Melanie Heil, Space ESA's Weather Space Segment coordinator	Melanie.Heil@esa.int
Richard Moissl, head of ESA's Planetary Defence office	richard.moissl@esa.int
Tim Flohrer, head of ESA's Space Debris office	Tim.Flohrer@esa.int
Tiago Soares, ESA's Clean Space lead engineer	Tiago.Soares@esa.int