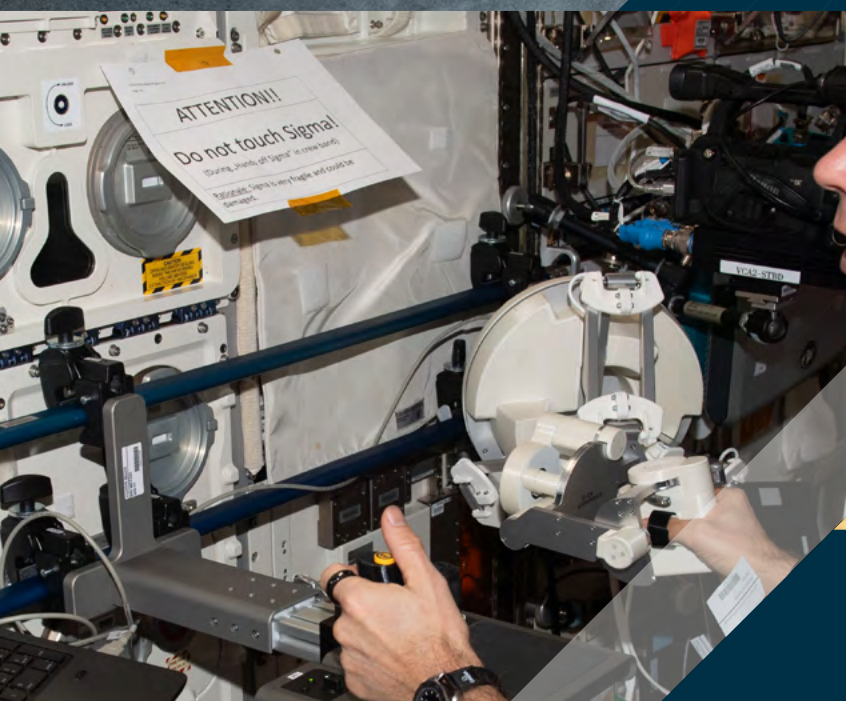
ESA ANNUAL REPORT 2024



→ THE EUROPEAN SPACE AGENCY

The Report is published in accordance with the terms of the Convention for the establishment of the European Space Agency, Article XII 1(b), which require the Director General to make an annual report to the Council.

Published under the responsibility of the Head of the Foresight, Strategy and Coordination Department of the European Space Agency.

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Renato Krpoun, Chair of the ESA Council.

FOREWORD

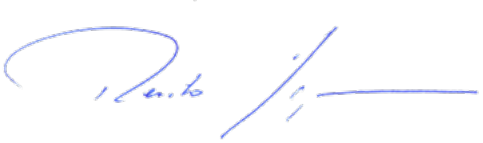
The ESA Annual Report, published each year in accordance with the Convention, highlights our achievements and demonstrates our confidence in ESA. Reflecting on past accomplishments is both an honour and a pleasure and I am proud to say that 2024 represents yet another remarkable year for ESA.

As usual, ESA continued to deliver for its Member States. The Agency's successes in 2024 span numerous areas and are described in detail in this report. To mention just one particularly noteworthy highlight, the inaugural flight of Ariane 6 and return to flight of Vega-C were two visible and very poignant reminders of Europe restoring its autonomous access to space.

The Space Council in Brussels in May 2024 represented an important step forward in the political domain, adopting as it did a joint resolution on strengthening European competitiveness through space. This key meeting also highlighted the close and trusting cooperation that exists between ESA, the European Union and their respective member States. Beyond that, international cooperation with partners worldwide remains a key objective and a central trademark of ESA.

The space sector is undergoing rapid transformation driven by new actors, fast-paced innovation and growing commercialisation within a complex and rapidly evolving geopolitical landscape. ESA is adapting to these changes by means of various lines of activity, including the ESA Transformation process. All of this is carried out under the guidance of, and in close coordination with the ESA Council and the Agency's other delegate bodies.

ESA has come a long way, and the future remains bright. I am confident that ESA will continue to spearhead our joint efforts to make more space for Europe.



Renato Krpoun
Chair of the ESA Council

ESA Director General Josef Aschbacher at the new ESA Headquarters in Paris, France, in May 2023.

DIRECTOR GENERAL'S FOREWORD

2024 was a year of outstanding achievements for the European Space Agency. As Director General, I take the greatest pride in stating that ESA carries out its programmes and projects with a combination of consummate skill, dedication and effectiveness. The following gives just a small flavour of the Agency's many successes in 2024:

Ariane 6 saw its first launch, and Vega-C returned to flight, thus restoring autonomous access to space. Thirteen satellites were launched and are now sending back information on Earth and our Universe. All of these missions are now performing impeccably. ESA's Astronaut Corps welcomed five new graduates and celebrated the return of two ESA astronauts from the ISS on their Huginn and Muninn missions. The LUNA facility in Cologne, established together with the German Space Agency DLR, is a facility unmatched by any other in the world, capable of simulating both human and robotic lunar missions.

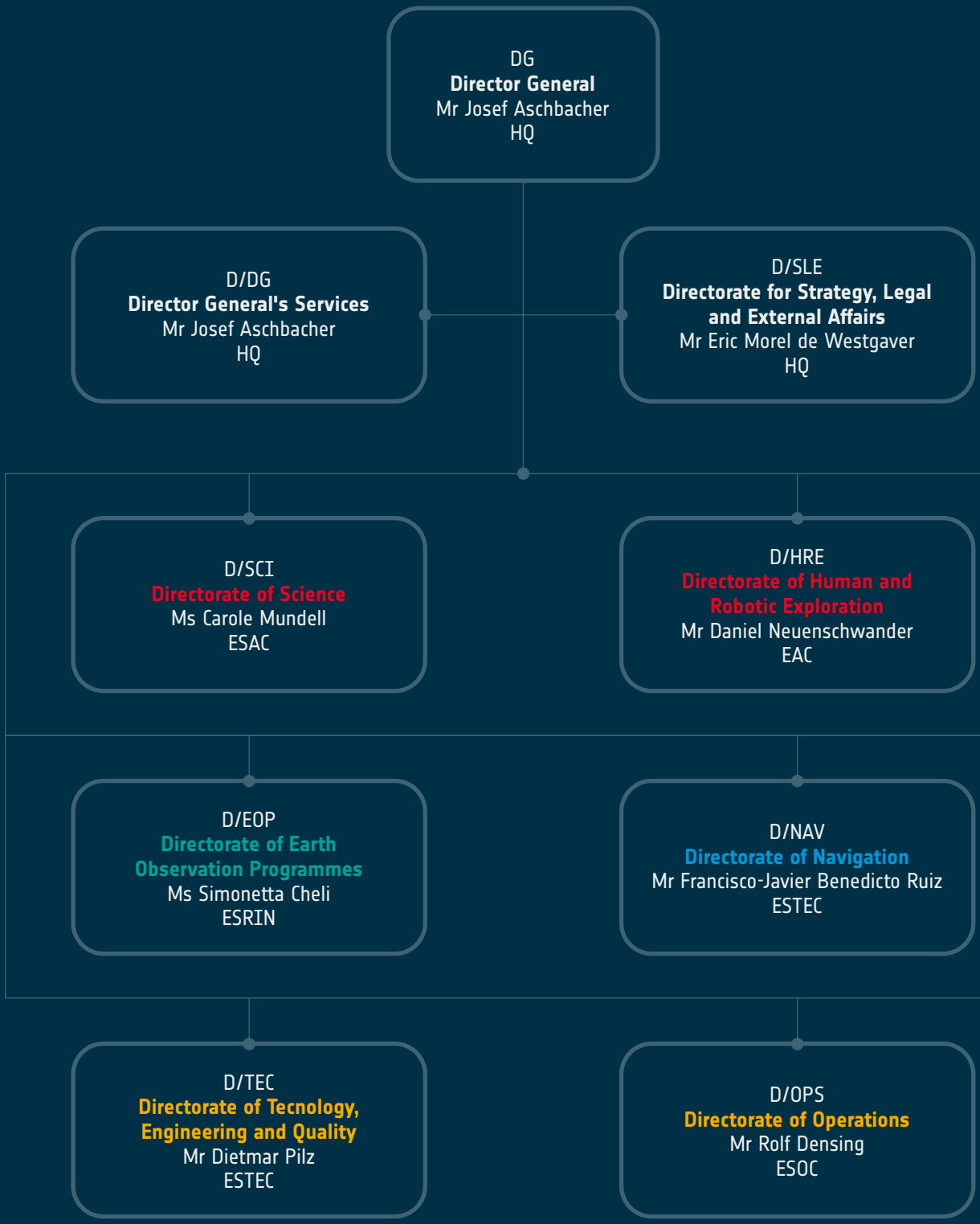
Another crucial event was the ESA-European Union Space Council in May. Apart from achieving important political results, the Space Council was also the occasion for both Member States and the EU to express their strong support for what ESA is doing and their trust in our Agency.

ESA Strategy 2040 has been presented to Council, building upon the orientations provided by Agenda 2025. In addition, the ESA Transformation, which aims to make ESA more modern, efficient and agile, continues to move forward.

This 2024 ESA Annual Report details the Agency's many accomplishments, demonstrating, in so doing, the myriad ways in which ESA's work brings benefits to society as a whole. Our Agency plays a central role in the European space sector, strengthening Europe's strategic space abilities and enhancing the welfare of its citizens.

Josef Aschbacher
ESA Director General
@AschbacherJosef

MANAGEMENT STRUCTURE



D/STS
Directorate of Space Transportation
Mr Toni Tolker-Nielsen (Acting)
HQ

D/CSC
Directorate of Connectivity and Secure Communications
Mr Laurent Jaffart
ECSAT

D/CIC
Directorate of Commercialisation, Industry and Competitiveness
Ms Geraldine Naja
HQ

D/HIF
Directorate of Internal Services
Mr Marco Ferrazzani
HQ

SCIENCE AND EXPLORATION

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SCIENCE

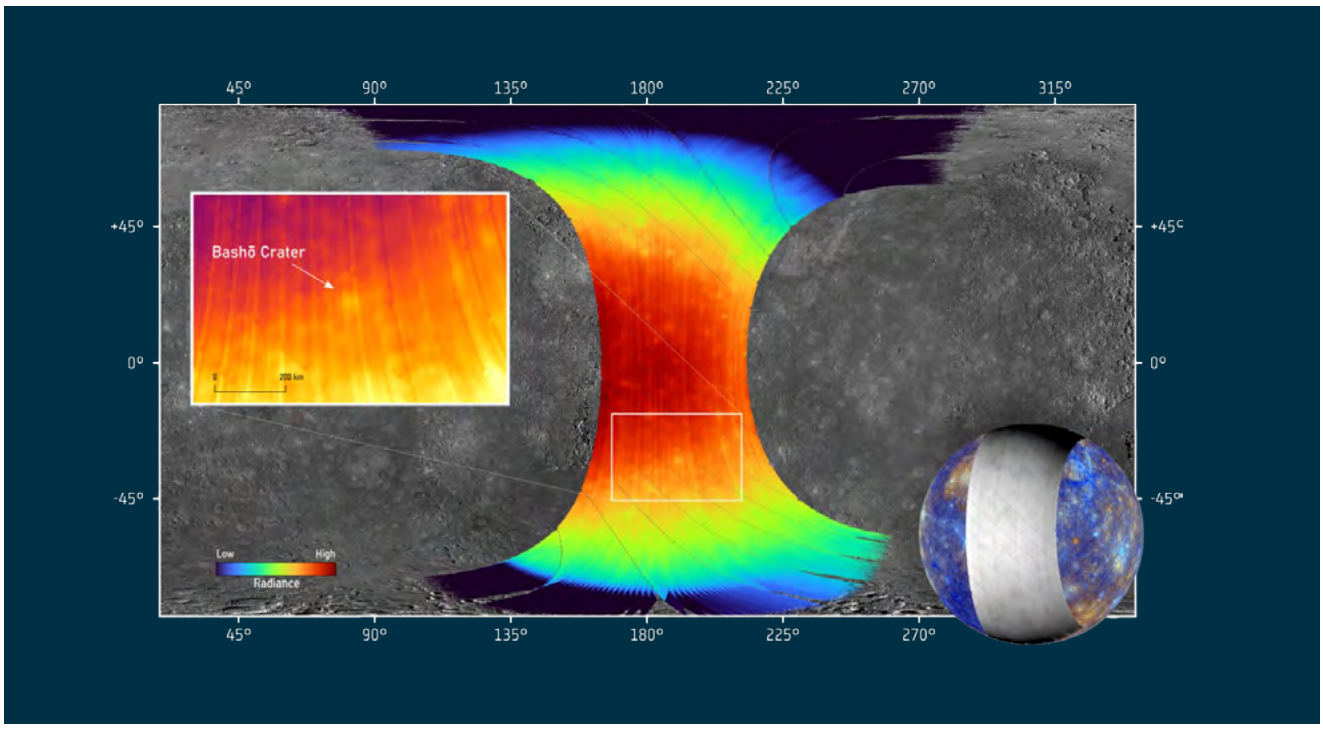
Scientific Achievements, Milestones and Firsts in 2024

2024 has been another year of notable achievements and milestones for the ESA Science Programme. From pioneering flybys to ground-breaking observations, ESA's science missions continue to push the boundaries of space science and deepen our understanding of the Universe. The dedication and ingenuity of the space science community ensure that the quest for knowledge and discovery is ever-evolving, paving the way for future discoveries and innovations.

The Jupiter Icy Moons Explorer (**JUICE**) is en route to unlocking the mysteries of the largest planet in our Solar System. After completing its inflight commissioning in early 2024, Juice made headlines with a world-first lunar-Earth flyby in August. During this gravity-assist manoeuvre, which shortened the journey to Jupiter by using the gravity of Earth and the Moon to change the spacecraft's speed and direction, a series of stunning images of the Earth and Moon were taken, showcasing the beauty and complexity of our home planet and its celestial companion. Juice continues its journey towards Jupiter where, upon arrival in 2031, it will embark on an ambitious mission to study the planet and its three large ocean-bearing moons, Ganymede, Callisto, and Europa. Equipped with a suite of remote-sensing, geophysical, and in situ instruments, aims to unravel the secrets of these intriguing celestial bodies.

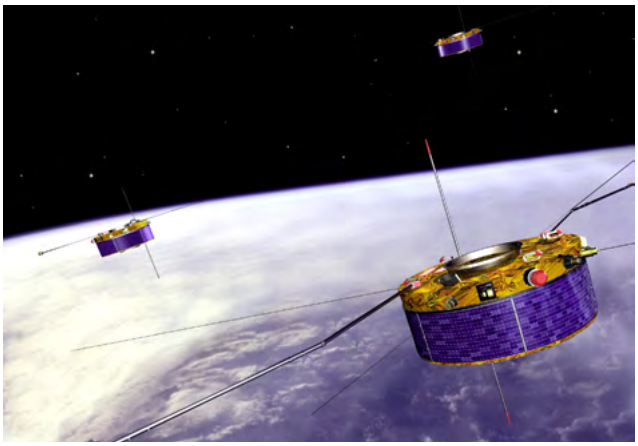
Challenges with power availability and electric propulsion have been successfully mitigated, leaving the **BepiColombo** mission on track to arrive at Mercury in November 2026. In September, the spacecraft made its fourth flyby of Mercury, providing an unprecedented close-up view of the planet's environment, skimming just 165 km above its surface. The mission achieved another milestone during its fifth flyby in December, becoming the first spacecraft to observe Mercury in mid-infrared light using its MERTIS instrument. These observations are set to enhance our understanding of Mercury's composition and thermal properties.

The Moon and Earth as seen by JUICE's monitoring camera during the world-first lunar-Earth gravity assist in August 2024.



After its sixth and final flyby of Mercury in January 2025, the BepiColombo spacecraft is now en route to approach its final orbit in November 2026.

