Space Safety Programme

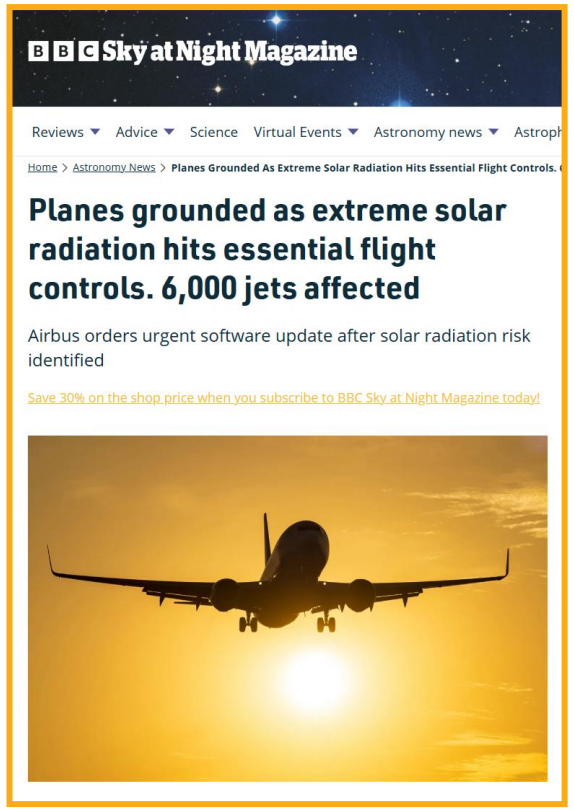
Dr. HOLGER KRAG
Space Safety Programme Manager
Directorate of Operations

EUROPEAN SPACE AGENCY

17/09/2026

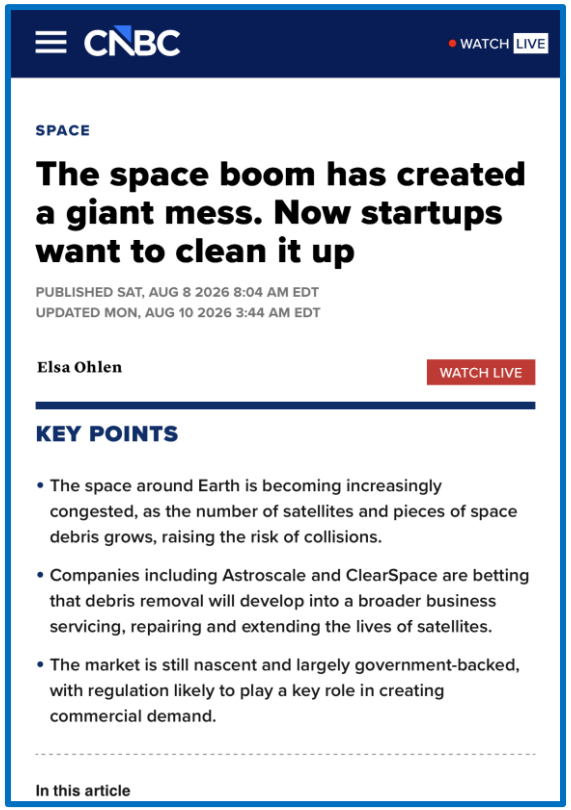
Space safety in society

Space Weather

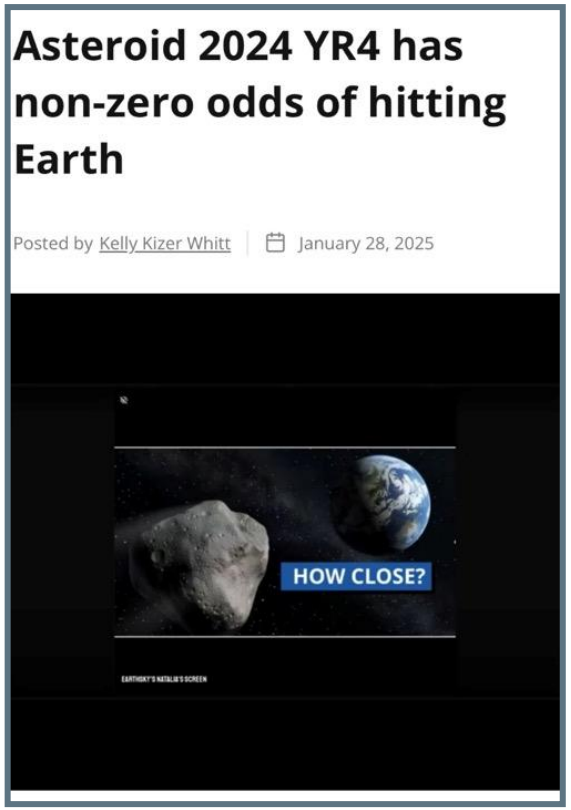


Space Debris

Clean Space



Planetary Defence



Space Safety Programme: programmatic goals & CM25

Space Weather

- Providing timely, accurate, and actionable space weather alerts through a pre-operational monitoring system
- Cooperating with a Space Weather governing entity

Space Debris & Clean Space

- Developing technologies for a Zero Debris approach
- Assessing risks from small-sized debris
- Demonstrating IOS technologies for space circular economy

Planetary Defence

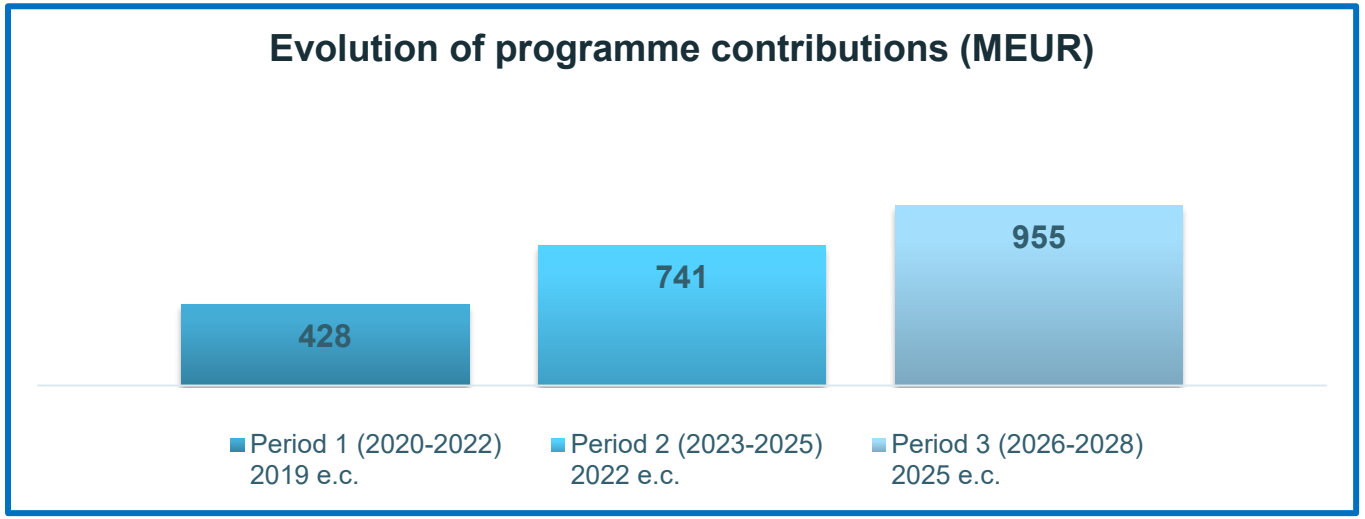
- Detecting asteroids > 40 m
- Warning of impacts at least three weeks in advance
- Deflecting asteroids smaller than 0.5 km

