

A composite graphic for a space safety program. At the top left, a bright sun or star is partially obscured by a large, fiery meteor streak. In the center, the Earth is shown from space, with a green and red atmospheric layer. To the left of Earth, a satellite is in orbit. Below the satellite, a small yellow component and a red wire are shown. To the right of Earth, another satellite is in orbit. Below that, a grey, irregularly shaped asteroid is shown. The background is a dark blue space filled with stars and two faint white orbital paths.

ESA'S SPACE SAFETY PROGRAMME

PROTECTION FROM HAZARDS ORIGINATING IN SPACE

HOW DOES ESA'S SPACE SAFETY PROGRAMME BENEFIT EUROPE?

Spotlight solutions

Stimulating a competitive space industry in Europe

Stimulating technology development and industry competitiveness with the **Cosmic Competitiveness segment**

Showing leadership and international collaboration with unique Space Safety missions like the **Planetary Defence Cornerstone missions Hera and Ramesses**

Timely warnings for asteroids

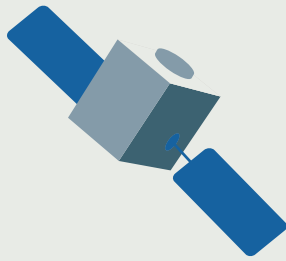
Better asteroid detection with the **Flyeye automated telescopes**

Improve asteroid orbit determination and impact risk assessment with **early warning systems** and long-term predictions

Keep the future of spaceflight safe and sustainable

Removing debris from orbit and developing in-orbit servicing with the **ADRIOS Cornerstone missions ClearSpace-1 and RISE**

Stopping the creation of more space debris, developing technologies to cope with the increased space traffic and get to **Zero Debris by 2030**



Protect critical infrastructure from space weather effects

Give time for mitigation to limit damage, and safeguard spacecraft and ground infrastructure with **Space Weather Cornerstone mission Vigil**

Delivering critical information to stakeholders and industry by building monitoring services and tools in the **ESA Space Weather Service Network**

We are constantly confronted with dangers in and from space, carrying with them the risk of sudden disaster and potentially derailing everyday life

In February 2025, a massive piece of space debris survived reentry and slammed into the ground in Poland. It is a vivid example of the objects circling Earth that may cause collisions and are increasingly problematic for critical satellite-dependent services. As the Sun goes through its peak of solar activity, beautiful auroras are at times visible all the way to southern Europe. Yet satellites in space and infrastructure on the ground experience adverse effects.

Critical services may fail as they struggle to withstand the radiation, particles and plasma slung our way.

Asteroid 2024 YR4 was a serious potential asteroid impact threat until it could be determined it will miss Earth. It underlined the urgent need to be ready with asteroid detection and deflection techniques for planetary defence.

ESA's Space Safety programme is dedicated to protecting our planet, its people and critical infrastructure from natural threats from space as well as humanmade ones

Independent, continuous access to critical data must be ensured for Europe, especially in the current time of geopolitical instability. And we can't stop there. If we want a future in space at all, we must clean up Earth's orbits and show leadership to make sure no more debris is generated.

While keeping us safe, the Space Safety programme's activities also help secure Europe's position in agree-

ment with ESA's Strategy 2040. Innovation is nurtured to meet our ambitious vision, driving technology adoption and stimulating a competitive European space industry.

ESA Space Safety programme activities are essential to making sure we can detect and predict space hazards in time. To ensure Europe is ready to protect its citizens, elevating the future of Europe.