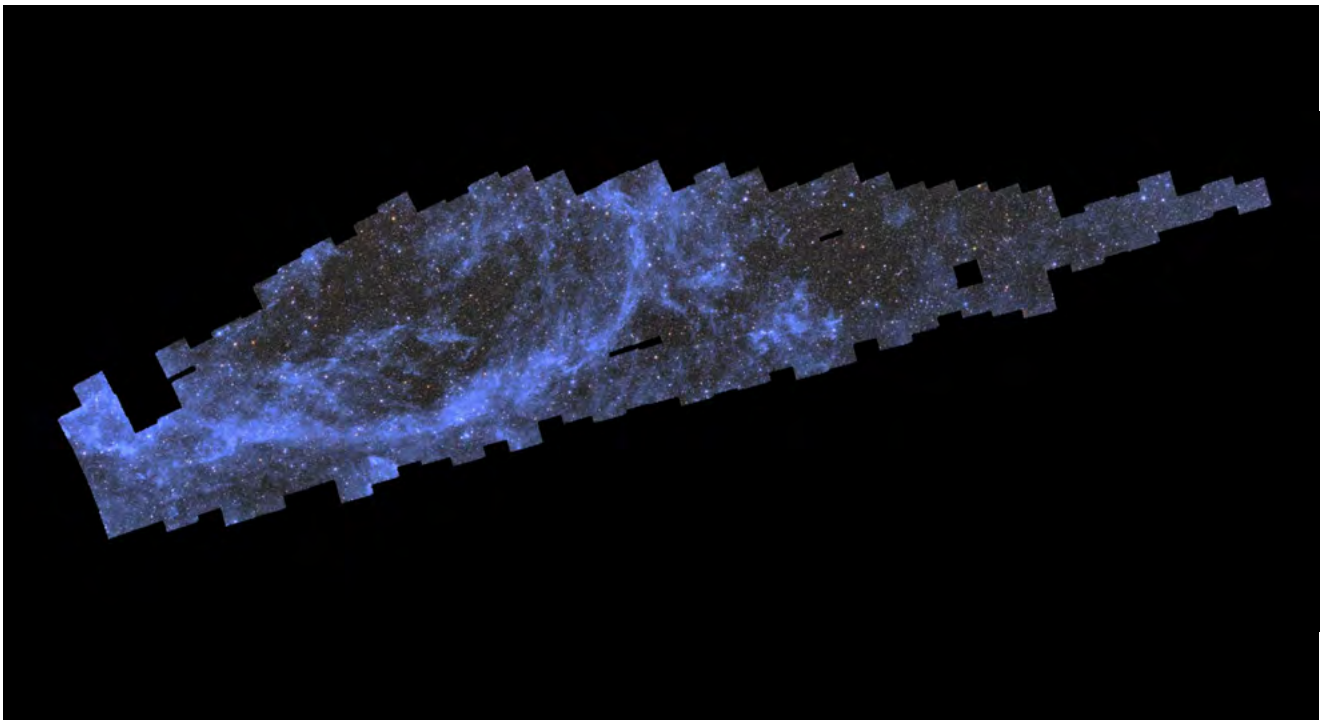
The **Cluster** mission, a pioneer in studying Earth's magnetospheric environment, reached a significant milestone in 2024. On 8 September, the first of four Cluster spacecraft re-entered Earth's atmosphere, signalling the end of its scientific operations. Cluster was the first constellation mission designed to study the 3D magnetospheric environment around Earth. Over its 24-year lifespan, Cluster delivered ground-breaking findings and contributed to over 3,200 scientific papers. Despite not being initially designed with safe end-of-mission requirements, the mission's "targeted re-entry" represented a pioneering effort in sustainable space utilisation, ensuring the safe disposal of the spacecraft in line with ESA's Zero Debris approach. The remaining three Cluster spacecraft will re-enter Earth's atmosphere in the course of the next two years.



The first of four Cluster spacecraft safely re-entered Earth's atmosphere in August 2024.

Euclid emerged as the star of 2024, capturing the imagination of the scientific community and public alike. Launched on 1 July 2023, Euclid began its nominal six-year survey of one-third of the visible Universe in February. The release of images collected during Euclid's Early Release Observations period provided a tantalising preview of the mission's potential.

In October, Euclid released its first section of the map of the Universe, showcasing a stunning mosaic of 260 observations made between 25 March and 8 April. This ground-breaking mission promises to revolutionise our understanding of the cosmos, shedding light on the distribution of dark matter and dark energy.



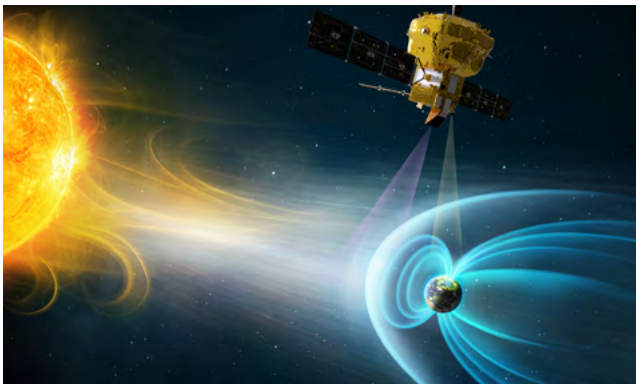
This mosaic made by ESA's Euclid space telescopes contains 260 observations collected between 25 March and 8 April 2024.

Completing Cosmic Vision

Significant progress has been achieved in developing the missions selected as part of the Cosmic Vision plan, ensuring they remain on track for their target launch dates.

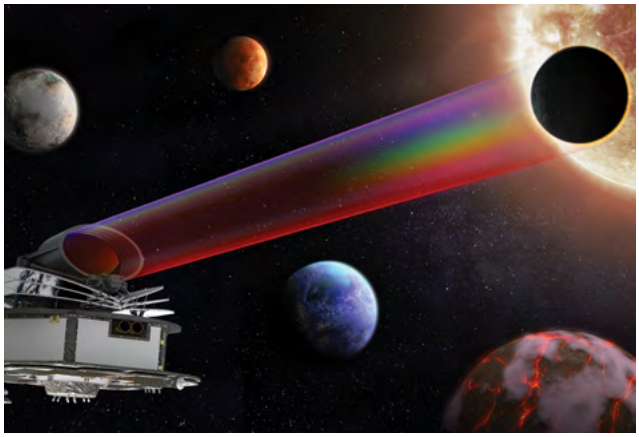
The **SMILE** (Solar wind Magnetosphere Ionosphere Link Explorer) mission, a collaboration with the Chinese Academy of Sciences, made significant strides in 2024 with the integration and testing of the entire spacecraft. The eagerly anticipated launch is scheduled for the end of 2025. SMILE will investigate Earth's magnetic environment on a global scale, enhancing our understanding of the Sun–Earth connection. The mission will observe the solar wind – streams of charged particles emanating from the Sun into interplanetary space – and study how these particles interact with the space around our planet.

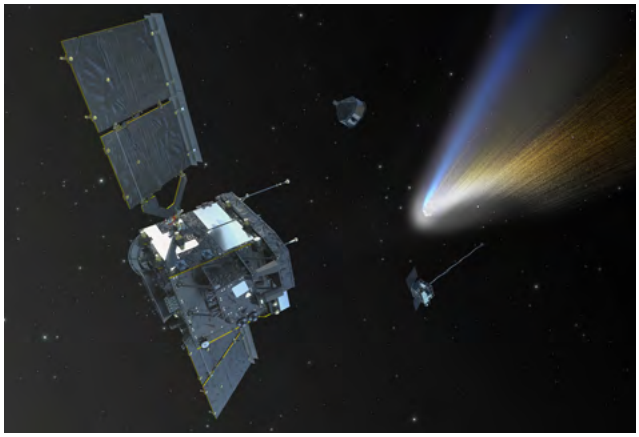
The **PLATO** (PLAnetary Transits and Oscillations of stars) mission is set to transform exoplanetary science by detecting terrestrial exoplanets and characterising their bulk properties, including those in the habitable zone of Sun-like stars. In 2024, the mission successfully passed key developmental milestones, paving the way for its launch in 2026.



SMILE (left) and PLATO (right) are on track for launch in 2025 and 2026 respectively.

The **Ariel** (Atmospheric Remote-sensing Infrared Exoplanet Large-survey) mission aims to observe approximately 1,000 planets orbiting distant stars. These observations will range from Jupiter- and Neptune-sized planets to super-Earths in various environments. Ariel's mission is the first to conduct a large-scale survey of the chemistry of exoplanet atmospheres. Planned for a 2029 launch, Ariel will journey alongside the **Comet Interceptor** mission, which aims to study a long-period comet (or an interstellar object) through simultaneous, multi-point observations. Both Ariel and Comet Interceptor progressed rapidly through their implementation reviews in 2024.



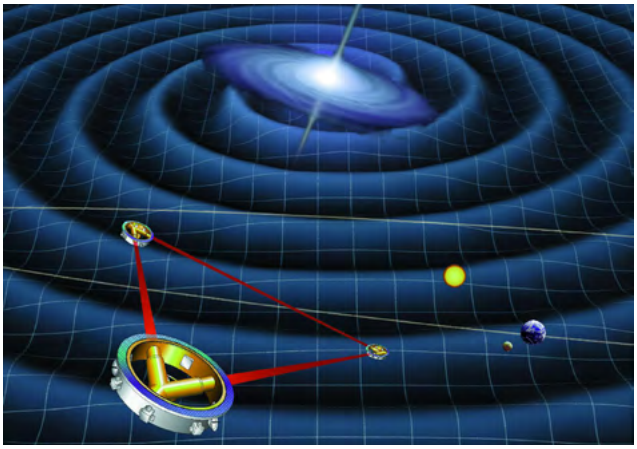


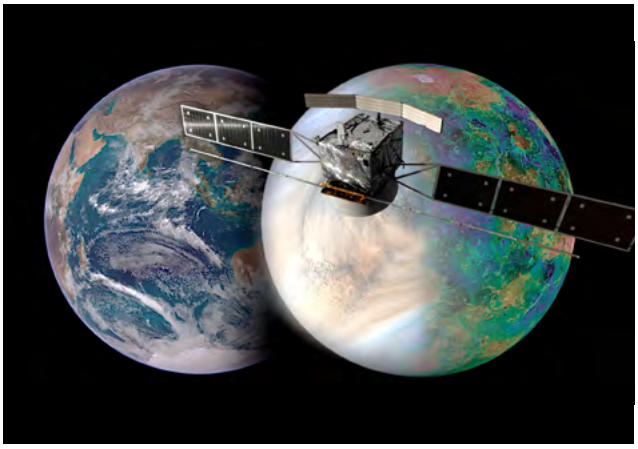
Ariel (left) and Comet Interceptor (right) will launch together in 2029.

LISA (Laser Interferometer Space Antenna), the first space-based gravitational wave observatory and the next large mission in the Cosmic Vision programme after JUICE, and **EnVision**, the first mission to explore Venus from its inner core to its upper atmosphere, received approval by the Science Programme Committee for the implementation phase in January. These missions have since achieved significant milestones in industrial contract assignments and instrument development.

The Cosmic Vision programme's grand finale will feature the **NewAthena** and **ARRAKIHS** missions. NewAthena, poised to become the largest X-ray observatory ever built, is slated for adoption in 2027, with a launch target of 2037. This mission promises to revolutionise X-ray astrophysics. Meanwhile, ARRAKIHS, a fast mission dedicated to hunting dark matter, is progressing towards adoption in mid-2026 and an anticipated launch in late 2030.

These major advancements set the stage for 2025–2037 to be an especially exciting time with the launch of new missions for the ESA Science Programme fleet. This period will reinforce European leadership across diverse scientific and technological adomains, fulfilling the goals of the Cosmic Vision plan. The renewed ESA Science Programme fleet will offer European scientists exceptional new missions, maintaining European scientific leadership on the global stage while fostering technological advancements and successes in the context of dynamic international cooperation.





The LISA (above) and EnVision (below) missions were adopted in the Science Programme in January 2024.

Setting sail on Voyage 2050

The time has come to lay the groundwork for the future, making strategic investments in technology and industrial preparation to prevent a European space science and technology "desertification" in the 2030s and beyond. With this in mind, the preparation and early implementation of the first missions of the Voyage 2050 long-term plan (following on from Cosmic Vision) have got under way with a number of tangible steps.

Next Large Mission: to the Moons of the Giant Planets

The technological and scientific groundwork for the upcoming Large mission (L4), dedicated to the scientific theme of the "Moons of the Giant Planets", has made significant progress. Various studies were concluded in early 2024, with an Expert Committee identifying Saturn's moon Enceladus as the most scientifically intriguing destination for in situ measurements. In June, two parallel industrial studies were initiated to explore the most promising mission concepts for L4. This mission aims to study the Saturnian system and its fascinating moon, Enceladus, known for its potential habitability. The preliminary design of this mission promises ground-breaking advancements in innovative technologies.

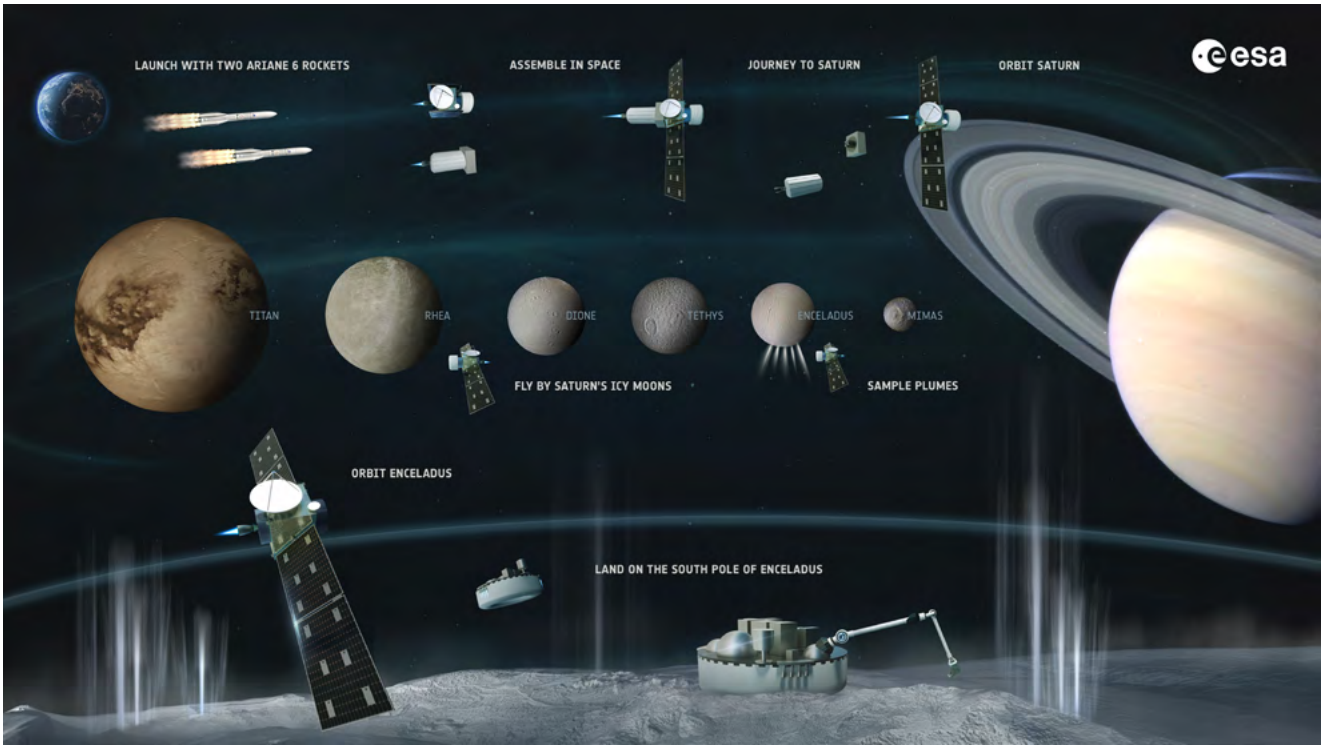
Seventh Medium Mission Selection

To ensure flexibility and a variety of scientific themes within the Science Programme, efforts are ongoing to select the seventh Medium mission for launch around 2036. This selection process involves three remaining candidates after several stages of intense competition. M-MATISSE, Plasma Observatory, and THESEUS were shortlisted in 2023, and by 2024 industry-supported studies (two per mission candidate) had advanced with contributions from community-driven science study teams. ESA has also supported payload technology development activities for the three candidate missions, and associated procurement activities are currently under way. A comprehensive Mission Selection Review is planned for mid-2026, with the final selection of the M7 mission scheduled to place shortly after.

New Calls for Medium and Fast Missions

In response to Member States' and community requests to maintain a diverse set of mission classes in the Science Programme during the Voyage 2050 era, a new call for Medium and Fast missions, as well as an exploratory call for a new category of agile and innovative mini-Fast missions, were announced in December. These calls will be issued on 19 March 2025, starting a process that will define the scientific priorities for the latter half of the 2030s through a bottom-up selection process, ensuring flexibility and diversity in the Science Programme.

The Voyage 2050 initiative represents an exciting chapter in space science, and promises to push back the boundaries of our knowledge and technological capabilities. By embracing this vision and taking decisive action now, we can ensure a vibrant and innovative future for European space science and technology.



Concept for a mission addressing the Voyage 2050 science theme 'Moons of the Giant Planets'.

HUMAN SPACEFLIGHT AND ROBOTIC EXPLORATION

Terrae Novae – Expanding Europe's Space Exploration horizons

ESA's programme for human and robotic exploration is called Terrae Novae, signifying the exploration of new worlds and new discoveries.

2024 saw the publication of the Explore2040 strategy (https://esamultimedia.esa.int/docs/HRE/Explore_2040.pdf). With one strategy for multiple destinations, Explore2040 provides a clear European-wide exploration path, from ongoing European presence in low Earth orbit up to sustained and responsible Moon and Mars exploration.

The year began with the continuation of the Huginn mission, in which Andreas Mogensen served as the sixth European commander of the International Space Station (ISS). In January he was joined on board the Station by the first ESA project astronaut, Markus Wandt, who conducted a range of experiments and educational activities during the 20-day Muninn mission, as part of the Axiom 3 flight. The career astronauts selected in 2022 (Sophie Adenot, Pablo Álvarez Fernández, Rosemary Coogan, Raphaël Liégeois and Marco Sieber) graduated from their basic training in April. Subsequently, Sophie Adenot and Raphaël Liégeois were assigned to ISS missions planned for 2026, while the other members of the class of 2022 began pre-assignment training in Houston. In parallel, ESA project astronaut Sławosz Uznański continued training for the short-duration Ignis mission as part of the Axiom 4 (private astronaut) mission planned for 2025. Members of the astronaut reserve also began training at the European Astronaut Centre (EAC). John McFall completed the first phase of the Fly! Feasibility study in which an astronaut with a physical disability will carry out a long-duration mission.