Council Ministerial 2025

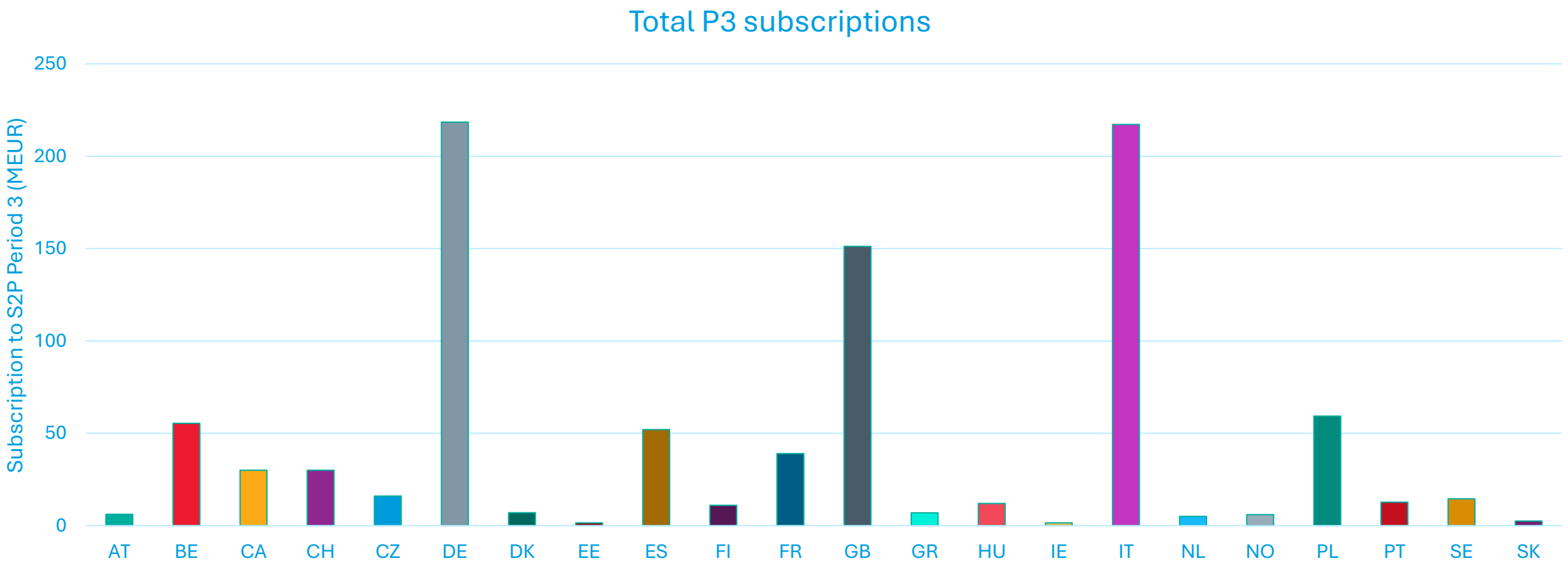
S2P target → 933 MEUR

Subscribed → 955 MEUR

Record high: oversubscription (102.4%)



CM25: overview



ESA UNCLASSIFIED – For ESA Official Use Only

Cornerstone and COSMIC missions advance key milestones

CORNERSTONE MISSIONS

VIGIL
Completed satellite PDR

RAMSES
Completed CDR

HERA
On track to meet Didymos in October 2026

CLEARSPACE-1
Phase B2/C/D approved

RISE
Completed SRR and entered Phase B2

CAT
Completed PRR

COSMIC MISSIONS

SWING
Progressing towards KPG-2

Flyeye-1
On track for move to Mt. Mufara

NEOMIR
Phase B1 approved

Competitiveness
Call for proposals launched

DRACO
Completed CDR

Zero Debris platform
Evolutions and technology developments ongoing

ESA Space Safety Fleet

ESA's Space Safety programme helps to protect our planet and infrastructure from hazards originating in space, and builds towards a sustainable future in space.

esa
→ THE EUROPEAN SPACE AGENCY

SPACE DEBRIS

Draco
Inside a fiery reentry

Cream in-orbit demonstration
Automated collision avoidance

Optimist
Registering tiny debris test

Sailor
Registering tiny debris

Visdoms-S
Optical debris observation

Omlet
Nudging space debris

LEMO demonstration
Cis-lunar debris monitoring

CLEAN SPACE

Prelude
Testing close-proximity operations

ClearSpace-1
Removal of small satellite

Rise
Mission life extension

Erase
Removal of large satellite

CAT
Removal of prepared satellite

EcoStars
Ecodesign technologies test

ORUM
In-orbit refurbishment

PLANETARY DEFENCE

Hera
Asteroid deflection validation

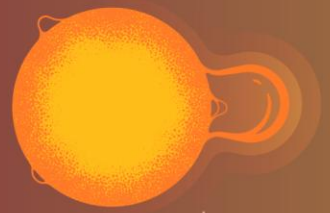
Flyeye telescope 1
Automated asteroid surveys