Explore all ESA Space Safety activities in this brochure! →

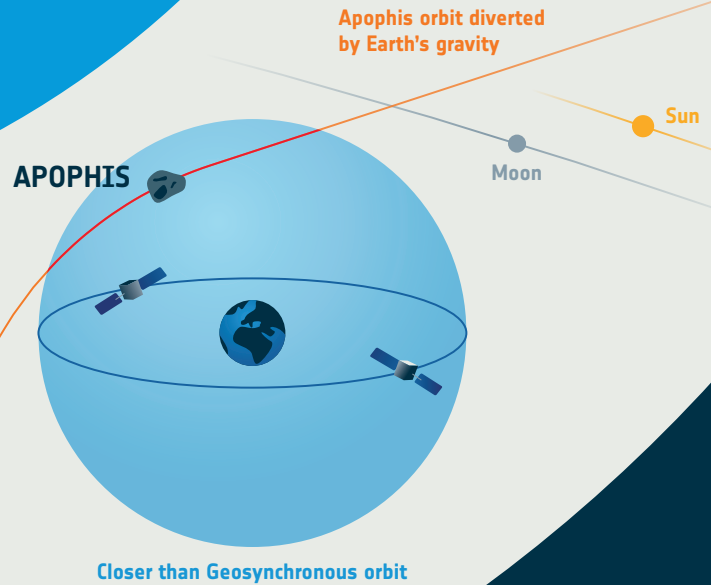
PLANETARY DEFENCE

Detecting, tracking and deflecting asteroids

Asteroids might be hurtling towards Earth at all times. ESA's Space Safety Programme's planetary defence activities aim to locate potential threats in time to mitigate their impact and possibly even preventing them.

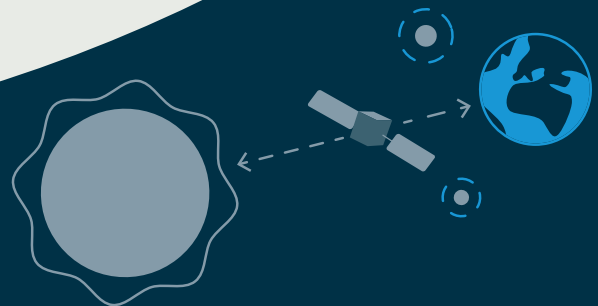
PREDICTING ASTEROID IMPACTS

The European asteroid observation network is coordinated by the Programme's **Near-Earth Object Coordination Centre (NEOCC)**. The NEOCC assesses observations to identify any impact threats and, when necessary, distributes the information to local authorities to enable timely mitigation measures.

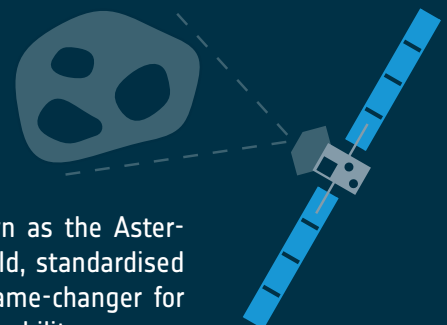


IMPROVING DETECTION CAPABILITIES

A network of automated **Flyeye telescopes** is built to survey the night skies, greatly extending our observational capacity. They scan for dangerous objects independently, alerting human astronomers once needed.

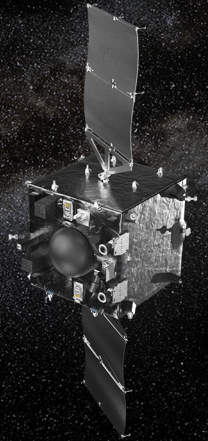


The **Neomir mission** will be positioned between the Sun and Earth, from where it can observe near-Earth objects days before impact that we are blind to from Earth. From there, it can observe near-Earth objects that we are blind to from Earth days before impact.



The **Satis mission**, also known as the Asteroid Inspector, is a quick-to-build, standardised nanosatellite that will be a game-changer for our asteroid reconnaissance capability.

PLANETARY DEFENCE CORNERSTONE



LEARNING TO DEFLECT ASTEROIDS

Asteroid deflection is no longer sci-fi, it is a skill we must hone before it is needed. The Space Safety Programme's very first mission **Hera** will examine the first test of asteroid deflection performed by NASA's DART. In doing so, Hera demonstrates asteroid 'scouting' or reconnaissance technologies.

ALL EYES ON APOPHIS – AND RAMSES

The entire world will be watching when the Apophis asteroid passes by very, very close to Earth in 2029. Observable with the naked eye in Europe, public interest in planetary defence capabilities will be immense.

Capitalising on the once-in-a-lifetime event, ESA's **Ramses mission** – with key support from JAXA – will be the one delivering images from space as it orbits and observes Apophis during its very close approach. The fixed launch window in 2028 mimics the tight time pressure of real reconnaissance missions in the future, testing capabilities in a very realistic way.

↑ *Ramses observing Apophis during its close approach*

PREDICTING SPACE WEATHER

Building space weather sensors and services

Space weather, or the fierce radiation, charged particles and plasma thrown our way by the Sun, can derail critical infrastructure in space and on Earth. Damages from big solar storms may run into the hundreds of billions of euros.