ESA project astronaut Marcus Wandt inside the seven-windowed cupola, the International Space Station's "window to the world".

ESA's astronaut class of 2022 including Sophie Adenot, Rosemary Coogan, Pablo Álvarez Fernández, Raphaël Liégeois, Marco Sieber, and Australian Space Agency's Katherine Bennell-Pegg during their graduation ceremony at ESA's European Astronaut Centre on 22 April 2024. Receiving certification marks their transition from candidates to fully qualified astronauts eligible for space missions.

Following the decision at the Seville Space Summit in November 2023 to develop a LEO cargo return service to ensure Europe's continued utilisation of LEO (low Earth orbit), two parallel contracts were signed with The Exploration Company and TAS-I, respectively, to begin the first phase of development.

Europe's journey to the Moon continued in 2024 through the preparation of elements contributing to the Artemis architecture, implementation of payloads on international partner or commercial lunar missions and development of European capabilities to access the lunar surface. The 3rd European Service Module (ESM) was delivered in September to NASA Kennedy Space Center, while the integration of subsequent modules continued. The ESM is an essential element of Artemis missions, with the NASA Orion capsule providing the means for astronauts to travel to and from cislunar space. Development of the European contributions to the lunar Gateway continued including Lunar Link, Lunar I-Hab and Lunar View as well as on two radiation monitoring payloads. The Lunar View phase B2CDE contract was signed in April.

The LUNA facility, an advanced testing environment for ESA astronauts and space technologies, was officially opened in September 2024 in Cologne, Germany. Managed by ESA and DLR, it provides highly realistic space technology research and development conditions.

The Negative Ions on Lunar Surface (NILS) payload was launched on board the Chinese Chang'e 6 lander, becoming the first ESA instrument on the lunar surface in June and delivering unique data on the lunar environment. Development progressed on the Argonaut large lander, which will provide an end-to-end European robotic lunar landing capability. The industrial prime contractor (TAS-I) was selected for the next phases of development, and a decision taken on the final engine selection. In September, the joint DLR-ESA LUNA facility was inaugurated at the European Astronaut Centre, providing a large lunar analogue to support development and validation of technologies, operation concepts and scientific instruments for lunar surface exploration.

ESA's NILS instrument, the first ever to detect negative ions on the Moon, confirmed their presence on the lunar surface, generated by interactions with the solar wind. Meanwhile, China's Chang'e-6 lander captured high-definition images of its landing site within the vast South Pole-Aitken Basin on the Moon's far side.

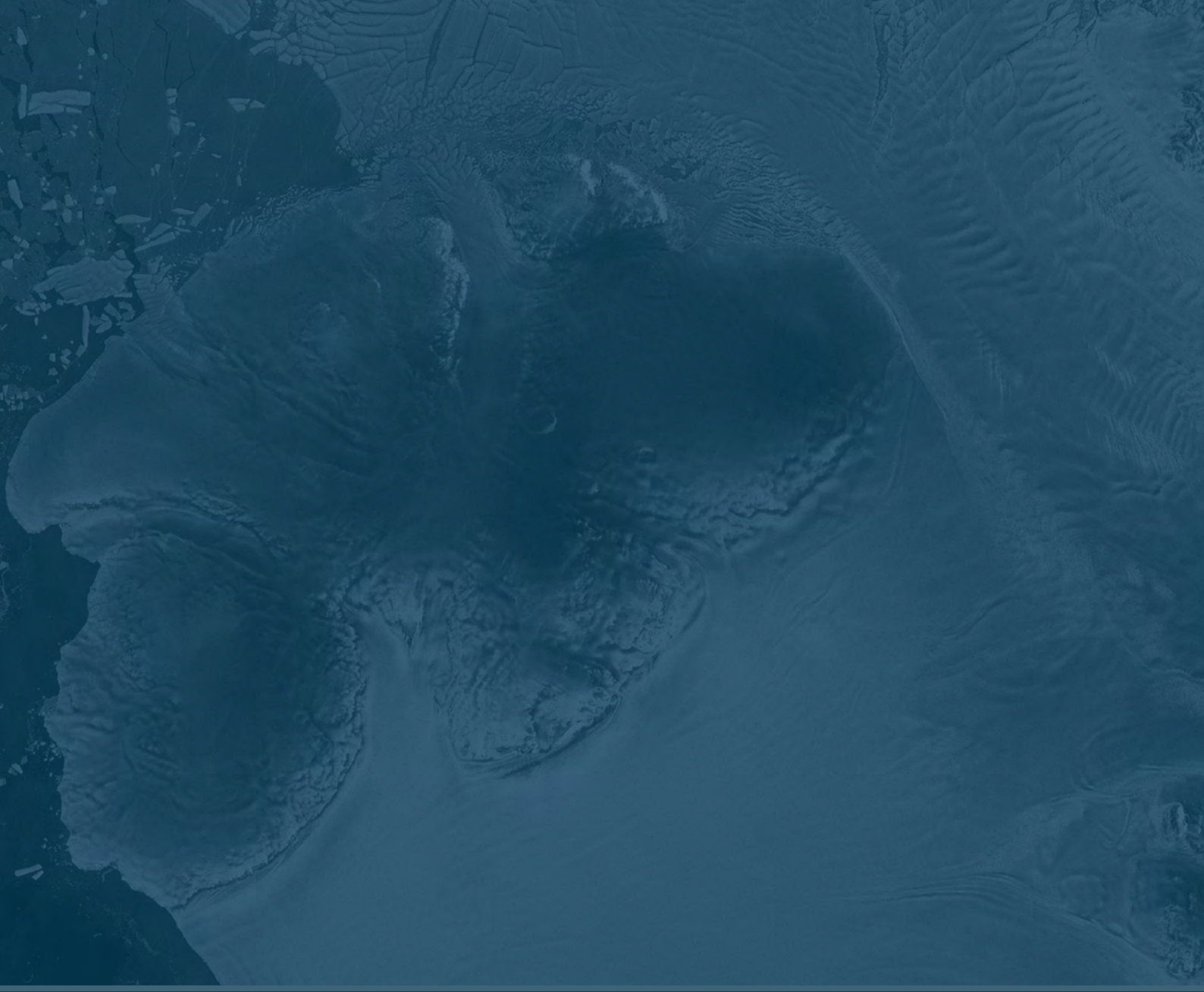
At Mars, the Trace Gas Orbiter (TGO) continued to act as a data relay for NASA surface rovers and landers, while providing a stream of data for science from onboard instruments. Several discoveries from TGO observations were reported in scientific publications in 2024, including observations of transient frost on top of extinct Martian volcanoes, mapping indicators of ancient water bodies and studies of the ionosphere. Expanding Europe's Mars exploration to the surface, the Rosalind Franklin mission will be the first spacecraft to sample the subsurface with the objective of searching for markers of past and present life. Excellent progress was made in preparation of Rosalind Franklin for launch in 2028, with signature of both the main development contract and the memorandum of understanding with NASA for cooperation and contributions to the mission.

In parallel, the various ground-based, suborbital and space platforms of Terrae Novae continued to support a broad range of scientific research and exploration preparation. In 2024, the SciSpacE pool of experiments counted 135 ongoing investigations, with 42 investigation projects in physical sciences and 93 investigation projects in life sciences. In addition, another 81 selected projects are under preparation.

New cooperation agreements in the area of space exploration were signed between ESA and the Indian Space Research Organisation (ISRO) and the United Arab Emirates' Mohammed Bin Rashid Space Centre (MBRSC), respectively.

ESA Astronaut Luca Parmitano collaborates with engineers to test the Lunar I-Hab mock-up, offering valuable feedback to enhance habitat design, ergonomics, and functionality for future Moon missions and long-term space exploration.

APPLICATIONS



22 Earth Observation

26 Connectivity and Secure Communications

30 Navigation

EARTH OBSERVATION

With five Agency missions launched in 2024, ESA's Earth observation programmes continued to deliver world-class science and operational satellites

By the end of 2024, ESA's Earth Observation Programmes had enabled a fleet of 16 operational satellites with the future of Europe's Earth observation capacity to be supported with the 40 missions under development and 22 missions in preparation.

The **FutureEO** programme – ESA's Earth observation envelope programme forming the heart of current and future Earth observation activities at the Agency and in Europe – continued with a string of successes in 2024, demonstrating its status as a world-leading research and development programme addressing scientific and societal challenges.

EarthCARE, an Earth Explorer mission developed in partnership with the Japanese Aerospace Exploration Agency (JAXA), launched on 28 May, is delivering ground-breaking information that is shedding new light on the role that clouds and aerosols play in regulating Earth's climate.

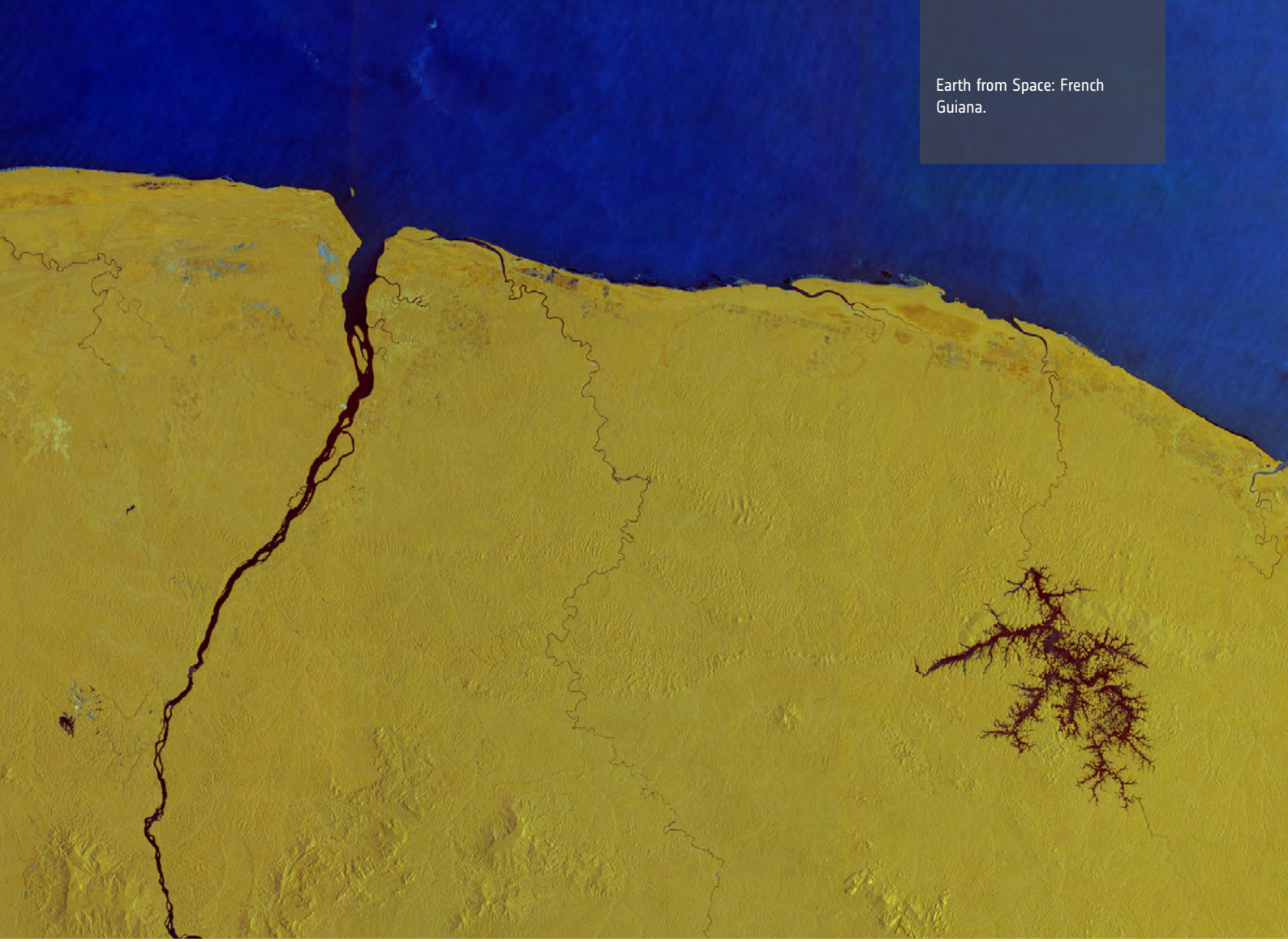
EarthCARE joined three other Earth Explorer missions in orbit – all operating well beyond their expected lifetimes – which were prepared, developed, launched and exploited thanks to FutureEO. One of these missions, **SWARM**, marked its 10-year anniversary with a gathering of 250 experts in April to exchange on the science results enabled by the mission.

ESA's new **Earth Observation Science Strategy**, developed over two years in consultation with more than 350 members of the broader Earth-system science community, was published. It outlines a bold vision for Earth science through the coming decade and will act as a guide for the development of European Earth Observation capacity to 2040 and beyond.

August saw the launch of the **Arctic Weather Satellite** (AWS), successfully demonstrating application of a New Space approach – rapid development on a low budget with the promotion of SME participation – for a pioneering mission to improve forecasts in the Arctic region. Related to other meteorological missions, an issue with the calibration system for the flexible combined imager MTGI1 was successful addressed with industry and EUMETSAT. Also launched at the same time as AWS was **Φsat-2**, a CubeSat further demonstrating the benefits of using artificial intelligence (AI) for innovative Earth observation.

Two **Copernicus** Sentinel satellites were delivered into orbit for the European Union (EU) Space Programme – Sentinel-2C on 5 September and Sentinel-1C on 5 December. Both satellites, online very shortly after launch and in perfect working order, have been welcomed by the operational services community. 2024 also saw continued progress towards the development of the next fleet of Copernicus missions including the six Sentinel Expansion missions, final funding for which was obtained following UK re-entry into the EU's Copernicus programme, and the start of work on Next-Generation Sentinels.

The **nine Sentinel satellites in orbit** deliver more than 25 terabytes of data daily. More than 200,000 new users have



Earth from Space: French Guiana.

registered to access and use Sentinel data with more than 700 petabytes of Sentinel products disseminated to date for use in services to society.

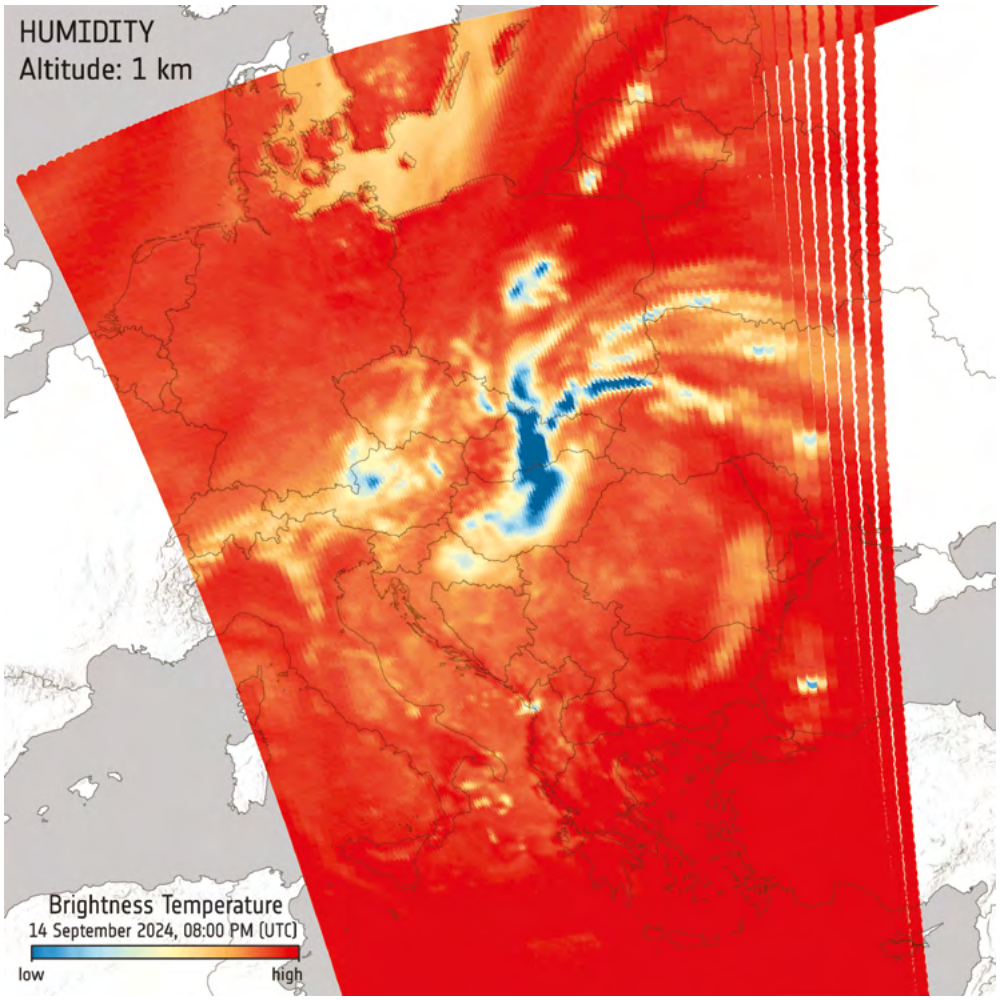
The data is used not only by EU Copernicus Services, but also by scientists and in ESA-funded R&I projects and initiatives. Unfortunately, 2024 saw catastrophic natural disasters occurring across the globe. Flooding was particularly severe in September in central Europe and a month later in Valencia (Spain), and Sentinel data was key in assessing the extent of the flooding and the damage caused. In terms of man-made environmental impacts, Sentinel-2 was used to detect plumes of nitrogen dioxide from power plants, marking a significant step forward in the ability to monitor air pollution.