Ramses
Rendezvous with Apophis

Flyeye telescope 2
Automated asteroid surveys

Neomir
Detecting hidden asteroids

SPACE WEATHER



Swing
Ionosphere monitoring

Sawa
Thermosphere monitoring

Aurora demonstration
Aurora monitoring test

Vigil
L5 space weather reporter

Sword
Radiation belt monitoring

Aurora constellation
Aurora monitoring quartet

Shield
CME advanced warning

Implementation phase

Preparation phase

Ground-based

2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | Future

NEOMIR – Near Earth Object Mission in Infrared

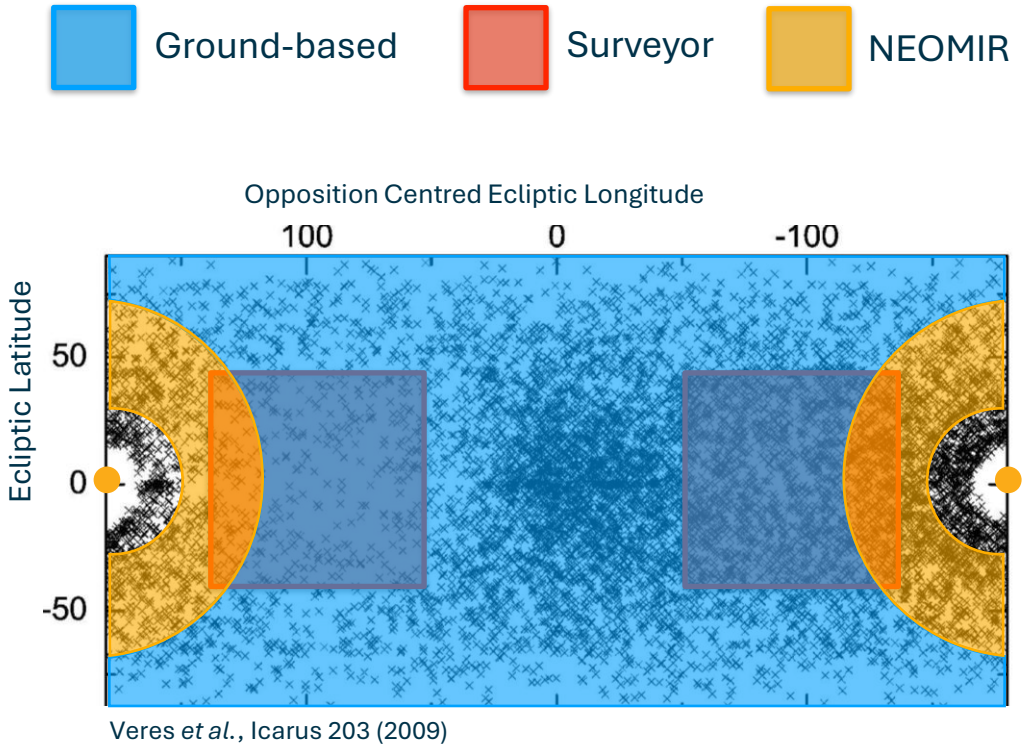
EUROPEAN SPACE AGENCY

NEOMIR – closing the Sun-approach detection gap

Thermal-infrared observations from L1 reveal approaching objects that ground surveys cannot see.

MISSION BASELINE

- Early warning and characterisation of newly detected NEOs
- Long-wave infrared observations around 10 µm
- Four 2k × 2k detectors operating near 45 K
- Complementary coverage to NASA's NEO Surveyor



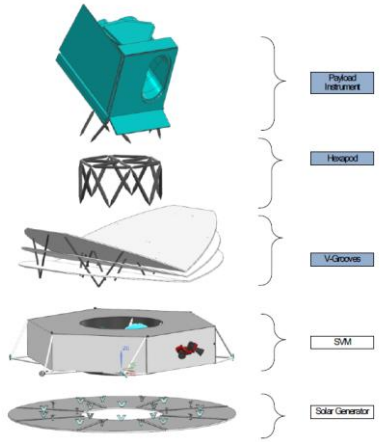
Veres *et al.*, Icarus 203 (2009)

Location of virtual impactors 1 day before impact date and area that is covered by on-going or foreseen surveys

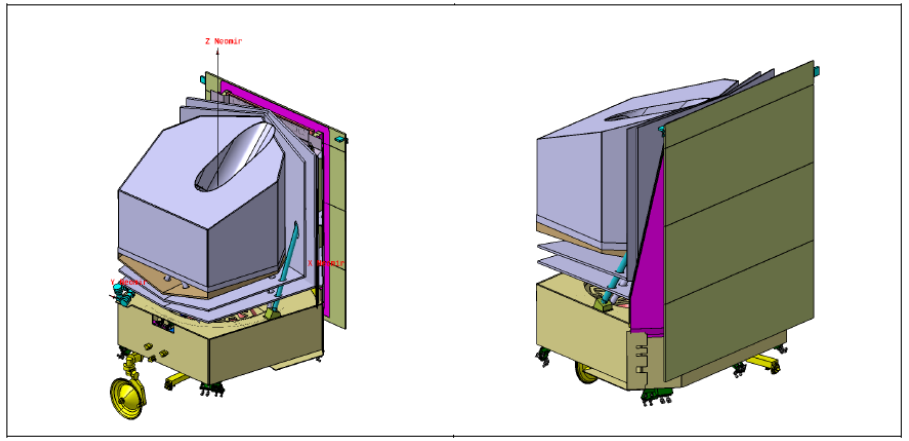
Focus → smaller imminent impactors approaching at low elongation

Two viable concepts converge on one Phase B1 path

A · PLANCK-LIKE



B · EUCLID-LIKE



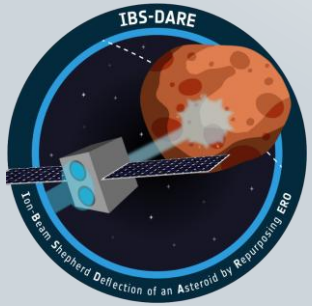
COMMON BASELINE

- Modular payload and service modules
- SEL2 → SEL1 transfer remains viable (~8 months)
- Detector operation near 45 K still needs consolidation
- NEOCC data flow and ground segment must be developed

PHASE B1 · INDUSTRIAL OPPORTUNITY

- Extensive RFI campaign planned in Phase B1
- Subsystem scope can reflect industry and national interest
- Q4 2026 kick-off; open competition with two parallel contracts
- Objective: implementation proposal ready for CMIN28

IBS DARE – Ion Beam Shepherd Deflection of an Asteroid using ERO



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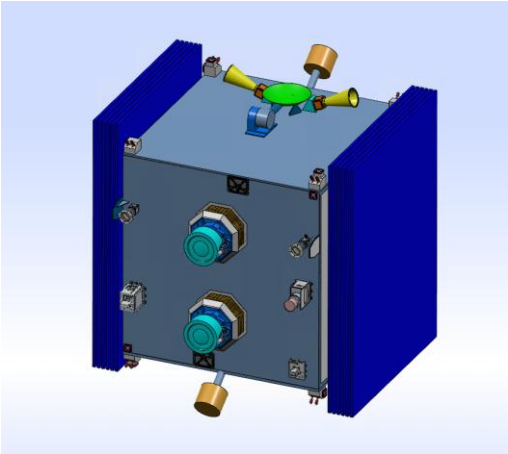
Ion Beam Shepherd Deflection of an Asteroid using ERO – IBS-DARE

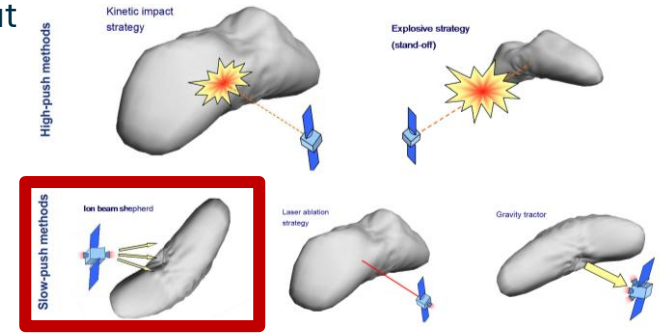
4 MISSION GOALS

- Demonstrate measurable asteroid orbit alteration using IBS.
- Validate IBS performance models through system measurements.
- Enable safe, automated close-proximity operations.
- Characterize target asteroids' physical and dynamical properties.