ESA'S SPACE WEATHER SERVICE NETWORK

- SSCC & SWE DATA CENTRE
- SOLAR WEATHER
- HELIOSPHERIC WEATHER
- SPACE RADIATION
- IONOSPHERIC WEATHER
- GEOMAGNETIC CONDITIONS

DEVELOPING SPACE WEATHER SERVICES

Solar storms can't be stopped. But their effects can be mitigated if space weather is forecast and 'nowcast' timely and accurately. The **ESA Space Weather Service Network** builds and matures the monitoring services needed for a dependable European space weather system.

The services deliver essential, actionable information for a range of industries, including power grids, telecommunications, navigation and satellite operations.

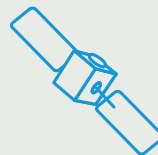


SPACE WEATHER SENSORS

Space weather services are impossible without accurate, real-time data. ESA's Space Safety programme builds a comprehensive **Distributed Space Weather Sensor System (DSWS)**:



AURORA
Keeps an eye on auroras and other parts of Earth's protective layers to protect ground infrastructure



SWORD
Enables 'nowcasting' of the space radiation environment, essential for spacecraft operators



NANOSATELLITES
Cost-effective missions that support the commercialisation of space weather monitoring

SPACE WEATHER CORNERSTONE



VIGIL IN DEEP SPACE

To protect critical infrastructure from space weather effects, experts have long expressed the need for a space weather mission to the Lagrange point five (L5) in deep space. From there, Vigil will observe the Sun's surface before the area turns into view from Earth, adding up to 4-5 days to our forecasting timespan.

The Vigil mission will be the first to stream operational data 24/7 from deep space. Vigil gives us time: advance warnings of oncoming solar storms lets us protect spacecraft and astronauts in space and infrastructure on the ground.

↑ *Vigil at Lagrange point 5*

MORE THAN THE SUM OF ITS PARTS

The game-changing impact of the Space Weather Cornerstone mission is underlined by the contribution by NASA and NOAA of key instruments as well as strong interest in future collaboration from Korean, Japanese and Indian space agencies.

Vigil – and later its next-gen successors – together with the **Distributed Space Weather Sensor System (D3S)** around Earth is an unmatched source of space weather data, ready to protect Europe's citizens and critical infrastructure.

TOWARDS SUSTAINABLE SPACEFLIGHT

Towards a clean and Zero Debris future

Orbits are getting dangerously crowded and collision risks increase rapidly. To have a future in space at all, we must stop adding space debris while we start cleaning up what's already there.

A CLEAN FUTURE IN SPACE

ESA's ambitious Zero Debris approach aims to stop creating new debris by 2030, with stringent standards and policies for its future missions that help stimulate technology development.

- **Zero-Debris satellites**, from CubeSats to large platforms, are built with support from the Space Safety programme as industrial partners adapt their production lines.
- A **De-orbiting Kit** is installed to execute a controlled re-entry from a low-Earth orbit at the launcher's end-of-life.
- The **CAT mission** demonstrates a standardised interface (to be built into future ESA Copernicus missions) to show how it can safely re-enter an incapacitated satellite.



TRUE SUSTAINABILITY

Clean space technologies go beyond debris prevention. The **Ecostars missions** demonstrate ecodesign technologies in space to prevent negative impacts on the Earth environment.

The end-goal of sustainable spaceflight is creating a true **Circular Economy in space**. Satellites should no longer be single-use, discarded after running low on fuel, a failure or outdated equipment. In-orbit services are the way forward.



ACTIVE DEBRIS REMOVAL & IN-ORBIT SERVICING CORNERSTONE



THE FIRST ACTIVE DEBRIS REMOVAL MISSION

ESA's **ClearSpace-1 mission** will be the first-ever mission to remove an unprepared and uncooperative piece of space debris from orbit. ClearSpace-1 will demonstrate the complex sensors and technologies needed for active debris removal, including critical relative navigation and close-proximity operations.

IN-ORBIT SERVICING

ESA's **RISE mission** is a commercial in-orbit servicing mission that will demonstrate that it can safely rendezvous with and dock to a geostationary client satellite.