The mission of **ERS-2** – ESA's second European Remote-Sensing Satellite – came to an end with its reentry over the Pacific Ocean in February. Together with ERS-1, the mission provided invaluable longterm data on land surfaces, ocean temperatures, ozone layer and polar ice extent that revolutionised our understanding of the Earth system. It was also called upon to monitor and assist the response to natural disasters and set the stage for many successor missions dedicated to studying our changing world, such as Envisat and the Copernicus Sentinels.

In addition to work on individual missions and their data, 2024 saw considerable efforts made by ESA to increase the use of Earth observation data by new users, for new applications, and piloting new modes of cooperation. One example in the international domain related to the progress on cooperation enabled by the EU Directorate-General for International Partnerships (DG INTPA) in Latin America, the Philippines and Africa. For ESA Member States, national Earth observation programmes saw continued involvement with IRIDE and an acceleration of involvement in CAMiLA (Poland), the Atlantic Constellation (Spain and Portugal) and the Greek constellation.

ESA's Directorate of Earth Observation Programmes also continued to engage in supporting the commercial Earth observation sector and organised a successful EO Commercialisation Forum in November which highlighted several successful companies benefiting from the InCubed programme. Support for the commercial sector is also being fostered through anchor tenancy agreements for the Third-Party Mission (TPM) programme and the Copernicus data buy managed on behalf of the EU Space Programme.

Several initiatives supporting the Space for a Green Future Accelerator related to the green transition information factory concept – a cloud-based platform fed by Earth observation and other geospatial data – continued to expand with the start of several kickstarters to allow new users to explore the underlying challenges and opportunities of transitioning to carbon neutrality by 2050 utilising cloud computing technologies and cutting-edge analytics.

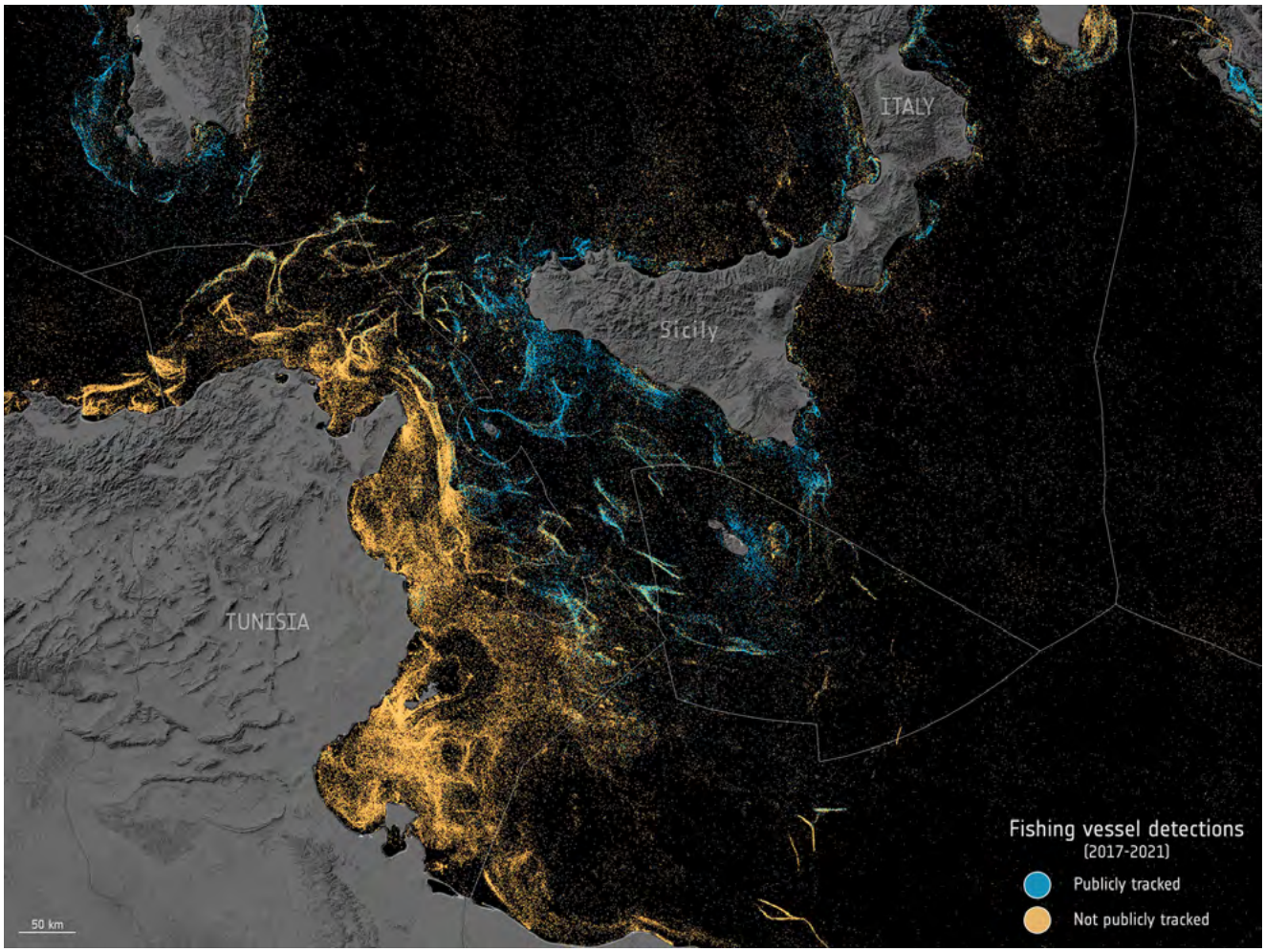


Arctic Weather Satellite delivers valuable insights

A prototype mission that aims to improve weather forecasts in the Arctic – a region that currently lacks data for accurate short-term forecasts. The satellite will build on existing monitoring satellites and will provide precise, short-term weather forecasts for the Arctic region. Despite its name, the Arctic Weather Satellite measures temperature and humidity at various altitudes around the world. However, its humidity data is particularly valuable for Arctic weather forecasting, as water vapour levels can change rapidly in this region.

Within a month of its launch on 16 August, AWS was delivering valuable, detailed temperature and humidity profiles in all weather conditions using a 19-channel cross-track scanning microwave radiometer which penetrates the atmosphere.

In the image, from data captured on 14 September, the measurements are shown in terms of "brightness temperature", with lower values (depicted in blue) indicating higher humidity levels. The torrential rainfall from Storm Boris is especially evident as dark blue regions low in the atmosphere over Hungary, Slovakia and Poland.



Satellite mapping reveals extensive industrial activity at sea

A ground-breaking study published in 2024 combined satellite data and artificial intelligence in order to throw new light on the number of vessels at sea, revealing that around 75% of the world's industrial fishing vessels have previously been "dark" to public tracking systems. Not all boats are legally required to broadcast their position, but vessels not included in public monitoring systems, often termed 'dark fleets', can pose challenges for protecting and managing natural resources. The study, published recently in the journal Nature, was led by Global Fishing Watch – an organisation that seeks to advance ocean governance through increased transparency of human activity at sea.

The map shows individual vessels detected by Sentinel-1 during 2017–2021, matched (blue) to known vessel positions from AIS broadcasts and unmatched vessels (orange). The vessels were classified as fishing or non-fishing with a deep-learning model. National exclusive economic zones are overlaid.

CONNECTIVITY AND SECURE COMMUNICATIONS

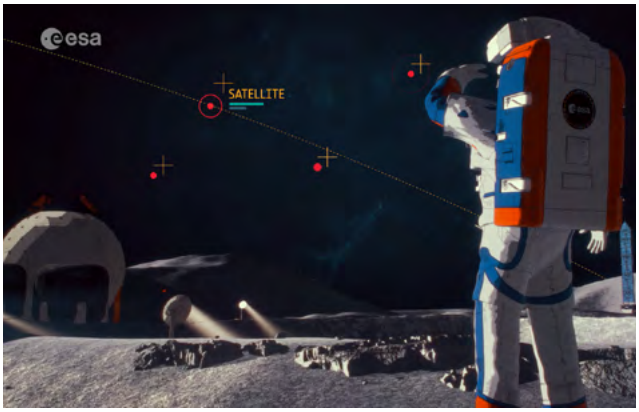
Connectivity underpins everyday life and represents a substantial segment (33%[2]) of the global space market. Consequently, a healthy satellite communication sector is critical to maintaining other space domains affordable. The satcom market, however, continued to undergo profound transformation in 2024, driven by new trends, big new players and a rapidly changing geopolitical context. Through its Connectivity and Secure Communications programmes, ESA is working to keep European industry competitive through both commercially and institutionally driven activities.

IRIS² and ESA Programme Related to EU Secure Connectivity

ESA will play a crucial role in the European Commission's third flagship in space, the €10.6bn IRIS² (Infrastructure for Resilience, Interconnectivity and Security by Satellite) programme, kicked off in Brussels in December. The resulting system will be a strategic asset for European autonomy, resilience and industrial competitiveness. The multi-orbit constellation of nearly 300 satellites in LEO and MEO will provide the European Union and its Member States with secure connectivity services for government authorities, businesses and citizens. ESA is overseeing the development on behalf of the European Commission through an ESA partnership contract with the SpaceRISE consortium and as qualification and validation authority on behalf of the Commission, throughout the 12-year contract duration.

Moonlight

ESA's Moonlight Programme will establish Europe's first ever cislunar satellite constellation dedicated to telecommunication and navigation for missions to the Moon, opening opportunities in the lunar market, both institutional (such as NASA's Artemis programme) and commercial, for European companies and fostering the predicted €100bn lunar economy. Moonlight, a Partnership Project with Telespazio (IT), was signed on 15 October.



Moonlight Enabling Lunar Communications and Navigation.

[2] Sources: Euroconsult "Space Economy Report" 2024, Euroconsult "Satellites to be Built and Launched" Report 2022

From left to right: Adel al Saleh, CEO of SES, Timo Personen, Director-General DG DEFIS, European Commission, Eva Berneke, CEO of the Eutelsat Group, Andrius Kublius, Commissioner for Defence and Space, Josef Aschbacher, Director General of the European Space Agency, Laurent Jaffart, Director for Connectivity and Secure Communications Directorate of the European Space Agency, Miguel Ángel Panduro, CEO of Hispasat.

Civil Security from Space

The Civil Security from Space Programme is enhancing Europe's ability to respond to crisis events using space assets. Two additional partnership projects were launched in 2024. Through the Ciseres project, ESA is supporting its industrial partner, Deimos (ES), to meet the challenges facing early warning systems for natural disasters by using onboard satellite image processing and predictive AI. The Safeplace project is a digital platform with Starion (BE) that will orchestrate data from ground and space assets to assist public safety stakeholders in crisis events through a single reliable interface.

ARTES 4.0

ARTES is the engine of competitiveness for satcom. It drives innovation by challenging the status quo and enabling disruptive technologies, products, systems, and services, and facilitates the growth of SMEs and New Space initiatives.

In 2024, Partnership Projects under ARTES continued to deliver innovative solutions to market through industry-initiated satellite projects. NEOSAT remains the most successful European telecom programme ever, with industry selling 20 satellites to date based on the platform developed, providing a return on investment for taxpayers of €20 for every €1 invested. This has been followed up by a new product line for the commercial geostationary telecommunications market called Novacom I and II with 16 satellites sold to date by TAS and Airbus.

ESA's Pacis 3, the Govsatcom Precursor, due for launch aboard the next-generation satellite SpainSat NG-1 in January 2025, was developed under a Partnership Project with Airbus Defence and Space and Hisdesat (ES). Pacis 3 will provide resilient, secure and affordable communications for a range of applications, such as secure telecommunications for governmental users and emergency response teams and for AI, big data and IoT (Internet of Things).

SpainSat NG1 transferred into CTH05 container in Toulouse.

Space for 5G/6G and Sustainable Connectivity

Society now demands continuous access in near real-time to data from around the world. Seamless integration of satellites with 5G terrestrial networks will ensure that ubiquity of connection between people, devices and businesses. ESA is facilitating the integration, whether through the public-private Sunrise project with Eutelsat/OneWeb and supported by the UK Space Agency to prepare for the next generation of the OneWeb LEO constellation, or through the 5G-EMERGE project with the European Broadcasting Union (EBU) aimed at converging satellite distribution with online delivery of media content in a cost-efficient manner over a large region.

Sunrise-enabled Sail for Tomorrow research expedition.

Space Systems for Safety and Security

The first commercial flights to test Iris satellite technology took to the air with the airline easyJet in January and approximately 4,500 flights in Europe followed suit with excellent performance throughout 2024. Iris is digitalising and optimising air traffic management to reduce emissions, improve flight safety and minimise delays.

Iris takes-off with easyJet first commercial flights in January 2024.

European Leadership in Optical and Quantum Communications

In 2024, ESA took great strides in realising its strategic vision for innovative high-throughput connectivity using cutting-edge optical technologies (''internet backbone beyond the cloud(s)''), embarking on the development of the HydRON Demonstration System , a ring of satellites in low Earth orbit and a multi-orbit extension.

As a world lead leader and key partner in quantum communications research and technology, ESA continued to leverage its expertise in the domain. The European Commission was preparing to sign with ESA in January 2025 an Amendment to Contribution Agreement on the European Union Secure Connectivity Programme, which

HydRON Element #1 Contract Signature at IAC

EuroQCI Contribution Agreement in Brussels.

would see ESA entrusted with the implementation of tasks required for the space-related elements of its European Quantum Communication Infrastructure (EuroQCI).

ESA projects SAGA and EAGLE-1 will provide significant contributions to EuroQCI. EAGLE-1, the QKD end-to-end system demonstrator, underwent its System Preliminary Design Review in December. SAGA, the in-orbit demonstrator that will design, develop and provide preliminary validation of the EuroQCI space segment, issued its Phase B2 ITT on 28 October.

NAVIGATION

From power grids, mobile networks, financial transactions and consumer solutions to aviation, road, rail and maritime transport, global navigation satellite systems (GNSS) have become one of the backbones of our interconnected world.

They provide indispensable positioning, navigation and timing (PNT) information any time, anywhere; underpinning critical institutional, commercial and civil services and applications that impact our daily lives.

The 30-year-old partnership between the European Space Agency, the European Union, European industry and national stakeholders has propelled European leadership in satellite navigation, as demonstrated once again in 2024 through crucial accomplishments for ESA Navigation.

The Galileo programme is progressing at full speed, with ESA overseeing the design, development and qualification of the systems for the programme owner, the European Union. With two dual launches, in April and September, four additional Galileo satellites were placed in orbit by ESA and entered operational service with the European Union Agency for the Space Programme (EUSPA), further enhancing the system's robustness, availability and precision and benefiting billions of users worldwide. The constellation is now complete as designed, with the required operational satellites plus one spare per orbital plane. Additionally, six more First Generation satellites are ready to be launched.

Meanwhile, 12 Second Generation (G2) satellites are being built by Airbus Defence and Space and Thales Alenia Space, under contract with ESA. Both models successfully passed the Critical Design Review milestone, leading to a ramp-up in production. Onboard equipment is also being manufactured, with components being delivered throughout 2024. The Galileo Second Generation satellites will be ground-breaking: they will have fully digital navigation payloads, use electric propulsion, host a more powerful navigation antenna, have inter-satellite link capacity and an advanced atomic clock configuration. Moreover, their architecture will offer a high degree of flexibility.

April also marked a major milestone for Galileo's ground segment—the largest in Europe and one of the continent's most critical infrastructures. A seamless migration was completed with no impact on users, preparing the system for Galileo's Second Generation.

Around the same time, Galileo's new Public Regulated Service (PRS) signals began broadcasting. This encrypted navigation service is designed specifically for authorised governmental users and critical applications, enhancing Europe's autonomy and resilience in satellite navigation.

In Toulouse, ESA Navigation teams brought forward EGNOS V3, the newest version of Europe's satellite-based augmentation system, financed and owned by the European Union. Already used in over 500 airports across the continent, EGNOS enhances precision, reliability and integrity of positioning signals for safety-of-life navigation services. EGNOS V3 will not only augment GPS signals, but also Galileo ones.

In 2024, ESA Navigation kicked off two of its own missions: the LEO-PNT demonstrator and the Genesis science mission.

The European Galileo navigation system has four more satellites in orbit following two launches in 2024. With 32 satellites now in orbit, Galileo is expanding its constellation, increasing reliability, robustness and ultimately precision, benefiting billions of users worldwide.

Approved at ESA's Council meeting at ministerial level in 2022, these missions are at the core of the FutureNAV programme, which enables ESA to respond to trends and needs in the field of PNT, ensuring Europe stays at the cutting edge of satellite navigation technology.

- Genesis will contribute to a highly improved International Terrestrial Reference Frame (ITRF) of Earth with an accuracy of 1 mm and a long-term stability of 0.1 mm/year, providing a coordinate system for the most rigorous navigation applications on our planet.
- LEO-PNT (low Earth orbit positioning, navigation and timing) is a constellation of ten demonstration satellites that will fly close to Earth and test the use of novel signals and frequency bands, unlocking exceptional resilience and accuracy in navigation that will potentially enable a long list of new applications and services.