ERO heritage

- Eight years of RIT-2X electric-propulsion development
- Precise deflection without contact or fragmentation
- A scalable path to European planetary defence

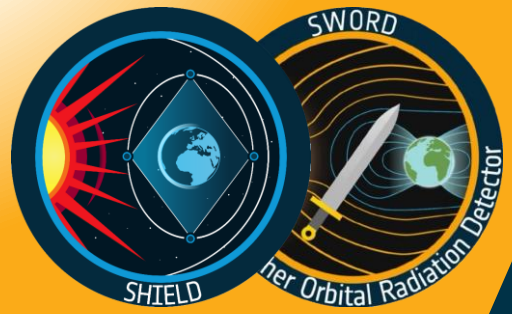


Credit ESA / Deimos Space

REFERENCE BASELINE		
Mission	Profile	Measurable orbit change
	Method	Remote, non-contact IBS
	Purpose	Scale to planetary defence
Spacecraft	Wet mass	2,449 kg
	Peak power	18 kW
Target	Scale	<150 m asteroids
	Baseline	2022 ST124
Lifetime	Operations	5 years
Profile	Launch 2035 · 2.5-year transfer · <2-year IBS	
	NAC, WAC, PALT + science payload	
Programme	≈€600m cost at completion	

Distributed Space Weather Sensors System (D3S)

SHIELD & SWORD



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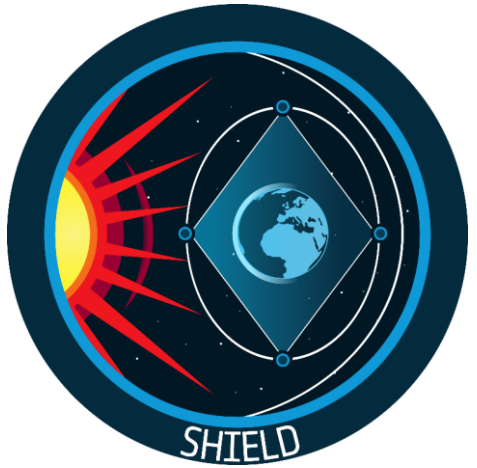
SHIELD Mission

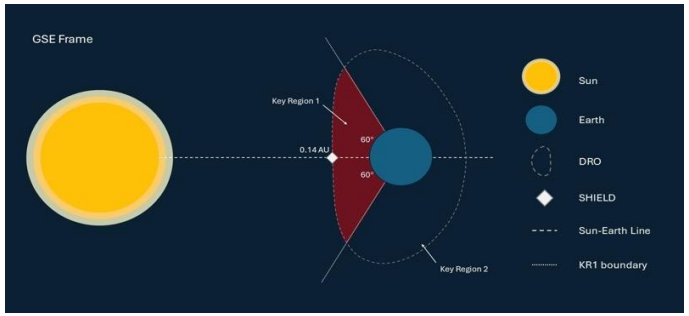
SHIELD → low-latency observations in Key Region 1 support Earth-impact prediction with approximately 120 minutes of lead time, depending on CME speed.

- Solar-wind observations in Key Region 2 support modelling and scientific research.
- High-energy solar-particle measurements detect Solar Energetic Particle events.



PHASE A/B1 FUNDED

→ Additional participation sought for Phase B1 in 2027



Sun-Earth Distant Retrograde Orbit in GSE Frame

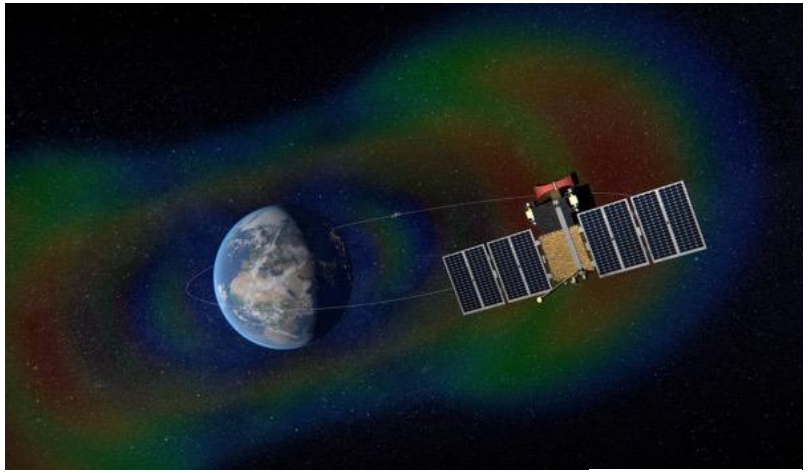
REFERENCE PAYLOAD

Plasma analyzer
Magnetometer
Radiation monitor
Commercial ground segment

Space Weather Orbital Radiation Detector – SWORD Mission

SWORD → low-latency in-situ observations of particle flux, pitch-angle distribution, magnetic field and plasma environment.

- GTO-type orbit with two satellites phased half an orbit apart
- Mission lifetime of at least three years – **target launch in 2032**



Credit: Redwire

PHASE A/B1 FUNDED

→ Parallel Phase A studies led by Redwire and Argotec
→ Instrument de-risking activities (S3-SW-12) and Phase B1 are planned in 2027

INDUSTRY PARTICIPATION SOUGHT

- Instruments
- Ground segment
- Operations
- Platform equipment
- GSE
- Test facilities
- Life-cycle assessment / ecodesign

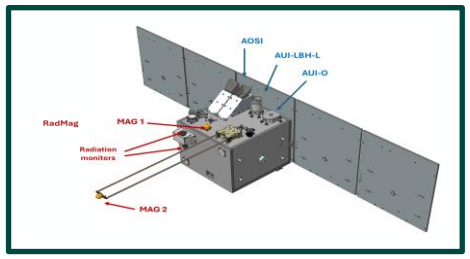
REFERENCE PAYLOAD

- Plasma analyser
- Magnetometer
- Charged particle monitor
- Medium / High / Very High Energy
- Commercial ground segment

Aurora

Continuously observe the Aurora Borealis to monitor how solar wind and coronal mass ejections affect the terrestrial system.

Improved magnetospheric and ionospheric modelling for space-weather nowcasting and forecasting, enabling potential new services.