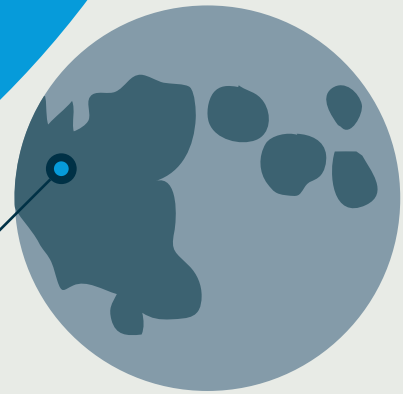
With the **ADRIOS Cornerstone missions**, the Space Safety programme is directly supporting the establishment of active debris removal as well as other in-orbit services like refuelling, refurbishment and assembling within Europe. This ensures that the European space industry will be at the forefront of this exciting new market.

↑ *RISE docking to a client satellite*

TOWARDS SUSTAINABLE SPACEFLIGHT

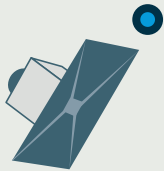
Technologies for increased space traffic

Space is getting congested. Tens of thousands of satellites will be hurtling around Earth over the next decade, accompanied by well over a million > 1 cm pieces of debris. Tracking debris and avoiding collisions is an ever more essential – and costly – part of spacecraft operations.



As we return to the Moon, a new monitoring mission will detect and track artificial objects and debris in the cislunar orbits.

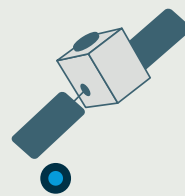
DEALING WITH SPACE DEBRIS



The **Sail Array for Impact Logging in Orbit (Sailor)** mission will monitor its large 100 m² sails for any holes that appear in them to better estimate the problem of space debris.

The **Verification of In-Situ Debris Optical Monitoring from Space (Visdoms)** will assess how many smaller than about 5 cm and even <1 cm pieces of debris there really are.

In the future, space debris deflection by **Laser** can become the cost-effective solution by making the debris move instead of the satellites.



The **Collision Risk Estimation and Automated Mitigation (CREAM)** is a collision avoidance system that automatically assesses the risk of in-space collisions and eases the decision-making process.



The **Destructive Reentry Assessment Container Object (Draco)** mission will collect unique measurements from inside the spacecraft during its reentry and breakup.

COMPETITIVENESS



The strong societal push for greater environmental commitments worldwide is permeating the space sector. It is leading to a global tightening of regulations – existing or planned – on the use of chemical pollutants, debris mitigation and remediation, safe in-orbit servicing, etc.

It is important to ensure that sustainable technologies and services are mature, affordable and ready to be taken on commercially in Europe. Various activities of the Space Safety Programme expressly aim to establish a European presence in new and emerging commercial markets.

↑ *The Izaña-1 laser ranging station, made by DiGOS GmbH with support from the Competitive Segment of the Space Safety Programme, is a testbed for ESA's optical technologies and tracking space debris for improved collision avoidance.*

The Competitiveness segment of the Space Safety programme in particular aims to speed up the process by which innovative ideas go from technologies to full-fledged products and services. The open call for innovation has already led to 15 projects of various sizes.

Keeping Europe, its people and its assets safe from asteroids, space weather and space debris can simultaneously be an opportunity to flourish in the growing markets of a sustainable future in space.

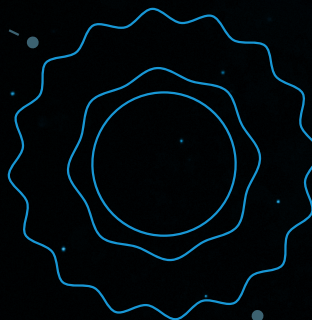
INVEST IN SPACE SAFETY

Funding opportunities

**ADRIOS
CORNERSTONE**



**SPACE WEATHER
CORNERSTONE**



ESA SPACE SAFETY PROGRAMME ELEMENTS

COSMIC ACTIVITY AREAS

- DEVELOP SPACE WEATHER SERVICES
- SPACE WEATHER SENSORS
- PREDICT ASTEROID IMPACTS
- TECHNOLOGIES FOR INCREASED SPACE TRAFFIC
- TOWARDS A CLEAN AND ZERO DEBRIS FUTURE
- COMPETITIVENESS

**PLANETARY DEFENCE
CORNERSTONE**



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