Under the lead of the Directorates of Connectivity and Secure Communications and in collaboration with the Directorates of Human and Robotic Exploration and Navigation, ESA kicked off Moonlight, a programme dedicated to establishing a satellite constellation for navigation and telecommunication services for the Moon. With over 400 lunar missions planned in the next two decades, Moonlight marks a significant step towards sustainable lunar exploration and the development of a lunar economy.

The Navigation Innovation and Support Programme (NAVISP) continued to foster innovation in positioning, navigation and timing (PNT) systems. With a record number of industry ideas having been submitted to NAVISP, the programme is cultivating European and Canadian industry capabilities.

In 2024, beyond advancing its programme portfolio, ESA Navigation has actively engaged with industry, agencies and organisations within the global PNT community. A key highlight was hosting the European Navigation Conference at ESTEC, further strengthening collaboration and innovation in satellite navigation. Additionally, the team has been involved in educational activities including the 15th edition of the ESA-JRC International Summer School on GNSS and the second edition of the ESA Academy training course on satellite navigation.

Six Galileo Second Generation (G2) satellites by Airbus Defence and Space and six more by Thales Alenia Space will form the first G2 fleet. Both models successfully completed their Critical Design Review in 2024.

SPACE SAFETY AND SECURETY

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SPACE SAFETY

ESA's Space Safety Programme is dedicated to the protection of Europe and its economies from disruption to critical space infrastructure and fostering new commercial opportunities in the European space sector.

ESA's Space Safety Programme is dedicated to the protection of European assets on ground and in space from hazards originating in space (space debris, space weather and near-Earth objects), as well as fostering new commercial opportunities in space safety and sustainability. A total of €733m (at 2022 economic conditions) were subscribed to the programme at the 2022 ESA Council meeting at ministerial level, an increment of 68%, with Slovakia and Canada joining the programme.

As the focal point of the ESA Zero Debris approach, the Space Safety Programme is the engine of an Agency-wide transformation for more responsible exploration and use of outer space. Following, in 2023, a thorough update of ESA's debris mitigation requirements and standards, influencing the design, construction, operation, and disposal phases of the Agency's missions and the community development of the Zero Debris Charter, ESA continues to lead global efforts on space debris mitigation and remediation. In addition, in 2024, ESA achieved major milestones in space weather and planetary defence.

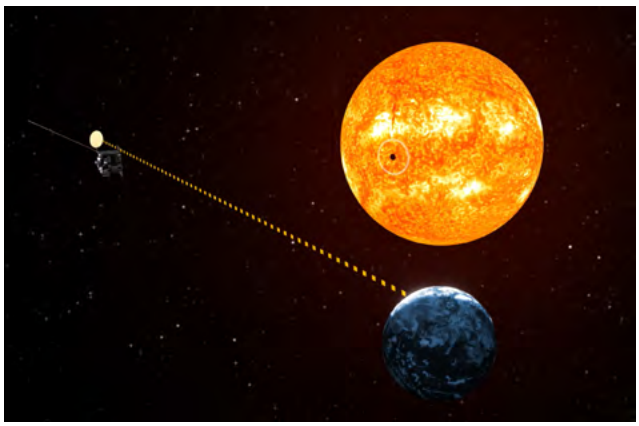
ESA's first space safety mission, Hera, was launched in October. As part of the world's first test of asteroid deflection, Hera will perform a detailed post-impact survey of the target asteroid, Dimorphos – the orbiting moonlet of a binary asteroid system known as Didymos. Now that

Hera asteroid mission launches to the sky on 7 October 2024.

NASA's DART mission has impacted the moonlet, Hera will turn the grand-scale experiment into a well understood and repeatable planetary defence technique. Demonstrating new technologies from autonomous navigation around an asteroid to low-gravity proximity operations, Hera will be humankind's first probe to rendezvous with a binary asteroid system and Europe's flagship Planetary Defender.

The Zero Debris Charter is receiving global support, and the Zero Debris Community is preparing the path towards implementation. Following the first signature ceremony in May, the Zero Debris Charter had by the end of the year been signed by close to 150 organisations worldwide, including 20 governments. In parallel, members of the Zero Debris Community have developed the first issue of the Zero Debris Technical Booklet, which provides an exhaustive list of needs and technical solutions to achieve a Zero Debris future. The inaugural Zero Debris Future Symposium and Zero Debris Week were held at ESA's ESOC establishment in Darmstadt, Germany, cementing its place as the heart of space safety in Europe.

At the Brussels Space Summit, ESA signed a contract with Airbus Defence & Space UK worth €340m for the development of its Vigil satellite. From its unique vantage point in deep space, Vigil will greatly improve our early warning of severe space weather events such as solar storms that may cause disruption on Earth. Vigil will continuously deliver near real-time data on potentially hazardous solar activity before it is detectable from Earth. Vigil's operational data from deep space will give operators of satellites, power grids and telecommunication systems time to take protective measures, and give human space explorers time to get to safety.



Vigil warns Earth.

Space Debris.

ESA's 2024 ESA Space Environment Report highlighted several key findings. More satellites were launched in 2023 than in any previous year driven by LEO commercial satellite constellations. Not enough satellites leave these heavily congested orbits at the end of their lives and are at risk of fragmenting into dangerous clouds of debris that linger in orbit for many years. Accordingly, active satellites must perform an increasing number of collision avoidance manoeuvres to move out of the way of other satellites and fragments of space debris. While the adoption of space debris mitigation measures is slowly improving, it is still not enough to stem the increase in the amount of space debris.

ESA has taken another important step towards sustainability in space with its first in-orbit servicing mission Rise. A €119m contract was signed with D-Orbit as the co-funding prime contractor. Rise is a commercial in-orbit servicing mission that aims to demonstrate that it can safely rendezvous and dock with a geostationary client satellite.

In-orbit servicing mission RISE.

ESA is committed to delivering on the promise of Zero Debris by 2030. To ensure compliant satellites can be designed and built in time, ESA is supporting industry during this technologically challenging transition. In June, three major European space industry players each signed a contract with ESA to develop large low Earth orbit (LEO) satellite platforms that comply with ESA Zero Debris standards.

GOCE in orbit.

IAC 2024 - Ramses contract signature.

In October, ESA signed a contract with OHB Italia SpA worth €63m to begin preparatory work on the Ramses mission to the infamous asteroid Apophis. Infamous because on 13 April 2029, the 375 m asteroid Apophis will pass within 32,000 km of Earth's surface – less than one tenth of the distance from Earth to the Moon. This extremely rare natural phenomenon will capture the attention of the entire world and offer a unique opportunity for scientific and planetary defence research.

The Clean Space Days 2024, held in October at ESA/ESTEC, brought together over 300 participants to discuss sustainable space missions. The event featured over 100 presentations on eco-design, in-orbit servicing, and zero debris. Highlights included the finalisation of the Zero Debris Technical Booklet, a workshop on atmospheric effects of spacecraft re-entry, and updates from the Eco-design Working Group. The event emphasised collaboration and continuous improvement, gathering feedback from participants and drawing up plans for future engagement.

SECURITY AND CYBER RESILIENCE

Cyber Resilience

In a climate of geopolitical instability and an evolving threat landscape, resilience is key. ESA's Security Strategy foresees a harmonised vision of distributed functions in a unique European cyber-ecosystem. In combination, the Security Assurance granted by the ESA Security Office (ESO) in application of the ESA Security Framework underpins ESA activities, and safeguards the investments of our Member States and international partners, supporting European resilience.

The ESA Security Office is working to enhance the resilience of all ESA activities and infrastructure by ensuring that the capabilities, tools and standards readily at the fingertips of our skilled and dedicated engineers are state-of-the-art.

Cyber Security Capabilities

ESA's advanced distributed and remotely (and securely) connected space-oriented cyber resilience capabilities will detect, respond to and recover from cyber attack:

- Cyber Security Operations Centre (C-SOC) operational as of May.
- Security Cyber Centre of Excellence (SCCoE) SCCoE Phase 1 operational as of August. Development of Phase 2 initiated in January.

Together, C-SOC and SCCoE form the ESA Cyber Resilience Security Baseline, the Agency's cyber security backbone composed of a geographically distributed system of systems with shared capabilities and security functions designed to be secure as designed and as built.

The ESA Cyber Security Evolution was launched in 2024 to further enhance ESA's capabilities, providing a complete and integrated cyber environment for the protection of the entire lifecycle (design, development and operations) of ESA's space programmes and overall activities. Through this evolution, ESA will enhance the C-SOC and SCCoE capabilities via the:

- Cyber Security Portable Operational Platform (C-POP), a secure platform for Member States and partners, enabling remote connection to ESA's Cyber Resilience Capabilities while ensuring need-to-know segregation and ultimately creating a European Threat Intelligence Sharing Network.
- CyberCube – an in-orbit flying testbed with onboard cyber capabilities for detection and protection against vulnerabilities and threats in space.

- Quantum Secure Verification Platform (QSVP) – a platform capable of testing quantum technologies from a security assurance perspective.

New technologies: ESA is launching studies on innovative technologies such as in the areas of quantum resistant cryptography, supply chain protection, space-to-ground communication links protection, cyber security protection for ground and space, artificial intelligence and security of new technologies (such as 5G). Each of these cyber security technologies, once they have reached a good technology readiness level (TRL), will be developed up to an operational level and injected in specific space programmes to support and contribute to reinforcing the overall security posture.

Security of Space Programmes

ESO certified all ESA's major security-critical space projects in 2024. The testing, validation and qualification functionalities provided by the SCCoE's ability to emulate a space project environment provide key tools to support the certification of space programmes, founded on a robust security risk management process, in line with the ESA Security Framework.

Corporate Security Infrastructure

ESO audited and certified the Agency's corporate infrastructure in accordance with the ESA Security Inspection Plan 2024, including the certification of security-critical tools and applications, and is performing an Agency-wide cyber security audit. The Security Monitoring and Vulnerability Detection capabilities of the C-SOC will provide the ESA Corporate Infrastructure with a resilience capability unique in Europe.

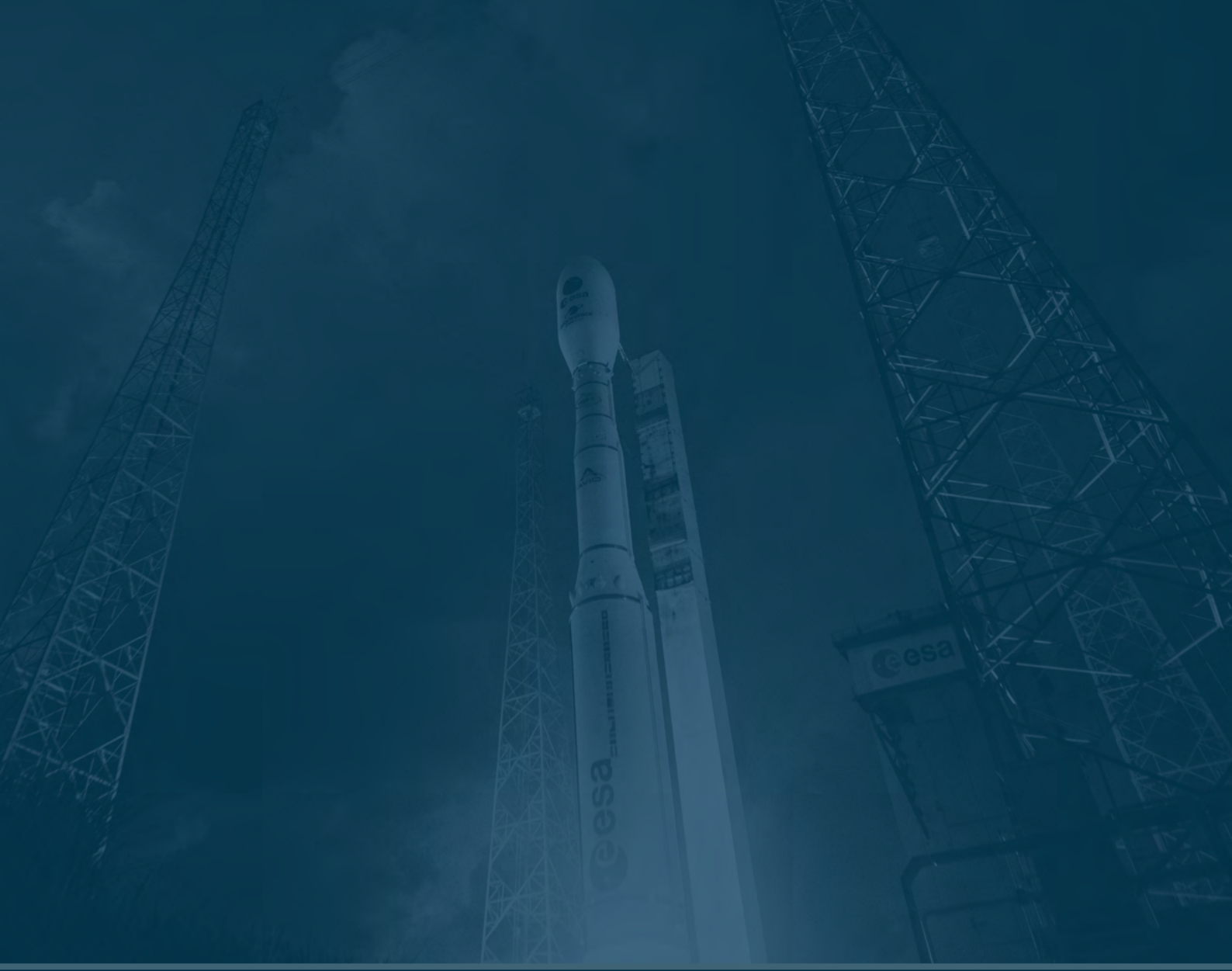
International Cooperation and Security Agreements:

The revised ESA-EU Security of Information Agreement was signed on 22 May, bolstering ESA cooperation with the EU in security-critical space activities.

In addition, ESA has signed Memorandums of Understanding with Estonia and Slovakia to enhance cooperation in cyber security and has concluded agreements with Slovakia, Canada and Cyprus on the mutual protection of classified information.

ESA has joined the EU Space Information Sharing and Analysis Centre (ISAC) as a public partner so as work together to support European threat intelligence sharing and resilience.

ENABLING AND SUPPORT



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SPACE TRANSPORTATION

2024 was a highly significant year for Europe as it restored its independent access to space with the successful inaugural flight of Ariane 6, the final flight and retirement of Vega and the return to flight of Vega-C after its failure during its first exploitation flight in December 2022.

Ariane 6

Following the conclusions of the combined test phase, Ariane 6 conducted its inaugural flight, designated VA262, from Europe's Spaceport in French Guiana on 9 July, validating the new heavy-lift rocket's ability to reach its target orbit and to deploy satellites and constellations.

It successfully deployed eight satellite missions into orbit (Robusta-3A, Replicator, Curium One, GRBBeta, CURIE, ISTSat-1, 3Cat-4 and OOV-Cube), activated five onboard experiments and demonstrated the versatility of the Ariane 6 upper stage with two successful ignitions of its Vinci engine.

The consolidated analysis of all flight data demonstrated that the launcher is performing as expected, and is therefore cleared to enter into commercial exploitation. A quick ramp-up to a yearly average launch rate of 9–10 launches per year will make it possible to deliver on the 32 launch service contracts presently in the manifest of Ariane 6.

Vega-C and Vega-C/E

Europe's Vega rocket was retired on its final flight, designated VV24, from Europe's Spaceport in French Guiana on 5 September, delivering the Sentinel-2C Earth observation satellite into orbit. It was the first rocket programme entirely managed by ESA. Consisting of four stages, three solid-propellant motors and a liquid-fuelled upper stage, Vega was first launched in 2012. During its operational lifetime of 20 successful flights, it launched important institutional and commercial missions, including Proba-V, IXV, Sentinel-2A, 2-B and 2-C and LISA Pathfinder. Vega is succeeded by Vega-C, which provides more payload capacity for the same launch cost.

Two successful Zefiro 40 solid rocket motor test firings in May and October confirmed the reliability of the redesigned Vega-C second stage and prepared for Vega-C's successful return-to-flight on 4 December, recovering from the failure of its first commercial flight in December 2022. Designated VV25, it launched the Sentinel-1C Earth observation satellite into orbit and marked the restart of routine commercial operations for the new launcher.

On 18 December, the main contract for the development of the new Vega-E launch system was signed between ESA and

Europe's new rocket Ariane 6 powered Europe into space, taking with it a varied selection of experiments, satellites, payload deployers and re-entry demonstrations that represent thousands across Europe, from students to industry and experienced space actors. This inaugural flight, designated VA262, taking place from Europe's Spaceport in French Guiana on 9 July 2024, is a demonstration flight to show the capabilities and prowess of Ariane 6 in escaping Earth's gravity and operating in space.

The final flight retiring the Vega rocket took place from Europe's Spaceport in French Guiana on 5 September 2024. It launched the Copernicus Sentinel-2C satellite and will replace its predecessor, Sentinel-2A, and deliver optical images from the visible to the shortwave-infrared region of the electromagnetic spectrum. The Vega rocket is succeeded by the more capable Vega-C and eventually by Vega-E, which is currently under development.

A redesigned Zefiro 40 solid rocket motor, the second stage of the Vega-C rocket, was successfully fired on 3 October 2024 for the second time by prime contractor Avio at its Salto di Quirra test facility in Sardinia, Italy. This second firing follows on from a first firing test of the motor in May 2024 and concluded the qualification tests for the improved engine nozzle design of the Zefiro-40, a pre-condition for Vega-C's return to flight on 4 December 2024.