INDUSTRIAL TEAM

OHB SWEDEN · CSL · Honeywell · ABSOLUT SYSTEM · HUN REN

TWO-STEP ARCHITECTURE

- **Aurora-D**
  Single-satellite demonstrator
- **Aurora-C**
  Constellation of four identical satellites

PAYLOAD SUITE

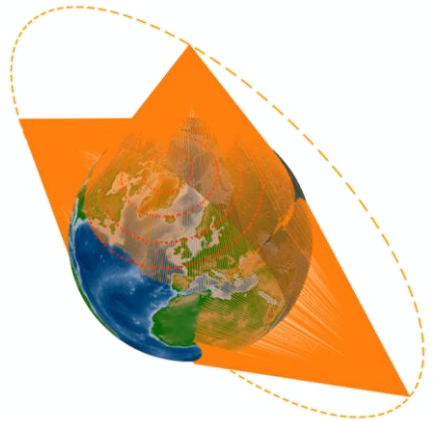
- **AUI**
  Auroral UV Imager
- **AOSI**
  Auroral Optical Spectral Imager
- **RadMag**
  Radiation Monitor + Magnetometer

PLATFORM

InnoSat catalog platform from OHB SE, tailored for mission in MEO

PROGRAMME STATUS

User community under consolidation
Phase B1 ongoing • **SRR** planned Q3 2026



Clean Space and Circular Economy

ERASE & ORUM

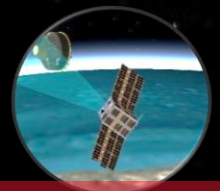
EUROPEAN SPACE AGENCY

ISAM

overview of ongoing mission developments at ESA

Close-Proximity Operations IOD

PRELUDE (S2P)

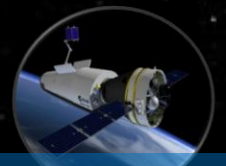


SROC (TEC)

LOGISTICS

ASTRIS (STS)

InSPoC-1 (STS)

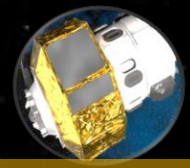


Space Rider (STS)

RAVEN (STS)

REFILLING

InSPoC-2 (STS)



ESPRIT – ERM (HRE)

AUTONOMY

InSPoC-3 (STS)

IN-SPACE CARGO

InSPoC-4 (STS)

PROPELLANT DEPOT

Odyssey (STS)

EoL DISPOSAL & Debris Removal SERVICE

ClearSpace-1 (S2P)

ELSA-M (CSC)

CAT (S2P)

ERASE (S2P)

AOCS Takeover

RISE (S2P)

Phoenix (CSC)

CIRCULARITY

ORUM (S2P) - REFURBISHMENT

RECYCLING

MANUFACTURING

More missions will be prepared and implemented…

Circular Space Economy Demonstrators – ERASE & ORUM

ERASE

ORUM

Shared enablers: robotics, modular interfaces, serviceability and electromagnetic compatibility.

PRE-PHASE A ACTIVITIES UNDERWAY

→ **ERASE:** five Phase 0 studies; MDR targeted for Q3 2026

→ **ORUM:** IRUS (Astroscale UK), MORPH (D-Orbit IT) and CIRCE (GMV ES) concept-consolidation studies kicked off in 2026

ERASE ROADMAP

Q3 2026 · Phase A
3 studies · 8 months · €2.25m

Q2 2027 · Phase B1
2 studies · 12 months · €6m

CM28 · Full implementation request
€8.25m way forward + ~€1m margin

ORUM DEMOS

IRUS · LEO prepared client
MORPH · GEO prepared client
CIRCE · LEO client TBC

Demonstrate refurbishment of OBC, reaction wheel, battery and/or solar arrays.

ZD & EcoStar Platform Roadmap

ESA/ADMIN/IPOL(2023)1 (link)
ESA Zero Debris Policy

ESA/ADMIN/IPOL(2025)1 (link)
ESA Ecodesign Policy

Very Large LEO PF
> 1000 kg

"Mid-Large" LEO PF
500-1000 kg

Small LEO PF
100-500 kg

CubeSat

Zero Debris – Large P/F – ph.1 → SRR-level
S2P FutureEO

AIRBUS DEFENCE & SPACE
OHB
ThalesAlenia Space

Zero Debris – Large P/F – ph.2 → PDR-level
S2P FutureEO

Zero Debris – Large P/F –future EOP missions

Sustainable "Mid-Large PF" Phase A
PrepE

Sustainable "Mid-Large PF" IOD Implemementation
S2P FutureEO

creotech
INDRA
SITAEL

EcoStar – ph.0
PrepE

EcoStar ph.0 consolidation
PrepE

EcoStar IOD ph.1 consolidation
S2P

EcoStar IOD – ph.2 → PDR-level
S2P

EcoStar IOD Implementation → Launch 2030
S2P + co-funding

Zero Debris – Small P/F – ph.1 → SRR-level
S2P FutureEO

Phase A consortia
ISISPACE
Neuraspace
Tyvak
AIKO
Uni of Turin
Alén Space
GMV
Romanian InSpace Engineering

CleanCube Ph. 0 + Ph. A
PrepE

CleanCube IOD Implementation → Launch 2028
S2P / GSTP + co-funding

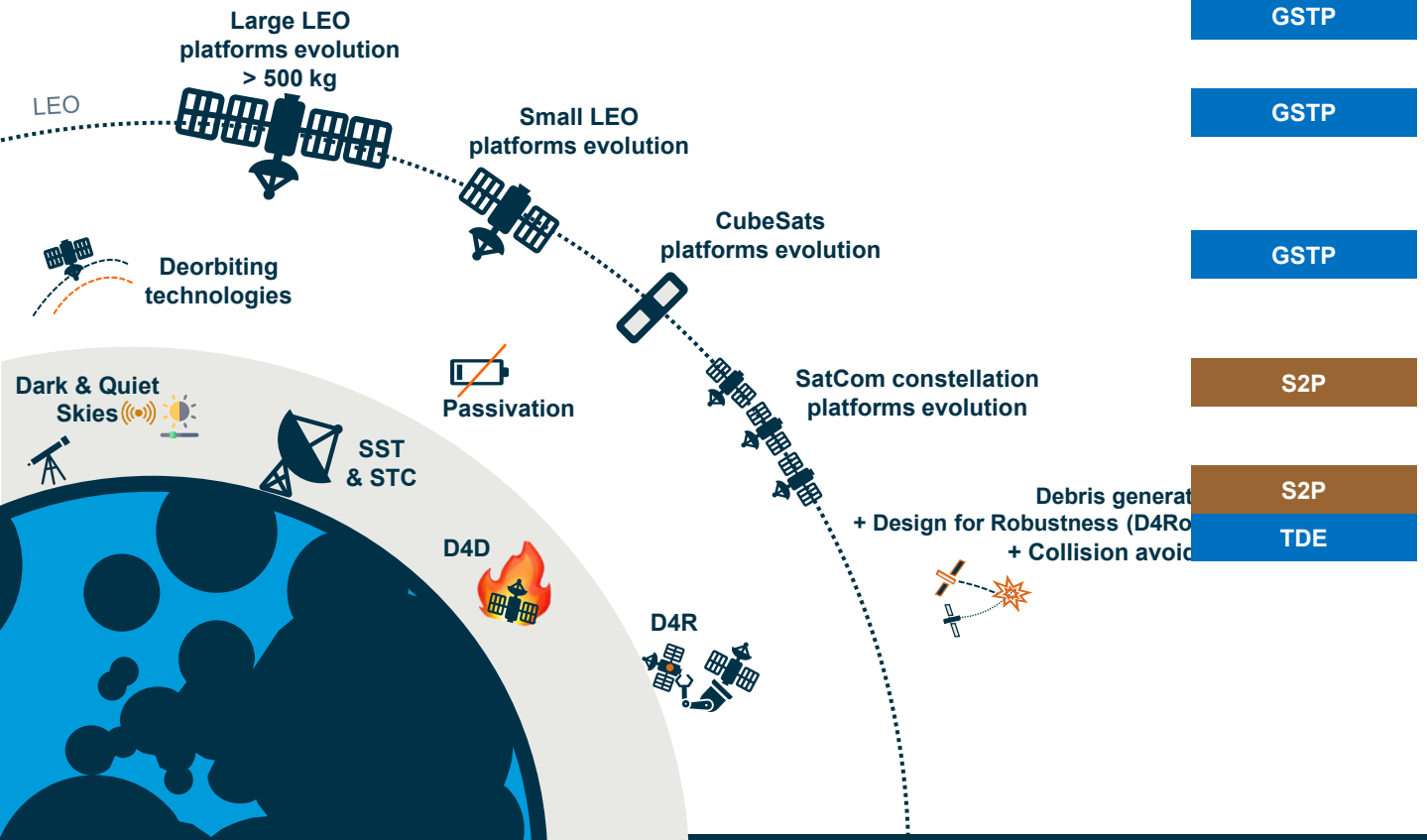
CM22
CM25
CM28

ESA SDM standards & Policy 2023
ESA Ecodesign Policy 2025
ESA SDM - standards update by 2030

Zero Debris Project: from P/Fs to Technology development

→ not running yet
= Approved and/or still waiting for a LoS from delegations

TODAY's OPPORTUNITIES



S2P
GSTP
GSTP
GSTP
S2P
S2P
TDE

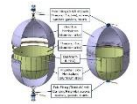
Zero Debris ESA activities

- Zero Debris Platforms evolution
- Reliable and safe disposal (deorbiting + passivation) systems
- Re-entry Safety & Design For Demise (D4D)
- Debris generation & Design For Robustness (D4Rob) to hypervelocity impacts
- Support to removal & Design For Removal (D4R)
- Dark and Quiet Skies (DQS)
- Break-Up and Collision Risk Management
- Space Surveillance and Tracking (SST) & Space Traffic Coordination (STC)

Design For Demise (D4D)

Selected in TDE WP 26-27 — Aapproved — Requested

Zero Debris LEO P/Fs activities (system-level): LARGE P/Fs, SMALL P/Fs, SATCOM CONSTELLATIONS



Demisable CP:
CP metallic tanks

< 40 L, 170 L

5 → 8 — MT Aerospace, ArianeGroup

Polish TF — 400 k€, →2024

GSTP — 1000 k€, →2024

TBD — 3.000 k€, 2026→2028

Demisable structural joints

3 → 4 → 6 → 8

ARTES AT — 600 k€, 2024→2026

ARTES AT — 1.000 k€, 2026→2028

EOP ? — 1.500 k€ →2030

Demisable Optical Payload

CFRP Optical bench: 2 → 6 — FutureEO — 900 k€, 2025→2027

P/L mechanical Interfaces: 2 → 5 — FutureEO — 900 k€, 2025→2026

Critical P/L elements: 2 → 5 — FutureEO ? — 900 k€, 2026→2028

8 — EOP ? — 4 M€, 2028 → 2030

OHB, TAS — ADS, TAS

Demisable EP:

COPV krypton tank

3 → 4 → 6 → 8

ARTES AT — 750 k€, 2024→2026

S2P — 800 k€, 2025→2026

EOP (NGGM)? — 1.500 k€ → 2029

tank & valve for Cubesats

2 → 4 → 6

TDE — 450 k€, 2026→2027

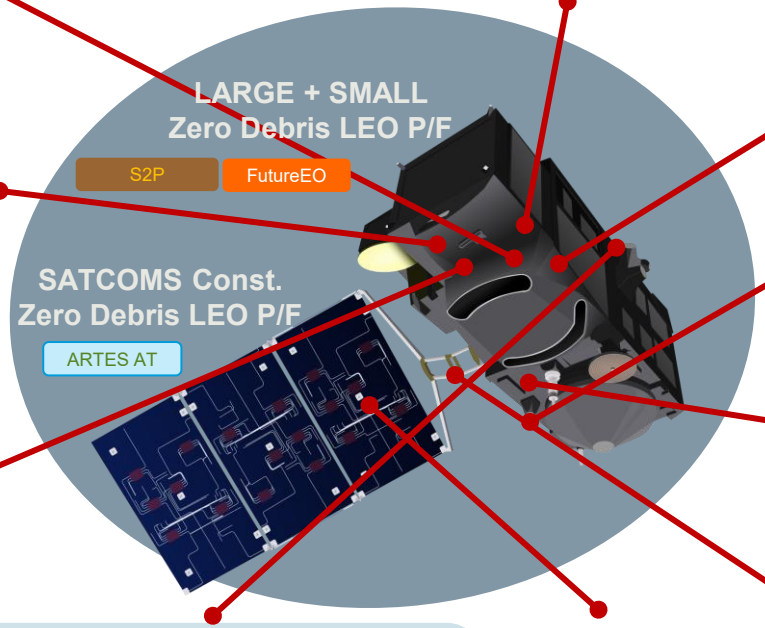
GSTP? — → 2029

EP thrusters for constellations

3 → 5 → 6

ARTES AT — 1200 k€, 2026→2027

ARTES AT — → 2029



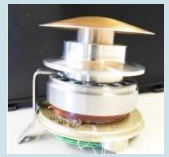
Demisable optical communication terminals

OHB, TESAT

2 → 4

TDE — 600 k€, 2026→2027

Demisable Reaction Wheels



3 → 4 → 6

FutureEO — TDE — GSTP DN

200 k€, 2026→2027 — 1.500 k€ → 2028

Rockwell Collins Astrofein

Guidelines for future electronics

2 → 4

TDE — 2026→2027

OHB

Demisable star trackers

2 → 4 → 6

TDE — 2026→2027

TBD — 1.500 k€→ 2029

Belstead

Demisable HDRM & Hinges

TAS

4 → 6

GSTP open comp. — 1.000 k€, 2026→2027

Demisable SADM

4 → 5 → 7

TDE — 725 k€ → 2027

TBD — 1.500 k€ 2027→ 2028

HTG, KDA

Ecodesign Project: recurrent P/F sustainable technologies

Achieve a 30-40% reduction of the environmental impacts of space missions by 2030
*→ **Sustainability for Technologies Expected to be Highly Recurrent***

Sustainable Propulsion

Iodine HET propulsion
4 ⋙ 7
GSTP Comp.
1500 k€, 2026→2027

Water-vapour electric propulsion
3 ⋙ 4 ⋙ 6
TDE | GSTP?
500 k€, 2026→2027 | → 2029