Avio. The contract covers all aspects of the development of the launch system such as rocket stages and assembly, adaptation of the launch pad, fuelling, launch pad systems and logistics followed by integrated and combined tests of the complete Vega-E launch system.

Vega-E will be slightly taller than Vega-C and fly with three stages instead of four. The third stage will be powered by a newly developed liquid-fuelled methane-oxygen rocket engine.

Vega-C's successful "return to flight", designated VV25, launched the third Copernicus Sentinel-1 satellite, Sentinel-1C on 4 December 2024. It is another key step in restoring Europe's independent access to space. Vega-C is the evolution of the Vega family of rockets and delivers increased performance, greater payload volume and improved competitiveness.

Europe's Spaceport

In 2024, ESA and CNES invited space and non-space companies from all ESA Member States to support the extraordinary maintenance and digital modernisation of Europe's Spaceport in French Guiana, issuing contract opportunities for the spaceport's telecom infrastructure, digitalisation and AI, data acquisition and processing, security and safety, sustainability and energy management efficiency.

Space Rider

Following its entry into Phase D, qualification and production, several full-scale model drop-test campaigns were conducted in 2024 at Salto di Quirra in Sardinia, Italy in preparation for authorising the manufacture of the flight model. The test campaigns with drops from a maximum height of 3.5 km validated the design of the enormous paraglider chute with a length of 27 m and a width of 10 m – around 10 times larger than a human parafoil.

Space Rider drop-test campaign in 2024 whereby a full-scale model of the future orbital laboratory was dropped from a helicopter to test and qualify the deployment of its parachutes, at Swalto di Quirra in Sardinia, Italy.

Future Preparation

Significant progress was made throughout 2024 in preparing the future of space transportation in Europe through the development of products, and the advancement of new and innovative technologies and demonstrators, including with the demonstration of reusable rocket engines and launcher stages within the Prometheus and Themis activities within the framework of the Future Launchers Preparatory Programme. Two contract riders worth approximately €230m were signed with ArianeGroup in November to continue the demonstration of the Prometheus engine and the reusable rocket stage demonstrator, Themis. The Prometheus MK1 engine reached its 1000 kN rated thrust in tests in December and the Themis T1H stage has been assembled for delivery to Esrange in Kiruna for suborbital flight tests in 2025.

In parallel, Boost! activities with commercial space transportation partners continued, with co-funding support contracts completed and new ones signed in 2024 anticipating the first inaugural orbital flights of European commercial launch service providers in 2025.

Follow-up of ESA Council meeting in Seville

2024 saw the implementation of important decisions taken by the ESA Council in Seville on 6 November 2023, allowing the ESA-developed Vega launcher to be commercialised by its prime contractor, Avio, and the adaptation of the former Ariane 5 integration building at Europe's Spaceport in French Guiana for the Vega-C launcher. A resolution adopted in July defined what constitutes a 'European launch service', in preparation for competition between European launch service providers, which is key to ensuring European autonomous access to space. It includes considerations on the nationality of the launch service provider and location of the launcher system development, manufacturing and launch operations. The ESA Council also authorised the use of Europe's Spaceport's launch range in French Guiana by four micro- and mini-launchers from European launch service providers Isar Aerospace, MaiaSpace, PLD Space and Rocket Factory Augsburg (RFA).

Implementation of the paradigm shift defined in the Seville resolution in 2023 was initiated through a new procurement scheme for the development of new European launch services in the form of a European Launcher Challenge (ELC). ESA will procure launch service demonstrations of evolved capacities building on the buoyant ecosystem of new European launch service providers presently developing micro- and mini-launchers. The ITT will be issued in early 2025 to prepare for fair contribution subscriptions by Member States at the ESA Council meeting at ministerial level in 2025.

In December 2024, the first Themis – Europe's demonstrator of a reusable rocket first stage – completed a "full fit-check" standing tall at ArianeGroup's facility in Les Mureaux, France. The 28-m tall model includes the main elements for Themis such as the engine bay, the fuel tanks, the flight control bay and the upper part. It is powered by the new-generation European Prometheus, an engine developed by ArianeGroup that runs on liquid methane and liquid oxygen and can vary its throttle in flight so as to be capable of landing.

This fit-check was one of the key requirements and one of the final steps in Les Mureaux to conclude the development phase of Themis – designated T1H for Themis 1-engine Hop – opening the way for its transport to the Esrange Space Centre in Sweden from where it will have its first flight next year. Its first flight will be a short hop, taking off and landing from the same location, organised as part of the European Commission Salto programme.

GROUND SYSTEMS ENGINEERING AND OPERATIONS

ESA's European Space Operations Centre (ESOC) is home to ESA's mission Operations and ground segment engineering experts. They are entrusted to operate ESA's cutting-edge missions, supported by the backbone of state-of-the-art antenna network and ground systems, including cybersecurity. It is also home to ESA's Space Safety Programme, whose expertise in space sustainability complements the operations domain, particularly in Space Debris and frequency management.

Reliable and trusted provider of Launch and Operation Support for cutting-edge institutional missions

In 2024, ESOC successfully supported the launch of five new missions, a record achievement, with special activities from launch simulations to Launch and Early Orbit Phase (LEOP) operations and subsequent commissioning. These missions were:

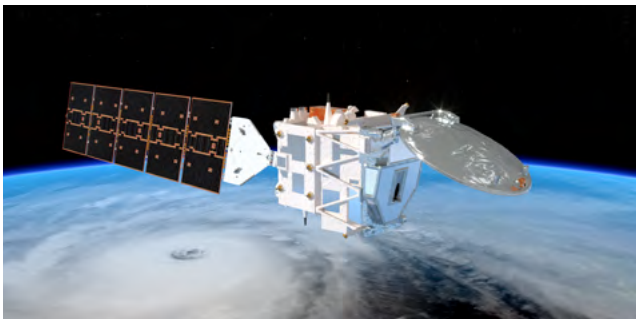
- **EarthCARE**: The mission control team gathered at ESOC assessing the satellite's core systems, calculating its precise orbit, and ensuring safe deployment of its solar array and radar instrument. Following LEOP, the work continued with a challenging six-month commissioning phase including the complex calibration of the mission's four instruments.

Mission control GO for EarthCARE launch.

P160C solid-propellant rocket motor QM3 test

- **Sentinel-2C**: Launched in September, the mission successfully completed its commissioning phase at the end of the year, with routine operations started in January 2025.
- **Sentinel-1C**: Following the launch, mission control at ESOC completed the series of complex deployment procedures, including the activation of its 12-meter-long radar antenna. Less than a week after its launch the Copernicus Sentinel-1C satellite delivered its first radar images of Earth.

Last Vega flight VV24 takes to the skies



EarthCARE over a typhoon

Copernicus Sentinel-1C

- **Hera**: Launched in October as the first mission in ESA's Space Safety Programme, Hera's LEOP was completed in under three days. Two months later, ESA's mission control performed the mission's first deep-space manoeuvre, putting Hera on a trajectory that will enable a gravity assist at Mars in March 2025.

Hera her CubeSats and their rocky target destination

- **Proba-3**: Following its December launch, mission operators at the European Space Security and Education Centre (ESEC), in Redu, Belgium. managed the first phase of the spacecraft's deployment, preparing it for the next critical phase of separation and formation flying in January 2025.

Proba-3's PSLV-XL liftoff.

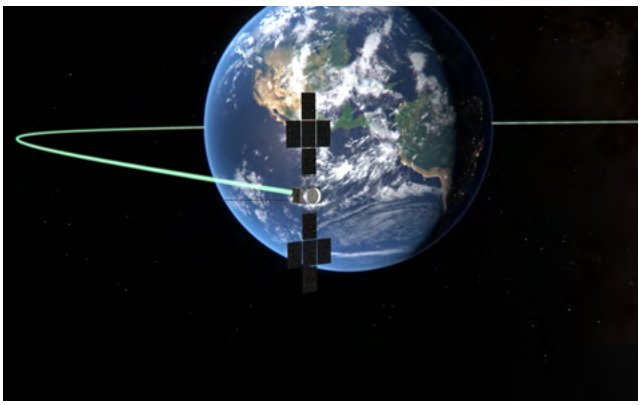
ESOC experience maximises science data return:

In 2024, missions again faced many unexpected challenges. By working closely with our industry partners, we ensure maximum science return and mission success. After a layer of ice formed on Euclid's optics, the mission functionality was restored, enabling sharp and accurate observations. For BepiColombo, ESOC defined a completely new trajectory after facing difficulties with the power generation and the electric propulsion system, ensuring that the mission will reach its destination of Mercury. Similarly, Gaia was fully restored to operational capability following a strike by a micrometeoroid.

BepiColombo's closest view of Mercury.

Expertise in Flight Dynamics:

Flybys are critical manoeuvres requiring precision, innovation, and flawless execution. ESOC's mission control teams have excelled in designing and managing these critical flybys. In 2024, BepiColombo completed its fourth and fifth Mercury flybys, capturing crucial images, including the first clear view of Mercury's south pole. Due to new mission constraints with the thruster, a new trajectory was devised that will achieve arrival at Mercury in November 2026. Additionally, in a world-first manoeuvre, ESOC used the gravity of both the Moon and Earth to reroute the JUICE spacecraft toward Venus, saving the mission between 100–150 kg of fuel.



Juice flies by Earth.

Advancements in Ground Segment Systems and Infrastructure

ESA's Estrack network is at the forefront of ground systems engineering, enhancing data transfer for missions like Euclid, Juice, BepiColombo and Hera. Recent cryogenic upgrades at Cebreros (Spain) and Malargüe (Argentina) stations have doubled data transfer rates and increased capacity for deep-space missions. These advancements ensure that ESA's missions achieve maximum scientific output.

ESA's Malargüe tracking station at sunrise.

The installation of the 122-tonne, 35m-diameter reflector dish at the New Norcia 3 antenna (Australia) in September was a successful milestone towards its completion on time, with the station set to be operational by the end of 2025. This additional capacity will help meet the demanding needs of ESA's deep-space missions and ensure their valuable data is safely downlinked.

Lifting the dish at ESA's newest deep space antenna.

In collaboration with European industry, the Directorate of Operations (OPS) has also made strides in developing optical communication systems, including NASA's Deep-Space Optical Communication (DSOC) ground segment, which will fly with NASA's Phyche spacecraft as an additional technology demonstrator. Optical connectivity to the Moon is also being extended, with a successful remote-operated optical link demonstration using NorSat-TD.

Advancements in AI for Ground Segment Engineering and Operations:

In 2024, OPS, in collaboration with industry and external users, led the development, validation and operationalisation of several AI-enabled applications. One AI application, for example, focused on decision recommendation for spacecraft operators, is used daily by 12 ESA missions and further adoption is ongoing; another AI application has been adopted for mission planning of ESA's XMM-Newton; while two more AI products for satellite and ground station health monitoring are currently being deployed.

Leading by example for a sustainable space and space debris mitigation:

ESOC is key player in promoting the sustainable use of space through safe satellite disposal and re-entry operations. In September, ESA achieved the world's first targeted satellite re-entry, with the first Cluster-2 satellite safely returning to Earth after 24 years of space weather research. This re-entry, over a low-traffic area, provided valuable data for future satellite designs. The other three Cluster-2 satellites have also been put on track for controlled re-entries. The re-entries of ERS-2 in February and OPS-SAT in May were also managed, and ESOC completed the controlled disposal of Sentinel-1B.

Cluster satellite reentering Earth's atmosphere.

A Trusted International Partner

In addition to serving ESA's missions, the Estrack network is the basis for many cross-support agreements with international partners, allowing ESA to benefit from agreements with other agencies in exchange for Estrack tracking hours, when demand allows. In 2024, ESA supported the successful landing of NASA's Intuitive Machines' IM-1 mission on the Moon. ESA also received the first signal from China's Chang'e 6 mission. In December, ESA signed an agreement with India's ISRO to provide ground station support for the Gaganyaan human spaceflight programme via the Estrack augmented network, which incorporates commercial providers.

TECHNICAL AND QUALITY MANAGEMENT

The Directorate of Technology, Engineering, and Quality (TEC) had a string of significant achievements in 2024, supporting ESA's leadership in innovation, technology development, and space sustainability. Here are just some of them:

Space Robotics

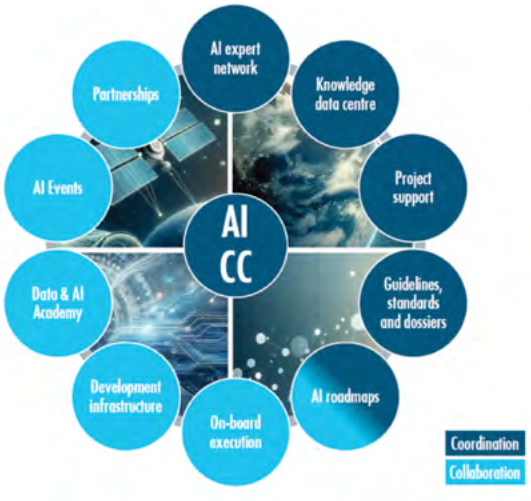
The Human-Robot Interaction Lab made two successful runs of the Surface Avatar experiment on the International Space Station (ISS). ESA astronaut Marcus Wandt (Axiom III) and NASA astronauts Tracy Dyson and Jeanette Epps remotely operated a fleet of robots from orbit, demonstrating robotic cooperation for potential contributions for the Moon and beyond. This collaboration with DLR is supporting autonomous robotic systems, with the next session scheduled for mid-2025.

The last preparation before the inauguration day – Spot now sports ESA blue proudly!

Marcus Wandt controlling a fleet of robots from on board the ISS for the Surface Avatar experiment.

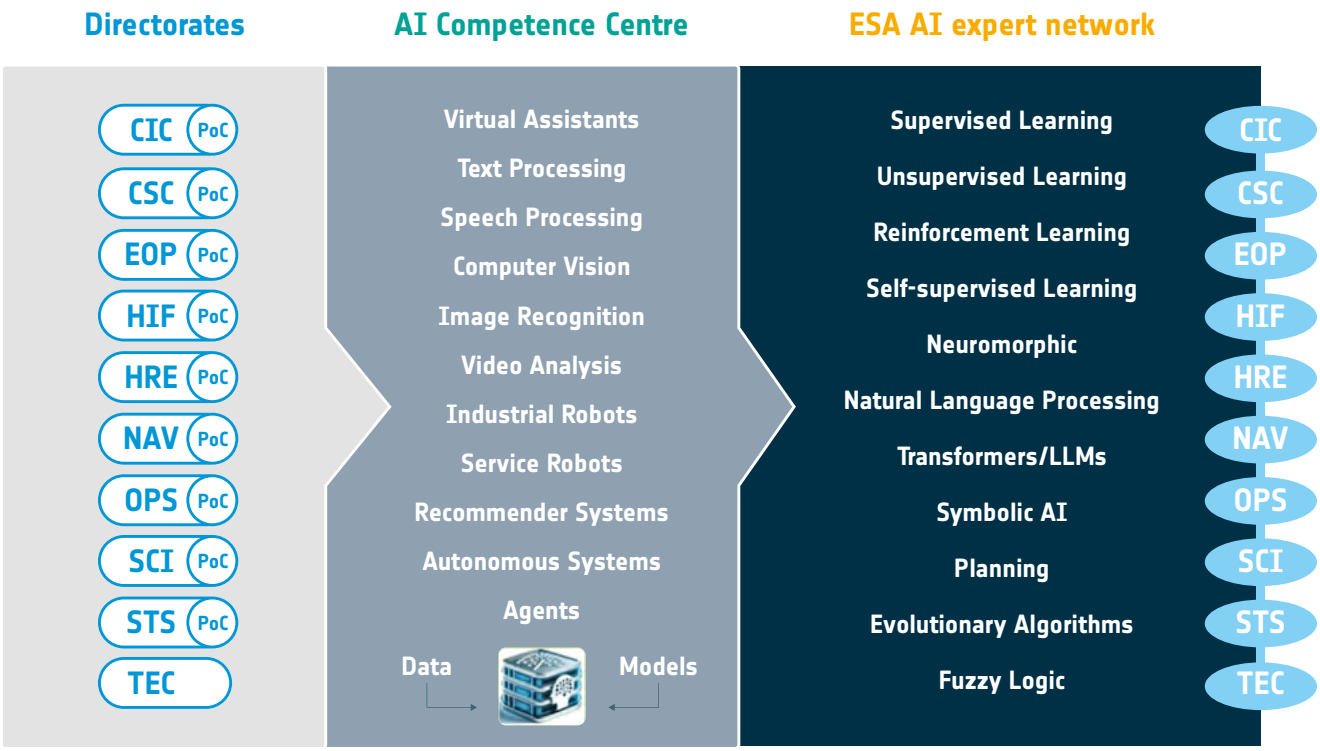
AI Centre of Competence

The AI ESA Strategy supports the integration of artificial intelligence (AI) across various space applications and operations focusing on four key areas: mission engineering and design, mission operations, insights from mission data, and Agency efficiency and effectiveness. By leveraging AI, ESA aims to enhance mission performance, streamline operations, and improve data utilisation. Central to this strategy is the establishment of the AI Competence Centre (AI CC), which will act as the hub for AI activities, offering support, guidance, and leadership across all ESA directorates. The AI Centre of Competence supports AI-specific activities planned for all application directorates and the prototyping of AI-based applications. The AI CC will support the rapid and efficient adoption of AI techniques, the consolidation of internal expertise, and the preparation of work plans for AI-powered products, the ultimate goal is to position ESA as a catalyst for AI-based applications by industry, enabling new space and ground applications by 2028. More than 400 activities have been initiated since 2020.