Sustainable Power distribution & storage

Solar cells
3 ⋙ 5
GSTP DN ?
2026 → 2027
Umicore

Batteries
2 ⋙ 4
TBD
2027→2029

Supercapacitors
3 ⋙ 6
GSTP Comp.
300 k€, 2026→2028

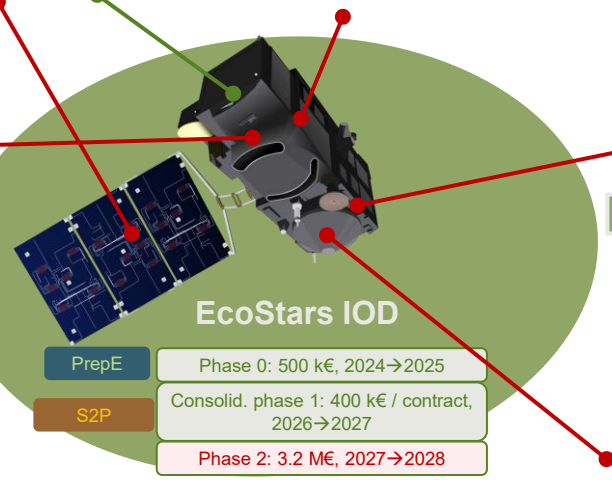
Sustainable harness
2 ⋙ 4 ⋙ 6
TDE | GSTP?
500 k€, 2027→2028 | → 2030

Sustainable Electronics

Sustainable antennas (3D-printed electronics)
2 ⋙ 4 ⋙ 6
TDE | GSTP?
750 k€, 2027→2028 | → 2030

High-precision wafer-level packaging for electronics
1 ⋙ 3 ⋙ 6
TDE | GSTP ?
300 k€, 2027→2028 | → 2031

Sustainable electronics manufacturing
2 ⋙ 4 ⋙ 6
TBD | GSTP?
2027→2028 | → 2030



Sustainable Manufacturing & Testing

Greener MAIT 2.0 processes
1 ⋙ 3
TDE
400 k€, 2024→2026

Sustainable Testing
S2P
TEC-F

Recycling of high-value scrap
3 ⋙ 6
GSTP Comp.
1.000 k€, 2026→2028

Composite structures
Bio-based, out of autoclave
2 ⋙ 4 ⋙ 6
TDE | GSTP?
500 k€, 2027→2028 | → 2030

Manufacturing with 3R capabilities
1 ⋙ 4 ⋙ 6
Discovery | TDE | GSTP Comp.
370 k€, 2021→2025 | 500 k€, 2026→2028

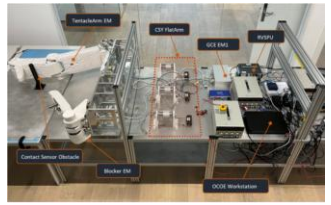
Eco-Demise
S2P | ESA Green Agenda

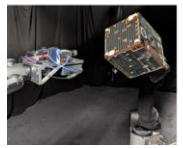
Ground-based resonance lidar monitoring atmospheric space debris tracers
Fraunhofer
1 ⋙ 4 ⋙ 5
Discovery | GSTP Comp.
175 k€, 2025→2026 | 1000 k€, 2027→2028

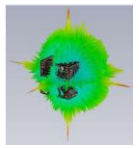
Progress on ESA Key ISAM projects (S2P) – Highlights Q3 2026

ClearSpace-1
ADR of ESA Unprepared target

- ✓ PATP to the Phase B2/C/D contract placed since beg. July
- ✓ Formal Technology Readiness Assessment
- ✓ activities un view of the System PDR & Ground Segment concept definition







Target Launch: 2030

CAT
ADR Interface demo prepared target

- ✓ Co-engineering sessions on GNC, Scalability and model-philosophy in July-August 2026
- ✓ PATP for Phase B1 in Septembre 2026
- ✓ CDR of CAT Payload EM in October 2026

Target Launch: 2030

PRELUDE
Inspection & CPO demonstration

- ✓ Project-level Final SRR July
- ✓ Phase B2, PATP since August
- ✓ ITT Phase C/D/E planned for Dec 2026

In-orbit **inspection** mission to demonstrate close approach operations with a cooperative unprepared client: Rendezvous sensors & visual base navigation algorithms IOD

Target Launch Date: Q1 2028

ERASE
End-of-Life services large unprepared LEO

- ✓ 2nd Co-engineering session with potential customers
- ✓ FR September 2026
- ✓ ITT Phase A October 2026
  OC : 3 // contracts for 8 months

Phase 0 primes

- Leonardo (IT)
- OHB (DE)
- GMV (ES)
- ADS (DE)
- TEC (DE)

Target Launch: 2031+

ISAM Use Cases Consolidation - Strategic Initiative

ESA ISAM User Directorates — Q3 2025

Open Call/RFI — Q2 2026

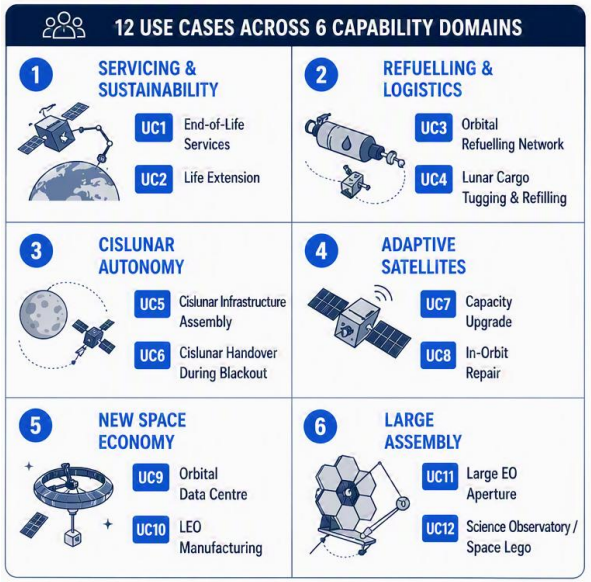
WG Activity

>50 candidate use cases identified

12 shortlisted for the July 2026 ESTEC workshop

2 Use cases pre-selected for **pilot** "Innovation sprints"

Selected Use Cases

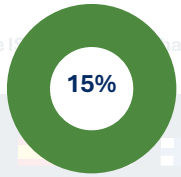


Community, Stakeholders and Participants

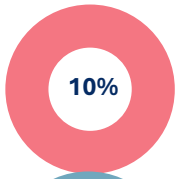
- 40+ participants
- 34 organizations

Satellite Operators

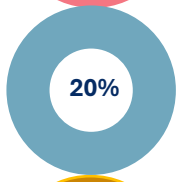
Large Space Industry



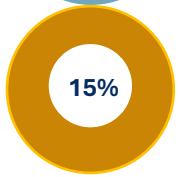
ISAM and Service Providers



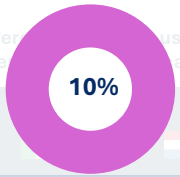
Investors / Insurances



SME and New Space Actors



Academia and Research Organisations



Institutional Actors.