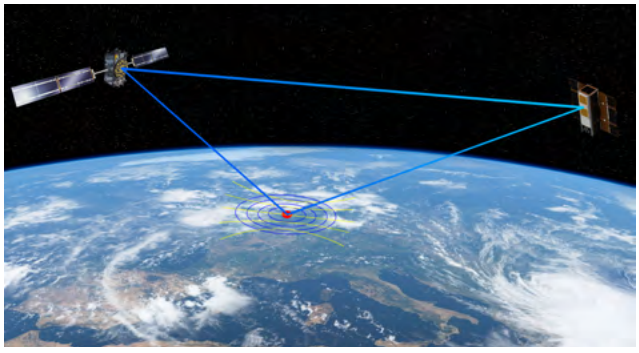
The multiple duties of the AI Competence Centre

Organising development of AI applications: 3 pillars

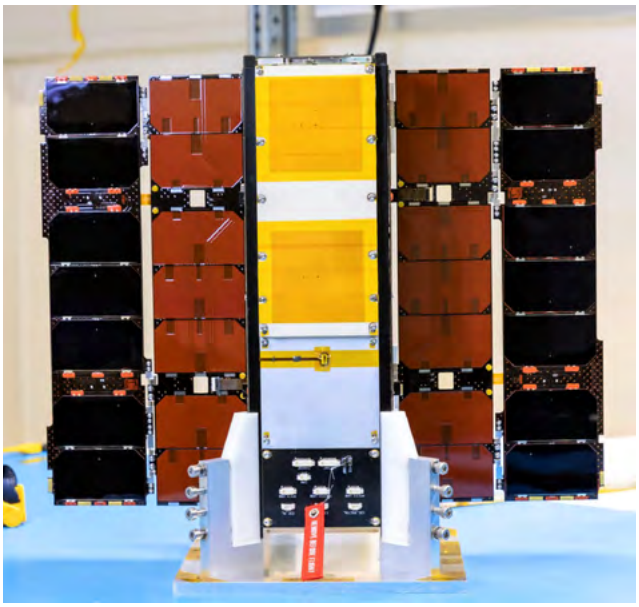


CubeSat Missions

The PRETTY (Passive REflecTometry and dosimeTrY) CubeSat completed its one-year mission, successfully demonstrating interferometric Global Navigation Satellite Systems Reflectometry (GNSS-R) for sea ice altimetry. This, ESA's first GNSS-R mission, represents a great leap forward in Earth observation capabilities. Additionally, its compact radiation dosimeter, SATDOS, was able to provide critical data on low Earth orbit radiation levels.



Configuration used for the GNSS-R experiment.



PRETTY proto-flight model before launch.

Space Sustainability and Safety

ESA played an important role in global space sustainability initiatives. The Zero Debris Charter gained momentum, with over 100 signatories, including 17 countries, committing to ambitious sustainability targets. In parallel, the Independent Safety Office reviewed more than 60 space debris mitigation plans, with over 50% of ESA-supported missions already aligned with Zero Debris principles. By 2030, all future ESA missions are expected to comply fully with the guidelines.

ESA presents the initial signatories for Zero Debris Charter.

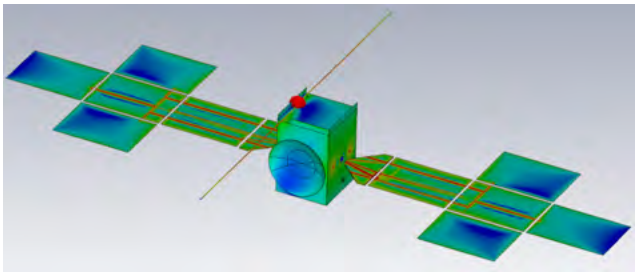
ESA is also modernising the planetary protection toolkits by using molecular biology and metagenomics techniques to enhance contamination monitoring during space exploration and give increased flexibility to project teams. A workshop was organised at NASA Ames in November with international agencies and experts with the aim of injecting the use of these methods into ESA missions and standards. This, in turn, will improve risk assessment frameworks, and enable sustainable and responsible space exploration, as outlined in Explore 2040 and the Terrae Novae vision for Moon and Mars missions.

Planetary Protection training provided by ESA at Fraunhofer Institute in Stuttgart.

TEC Engineering Excellence and Mission Support

Unfolding Inflight Interference of the RIME Instrument on Juice

The Radar for Icy Moon Exploration (RIME) on Juice operates at 9 MHz, a frequency susceptible to unintentional interference from spacecraft electronics. This posed a risk to its ability to characterise subsurface properties of Jupiter's icy moons. A multidisciplinary team from TEC collaborated with system engineers and project architects to identify the dominant interference path. Through inflight data analysis, 3D EMI simulations, and on-ground EMC testing at ESOC, they confirmed that interference originates as spurious voltage variations, propagates via harness bundles, and ultimately radiates through the solar arrays. This complex mechanism involves multiple conversions, including common mode to differential mode and conducted to radiated interference. This successful investigation, made possible by cross-domain expertise, now enables the exploration of inflight mitigation strategies and informs future missions such as EnVision.



Simulation from the 3-D EMI simulations on the Juice spacecraft.

Research and Development Programmes in TEC

2024 saw a wealth of highlights from ESA's R&D programmes such as Hera and Proba-3. In October, Hera was launched towards the Didymos binary asteroid to conduct the very first assessment of its internal properties, and to measure in great detail the outcome of the NASA DART mission's kinetic impactor test. While Hera is implemented through ESA's Space Safety Programme, several of the industry participants carried out technology pre-developments under the General Support Technology Programme (GSTP), including for the CubeSat deployer and Juventas' antenna mechanism.

In December, Proba-3 was launched as the world's first precise formation flying mission. Once demonstrated, this technology will fulfil a major space industry goal and enable linking several small satellites in space. The fourth in the Proba series, Proba-3 is funded through the GSTP. The next stage of several GSTP technology demonstration missions were approved in 2023: the Lunar Meteoroid Impacts Observer (LUMIO), the Heliospheric Pioneer for Solar and Interplanetary Threats Defence (HENON) CubeSat and the Arctic Ocean Surveillance precursor mission.

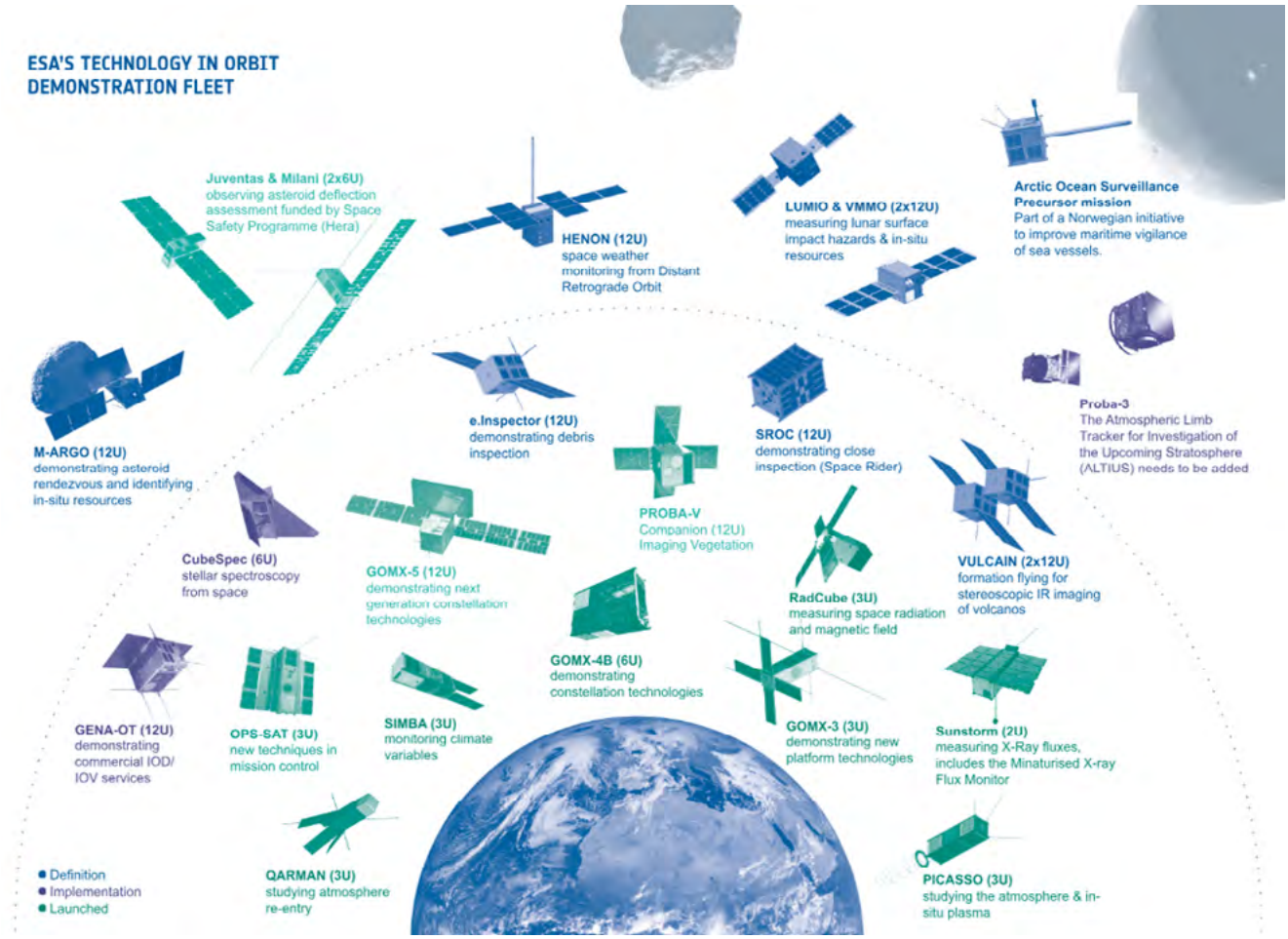
Proba-3 was launched in December 2024 on board the Indian Space Research Organisation's PSLV launcher.

The GSTP achieved a record-breaking €237m in new contractual commitments – an increase of around 50% – and €165m in industrial cost for the first time, demonstrating strong support to industry and effective results.

Via the Preparation element, ESA kicked off over 60 early-phase system studies in 2024 with and for all application directorates in preparation of programme proposals at the 2025 Council meeting at ministerial level (CM25). These include system studies for the M7 and ARRAKIHS, L4 concept studies, Argonaut and exploratory studies on low-cost Mars mission platforms, Neomir, CAT-IOD, circular economy and debris related studies, EE-11, Sentinel-3NG, as well as preparation activities of launch services from European privately developed mini/micro launchers.

In 2024, ESA kicked off 145 Discovery R&D activities, many with commercial ambitions, with a large SME share of 31% and 51%, and all starting from ideas submitted on the Open Space Innovation Platform (OSIP). All activities from the VLEO campaign started and a new campaign (new approaches for Large Space Structure Construction, Maintenance, and Recycling Technologies (LATTICE)) began, which received 69 ideas.

In July, the Joint Task Force (JTF) of the European Commission, ESA and the European Defence Agency on Critical Space Technologies for European Strategic Non-Dependence published its Action List for 2024–2026. This list identifies issues of dependency on non-European technology, which will be implemented in ESA through programmes such as the Technology Development Element (TDE).



ESA's technology In Orbit demonstration fleet funded through GSTP.

ESA Education

2024 marked the second year of implementation of Space for Education 2030, the ESA Education Programme's long-term vision and plan, whose main objectives are to respond to Member States' needs in terms of education, in line with current trends in the (new) space and educational sectors; to address the emerging competence and skills demand posed by current societal challenges; and to increase the Programme's impact through a diversification of the target audiences and subject domains. The Programme portfolio was further expanded, by means of new – theoretical and practical – training and learning activities as well as new inspiration initiatives, which were successfully implemented in close collaboration with nearly all ESA directorates.

Activity on supercontinuum generation in a nitride semiconductor photonic integrated circuit (contract 4000144309 with Hexisense SA, CH).

RESOURCES MANAGEMENT, CORPORATE ACTIVITIES AND EXTERNAL RELATIONS

58 Commercialisation, Industry and Competitiveness

60 Human Resources, Facility Management and Digital Transformation

COMMERCIALISATION, INDUSTRY AND COMPETITIVENESS

Programmes and activities regarding commercialisation: BASS and ScaleUp

The Business Applications and Space Solutions (BASS) programme aims to open commercial opportunities for space applications in non-space sectors such as automotive, agriculture, transportation and health, promoting applications of space technology and data to improve life and develop business on Earth.

Its portfolio now includes more than 400 space solutions for markets throughout the downstream economy. Projects are co-funded with industry, since the aim is for companies to launch new products and services commercially, and half (51%) lead directly to a first sale even before the ESA project is completed.

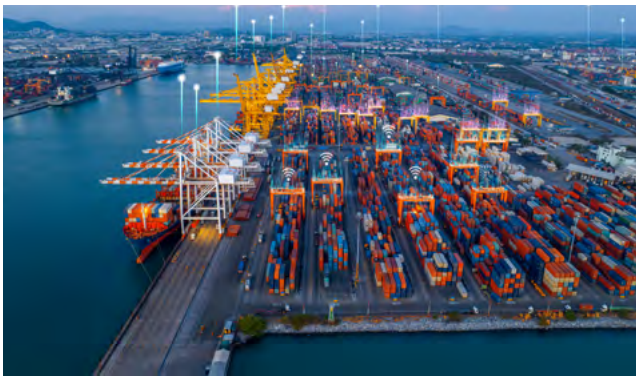
This success is achieved through proactive marketing outreach beyond the space sector, and in partnership with more than 40 lead organisations in mobility, city management, energy, land use, sport and tourism who work with the BASS team to define work plans and to grow the SME community. 14 mayors and municipal authorities have joined ESA's Task Force for Smart and Green Cities, with nine more in discussion as the network reaches beyond Europe. The Energy and Maritime Sustainability Task Forces, each comprising 11 international organisations spanning their entire supply chains, shape active work programmes supporting the transition to low carbon energy and mobility, and in 2024 a new Bioeconomy Task Force took on this role for food production and land use.

With half (48%) of its activities contributing to the Green Transition and 81% contributing to United Nations Sustainable Development Goals, BASS brings positive change in the world through the action of competitive and commercial European businesses, making a substantive contribution to Agenda 2025 and to the goals of Strategy 2040.

The **ScaleUp** programme supports the growth of industrial players in new and emerging markets. In 2024 the programme saw significant advancements across its various networks – the BIC network, the Broker Network, the PhiLabNet, and the Investor Network – as well as focusing on in-orbit demonstration and validation, and initiated a network of European providers of business acceleration with the first Business Accelerator set up in Germany.

BIC Network: The ESA BIC Network continued to expand in 2024, now featuring 32 ESA BICs in 22 Participating States and new initiatives to enhance collaboration and support for start-ups. Notable events included the EPIC Space Startup Competition to connect with Japanese, Indian and Singaporean ecosystems and the 20th Anniversary of the ESA BIC Network, which provides platforms for start-ups to connect with investors and industry leaders.

The ESA BIC Network survey results from 2020 to 2023 demonstrate the very high socioeconomic impact of the activity, with over €1.25bn in private investment raised during this period. ESA BIC-supported start-ups generated Over €232m in revenue in 2023. The programme also created and sustained over 5,000 full-time jobs in that same year.



The BASS Task Forces focusing on Smart and Green Cities, Energy, Maritime, and Bioeconomy are growing and actively shaping initiatives that support the transition to more sustainable solutions and address challenges in their respective fields.

Technology Broker Network: The ESA Technology Broker Network experienced significant growth in 2024, with activities established in Denmark, Italy, Spain and the United Kingdom. New contract extensions and expansions were implemented for Austria and Belgium.

In 2024, ESA Technology Brokers identified 104 cases where space technology could help non-space companies, leading to 331 connections made. Of these, 107 received funding or consultancy support, and 17 resulted in commercial agreements.

Phi-labNet: The Phi-lab Network saw substantial development in 2024, with new contracts signed and initiatives already launched in 10 countries. At the date of writing, the existing Phi-Labs have the following themes: Austria: Industrial innovation for the upstream domain; Norway: Arctic requirements and needs; Spain: Space technologies and their application to boost climate resilience; Switzerland: Deep tech innovation (quantum, data, materials); United Kingdom: Space-enabled sustainability technologies; Finland: Sensors / GIS computing and digital geospatial services (EO, PNT, GNSS); Netherlands: EO, critical PNT infrastructure, secure satellite communication; Ireland: Advanced manufacturing; Poland: Robotic and AI for autonomy; Sweden: Robotic and AI for autonomy. The Phi-Lab in Germany is not expected to begin operations before 2026.

The **ESA Investor Networ**k grew to include 67 new venture capital firms and banks. The Investor Forum was held in Frankfurt with about 200 participants providing opportunities for start-ups to connect with investors and showcase their business innovations.