Evaluation and Conclusions

- Users and Needs
- Value Proposition and Expected Impact
- Value Chain and Key Stakeholder
- Core Concepts and Enabling Capabilities
- Commercial and Delivery Considerations
- Programmatic Implementation and Risks

Critical Analysis and Next Step

2 Pilot Use Cases CALL OPEN

a) **MultiUsers Orbital Refilling Network-** a shared and evolutive refilling ecosystem enabling scalable inorbit logistics across different orbits.

b) **Extending The Lifetime of High Value Assets -** a mission infrastructure addressing the needs of highcost missions to maximise their usable lifetimes.

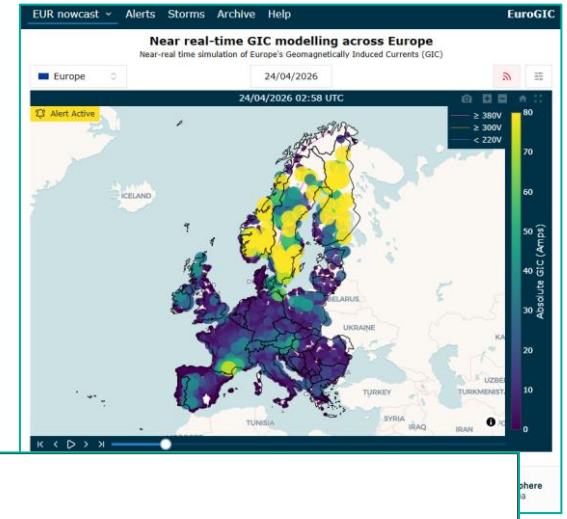
More use cases will follow

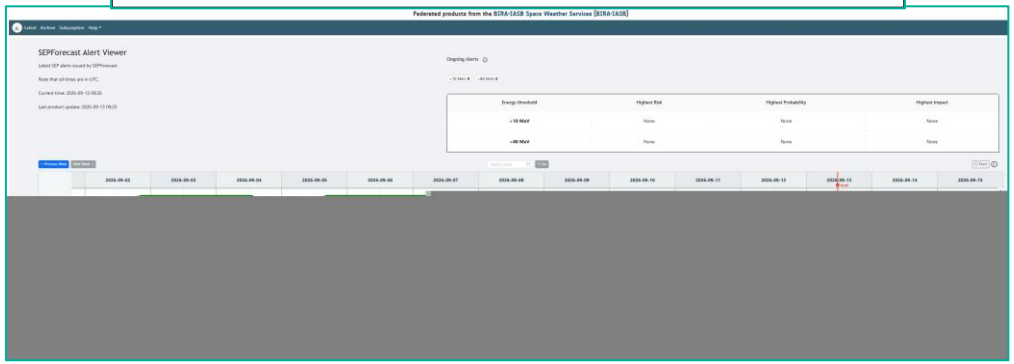
COSMIC Opportunities

EUROPEAN SPACE AGENCY

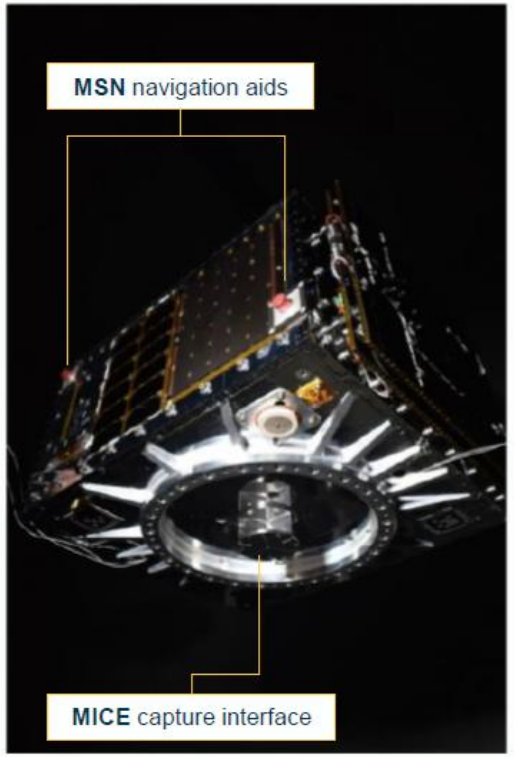
SWE Service Network

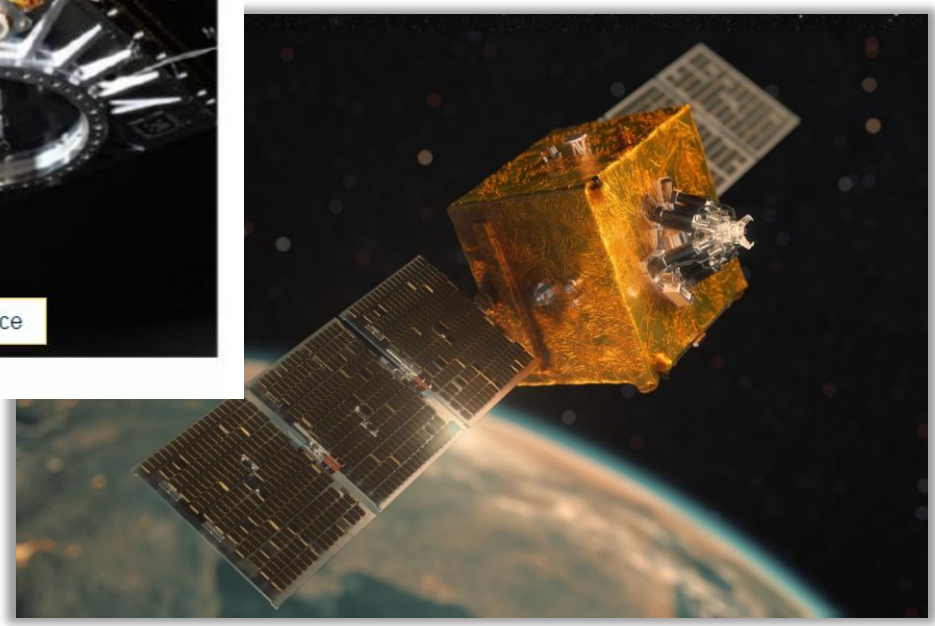
- SWESNET pre-operational services running smoothly
  → Continuity secured to Q1/2027
- SWE Portal Release 3.17 in preparation 14th October 2026
  - EuroGIC (S1-SW-17) introduction [Lead: Starion UK, BGS, Geosphere AT]
  - RBFAN-2 (S1-SW-14), further expansion of RBFAN-1 product group with additional products and configurable user interface [Lead: ONERA]
  - Access to NGRM data from MetOpSG-A1 via data browser and API
- RBFAN-3 (S2-SW-06-B) Space Environment Characterisation Nowcast and Forecast, KO held 7th September 2026





CAT – Capture of a Cooperative Target





Competitiveness Segment

- The CfP for Period 3 is open on Open Space Innovation Platform **(OSIP)**
- In total, 7 activities are still running from P2, 10 have concluded.
- The new Call for P3 has received 12 Outline Proposals which are being evaluated
  - ➢ 8 out of 12 have been advanced to Full Proposal stage
  - ➢ These 8 activities combined are committing 6.6 M€ total industrial value (~70 % of the targeted value from the implementation plan)