Industrial Policy and Audits

One focus in ESA's industrial policy evolution has been to show greater flexibility in the application of geo-return rules, while safeguarding Member States' return on investment and enhancing the competitiveness of European industry. The newly introduced "fair contribution" concept will be proposed for the European Launcher Challenge at the 2025 Council meeting at ministerial level (CM25).

Slovenia became ESA's 23rd Member State, made possible by the close cooperation between the Industrial Policy and External Relations teams, and the Slovenian Delegation.

Over 100 industrial audits were conducted, resulting in economic savings of more than €100m.

Numerous industry events, training sessions and interactions with national delegations were organised, while the Industry Space Days took place in September at ESTEC, attended by 2,300.

In addition, ESA published its first public Space Economy Report and the European Centre for Space Economy and Commerce (ECSECO) continues to develop strongly, reaching 300 members in 2024.

Contracts

New Contracting Regulations were adopted, the main objective being to simplify the rules according to which ESA tender actions are conducted. Moreover, a significant improvement has been achieved in the duration of the tendering process, with a reduction of more than 30% in time to contract for standard procurements since 2022.

HUMAN RESOURCES, FACILITY MANAGEMENT AND DIGITAL TRANSFORMATION

HUMAN RESOURCES AND WORKFORCE

Ensuring ESA's effectiveness and attractiveness in a rapidly changing global context is vital to maintaining its status as a modern, world-class space agency and exemplary workplace. Careers at ESA are being promoted both online and in person. In August, ESA returned to Gamescom, the world's largest video game fair, which attracted a record-breaking 335,000 visitors to Cologne, Germany. At the busy ESA stand, a multidisciplinary team welcomed space fans, game developers, gamers and potential candidates. In addition to its participation in in-person events, ESA has been present on LinkedIn for some years now. By the end of 2024, ESA's LinkedIn pages had nearly 770,000 followers.

As reported in the 2023 Annual Report, there was an unprecedented number of job requisitions (JRs) published, and a significant number of hires. In 2024, 322 new external hires were made along with 97 internal reassignments, facilitated by the publication of 370 permanent and fixed-term positions. This further increase in recruitment aligns with previous years, which had already seen a surge in JRs due to a recruitment wave and efforts to source key competencies.

To contribute to the development of the future workforce, the Agency also recruited 110 ESA Graduate Trainees, 35 Internal Research Fellows and 310 interns, in addition to permanent and fixed-term roles.

Additionally, ESA has reduced the time-to-recruit by 42% compared to 2022. This efficiency was achieved through streamlined recruitment processes and more effective hiring strategies.

The table below provides an overview of the distribution of staff per nationality and grade level at 31 December 2024.

Member States	Hors Classe	A	L	B	C	Total Staff
Austria	1	36	1	2		40
Belgium	1	117		3		121
Czech Republic		9				9
Denmark		11		1		12
Estonia		6		2		8
Finland		24		2		26
France	2	583	9	45	3	642
Germany	2	493	4	27		526
Greece		31		2		33
Hungary		14				14
Ireland		17	1	2		20
Italy	2	504		14		520
Lithuania		4				4
Luxemburg		6				6
Norway		22		2		24
Poland		37		1		38
Portugal		41		2		43
Romania		41				41
Slovakia		2				2
Slovenia		2		1		3
Spain	1	251		3		255
Sweden		36		1		37
Switzerland	1	23		1		23
Netherlands		67		7		74
United Kingdom	1	292	2	15		310
Total	**11**	**2667**	**17**	**133**	**3**	**2831**
Non-Member States			**17**			
Canada		27		1		28
Total		**27**		**1**		**28**
Grand Total	**11**	**2694**	**17**	**134**	**3**	**2859**

SITES AND FACILITY MANAGEMENT

At ESA, the physical infrastructure is evolving to match the ambition of our space programmes, providing a world-class working environment that fosters innovation and collaboration. For the Estates and Facilities Management Department, 2024 was notable for several milestone achievements in the evolution of our sites.

The Accelerated Infrastructure Project (AIP) at **ESTEC (Netherlands)** and **ESOC (Germany)** is a multi-year initiative designed to reinvigorate our general-purpose infrastructure, ensuring it meets the highest standards of sustainability, efficiency and functionality. Together, the ESOC and ESTEC sites represent 66% of ESA's built environment. The AIP is crucial to the aspiration of the Agency to transform the mission control infrastructure at ESOC and to maintain the pre-eminence of ESTEC's test facilities, laboratories and workshops. At ESOC, ESA took a crucial step forward in May by signing a contract with H2S Architekten, a Darmstadt-based architecture office, for the construction of the ESA Future Missions Control Centre. This sustainable and ultra-functional building will be the focal point of the campus, accommodating new missions and technologies. It will reinforce ESOC as Europe's Centre of Excellence for satellite operations, enhancing operational efficiency and flexibility with support for parallel launches, an energy-efficient data centre, secure areas, visitor access, and training facilities. Construction is planned to commence in 2025.

One of the most eye-catching elements of AIP ESTEC, was unveiled in November. "The Orbit" will be the elliptical connection that links the new buildings. This project will deliver a significant urban planning overhaul of the ESTEC site, modifying around 32,000m² of floor space. ESA have partnered with Witteveen+Bos, a Dutch engineering company, for the project management, design and engineering and supervision of the main demolition and construction works, which is planned to commence in 2026.

The new ESA-DLR LUNA analogue facility at the **ESA Astronaut Center (EAC) in Germany** was inaugurated in September. It is a ground-breaking innovation that includes a 700m2 regolith testbed, bringing the lunar surface to Earth. The facility allows astronauts, scientists, and experts to train and test cutting-edge technologies in preparation for future Moon missions.

Following major renovation, a new building (Building B) at **ESAC (Spain)** officially opened its doors in December. It showcases a sustainable, modern and flexible working environment, and hosts the ESAC data centre – the digital library of the Universe – which processes and archives the data of the scientific missions of the Agency, an important step in the implementation of ESA's data centre strategy. The building also provides spaces for science operations, education and outreach.

ESRIN (Italy) hosted almost 40,000 visitors in 2024, including many VIP visits. One of the highlights was the visit of Italian President Sergio Mattarella, who inaugurated the new ESRIN Visitors Centre.

Three events were organised on site to mark the launches of EarthCARE, Sentinel-2C on the final flight of Vega and Sentinel-1C on the return to flight of Vega-C.

In the framework of the European Researchers' Night, the ESRIN Open Day was organised in cooperation with Frascati Scienza and other local Italian research institutions.

The ESRIN School days involved nearly 1,500 participants in an effort to inspire young students to study and pursue a career in STEM.

The establishment hosted many scientific workshops, seminars and industrial meetings, including visitors from the general public to the 3D Φ-Experience, Memorabilia Wall, ESA Archives and ESRIN Visitors Centre.

The establishment of the ESA High Performance Computing facility at ESRIN was finalised, with its inauguration planned for March 2025.

ESRIN continued to work on the sustainability agenda and received a LEED & WELL Platinum Certification on sustainability and well-being for Building 14, making it one of the most sustainable buildings in all of Europe. Additionally, the ESRIN solar power plant was upgraded to reach a production of 800 KWp – another example of how ESRIN continues to lead ESA in health, safety, and environmental standards.

Related to this, work was initiated on Building 9 to achieve 100% seismic reinforcement across the ESRIN site.

European Space Security and Education Centre (ESEC)

2024 was a year of achievements and significant moments for ESEC: most notably the visit on 15 May of His Majesty King Philippe of the Belgians, in the presence of the ESA Director General, the ESA Director of Strategy, Legal and External Affairs and Belgian official representatives. The visit was testament to the interest that Belgium has in space and the development of the ESEC centre, in particular.

In addition, the successful launch of Proba-3 served as a key milestone showing the capability to control complex satellite operations from ESEC.

Finally, construction got under way of the new cyber security centre (ECSC), which will be a cornerstone in terms of strengthening the security of ESA and its partners in space missions. The ECSC, which reflects ESEC's ongoing commitment to providing the highly secure modern infrastructure needed to protect space activities, will meet the strictest of security standards.

ECSC Construction site – November 2024

Visit of His Majesty King Philippe of the Belgians 15 May 2024

DIGITAL TRANSFORMATION AND INFORMATION TECHNOLOGY

esaIT applications services migrated to a standardised service provision contract facilitating users with automated access, also improving response time thanks to an enhanced digital library used to address user issues. esaIT end-user services streamlined support across all ESA sites, managing over 9,000 users and 40,000 meetings monthly, maintaining 265 videoconference rooms and efficiently handling 12,000 helpdesk tickets per month.

The main esaIT advancements include software-defined networking maximising user benefits by improving performance, enhancing security, making it easier to adapt the network to changing needs in a cost-efficient manner. esaIT has fostered an increase of 40% annually in the adoption of private cloud (esacloud) services by ESA directorates and supported a 25% increase in software projects managed in esaIT collaborative software development platforms.

The ESA Cyber Security Operations Centre (CSOC) has been operational since the end of 2024, and ESACERT (the ESA Computer and Communications Emergency Response Team) managed a 75% increase in support compared to the previous year, avoiding major cyber security incidents.

esaIT has also established a ChatGPT-like solution (named ASK_ESA) allowing users to save time on the retrieval of information across ESA and introduced Microsoft Copilot in order to help the ESA workforce by integrating AI capabilities into various Microsoft applications with a dedicated adoption programme for end users to enhance productivity and collaboration.

The Digital Transformation Office implemented the Agency's Digital Transformation framework, establishing key components and reference frameworks, launching the Digital Steering Committee, a body responsible for assessing and making decisions on various digital projects within the Agency. It oversees 200+ digital projects, with 30 decisions made and 16 projects under active monitoring.

The Digital Transformation Office also coordinated the definition of the ESA AI strategy and then launched it, consolidating the Agency's AI roadmap and delivering AI use cases.

The ESA data governance framework has been designed to ensure the effective management, protection and utilisation of data across the Agency, with major deliveries having included the ESA Dashboard and Member States' Dashboard proof of concept to ESA delegates, designed to provide a comprehensive overview of key performance indicators (KPIs) and other relevant data for Member States.

The Space HPC project progressed significantly, through system development and site preparation, aiming for inauguration in March 2025, prior to being deployed for internal and external use cases that have never operated before in such a context.

FINANCE, PLANNING AND CONTROL

The ESA executive is contributing to the 2025 Council at Ministerial level (CM25) preparation through consolidated financial plans, support to the Director General and decision preparation, and to the ESA Transformation, in particular new resources management models, project management reinforcement and digital transformation initiatives.

Financial Accounting and Operations

With the 2024 accounts, ESA aims to repeat its 2023 achievement of marking 12 years of unqualified financial statements and, for the third consecutive year, receiving no audit recommendations, thus ensuring continued stakeholder confidence in ESA's financial management.

Through digitalised processes, ESA executed 39,820 payments, incorporating special payment acceleration measures for industry, with an average time-to-payment of 15 calendar days in contrast to ESA's 30-day contractual terms. Digitalisation continued in invoice processing and travel expense management.

Treasury adopted full usage of a new tool to support end-to-end operations and management, with improved automation, security and reporting. Effective cash investment has secured record returns for Member States.

Corporate Planning, Budgeting and Controlling

Budgets, long-term planning and Agency-wide multi-year financial plans and strategies were developed. Following the endorsement of the 2025 cost plans by Programme Boards, Council adopted the 2025 budgets (€7.68bn for ESA Mandatory and Optional programmes and for third-party activities).

Departmental digitalisation efforts made progress, including further development, the streamlining and automation of processes, modernising of controlling tools and management dashboards.

Notes to the Financial Statements

As required by the ESA Financial Regulations, the Agency's annual Financial Statements are prepared in accordance with International Public Sector Accounting Standards (IPSAS) since 2010.

The Financial Information presented herewith was extracted from the audited ESA Financial Statements for the financial year 2024. This Financial Information consists of the following extracted components:

- Statement of Financial Position;
- Statement of Financial Performance;
- Statement of Changes in Net Assets/Equity;
- Statement of Cash Flows.

The net surplus of 2024 amounts to 1,017.3 M€ compared to 1,512.5 M€ in 2023. The breakdown is as follows:

- 1,090.5 M€ net surplus for ESA activities and programmes (1,584.3 M€ net surplus in 2023)
- 88.6 M€ net deficit for Pensions (86.4 M€ net deficit in 2023)
- 15.4 M€ net surplus for Social Security (14.6 M€ net surplus in 2023)

The result of 2024 decreased by 495.2 M€ compared to 2023 mainly due to increased operating expenses by 531.4 M€ compared to prior year.

The financial result amounts to a surplus of 252.7 M€ compared to a surplus of 224.2 M€ in 2023, resulting in an increase of 28.5 M€. The financial surplus in 2024 is mainly related to the positive bank interest of the treasury in 2024 and the performance of the Pension Buffer fund in 2024.

The Financial Information presented hereinafter, was extracted from the ESA Financial Statements 2024. ESA Financial Statements 2024 also include a summary of significant accounting policy and Notes to the Financial Statements and were audited by the Audit Commission of the European Space Agency. The Audit Commission conducted its audit in accordance with the International Standards on Auditing (ISA). As required by the Financial Regulations, this audit included also the aspect of regularity. In the Audit Commission's opinion, the 2024 audited Financial Statements give a true and fair view of the Financial Position of the European Space Agency as at 31 December 2024, and of its Financial Performance and its Statement Cash Flows for the 12 month period ended 31 December 2024, in accordance with International Public Sector Accounting Standards (IPSAS).

Concerning the aspect of regularity, the Audit Commission reported that nothing came to its attention, which would indicate that the transactions of ESA have not been made, in all significant respects, in accordance with the Regulations of the European Space Agency.

The audited Financial Statements and the Independent Auditor's report were submitted to the Council in accordance with the ESA Financial Regulations, which were approved by the Council Meeting on 12 June 2025.

I. STATEMENT OF FINANCIAL POSITION

	31 December 2024 million €	31 December 2023 million €
Total Assets	**20,096.0**	**19,654.7**
Current assets	**6,245.2**	**6,500.6**
Cash and cash equivalents	4,059.2	3,971.9
Recoverables from non-exchange transactions	153.3	254.1
Receivables from exchange transactions	1,363.2	1,700.5
Inventories	669.5	574.1
Non-current assets	**13,850.8**	**13,154.1**
Recoverables from non-exchange transactions	2.3	2.4
Receivables from exchange transactions	903.0	811.4
Financial assets	1,502.0	1,320.8
Property, plant and equipment	11,173.1	10,712.7
Intangible assets	270.4	306.8
Total Liabilities	**10,630.8**	**11,513.8**
Current liabilities	**3,375.9**	**4,316.1**
Payables under exchange transactions	**2,699.8**	**3,655.2**
Current payables	923.8	1,616.9
Pre-financing from exchange transactions	1,260.8	1,661.3
Deferred income	515.2	377.0
Contributions and other payables	**333.5**	**330.3**
Prepaid contributions and other amounts payable to Member/Participating States	330.2	303.9
Pre-financing from non-exchange transactions	2.3	2.2
Other financial liabilities	0.0	0.5
Other payables	1.0	23.7
Employee benefits obligations	**304.5**	**287.7**
Provisions	**38.1**	**42.8**
Non-current liabilities	**7,254.9**	**7,197.8**
Employee benefits obligations	6,268.4	6,397.3
Other payables	498.9	299.7
Deferred income	251.6	276.3
Pre-financing from exchange transactions	236.0	224.5
Net Assets	**9,465.2**	**8,140.9**
Reserves	**12,725.6**	**10,819.6**
Amounts to be called from Member States	**-4,277.7**	**-4,191.2**
Net Surplus/ (Deficit) for the period	**1,017.3**	**1,512.5**
Net Assets	**9,465.2**	**8,140.9**

II. STATEMENT OF FINANCIAL PERFORMANCE

	Notes	2024 million €	2023 million €
Operating Revenues		**6,749.2**	**6,741.5**
Contributions from Member/Participating States		5,125.0	5,044.3
Other contributions and grants		2.3	17.5
Revenues from exchange transactions		1,186.7	1,253.8
Staff contributions		79.5	73.5
Other operating income		355.7	352.4
Operating Expenses		**-5,984.6**	**-5,453.2**
Purchases		-2,525.2	-2,407.1
External Servicies		-1,562.2	-1,366.5
Staff expenses		-767.8	-706.9
Other Operating expenses		-351.1	-329.1
Expenses from non-exchange transaction (*)		-12.7	-30.4
Depreciation and amortization		-717.5	-581.7
Impairment		-30.5	-20.2
Write-downs inventories and fixed assets, doubtful debts, provisions for future losses		-78.6	-11.3
Net Surplus / (Deficit) from Operating activities		**764.6**	**1,288.3**
Financial Activities		**252.7**	**224.2**
Financial revenue		316.4	255.7
Financial expenses		-63.7	-31.5
Net Surplus / (Deficit) for the period		**1,017.3**	**1,512.5**

III. STATEMENT OF CHANGES IN NET ASSETS

		31 December 2022 million €	Allocation of audited 2022 surplus/ (deficit) million €	2023 Net Surplus million €	Change in the present value of the Employee Benefit Defined Benefit Obligation million €	Fair Value adjustments million €	Allocation of financial interests million €	Other changes million €	31 December 2023 million €
RESERVES	**A**	**10,647.3**	**812.3**		**-665.4**	**30.9**	**-5.5**	**-0.0**	**10,819.6**
Member States Capital and Reserves		**-35.9**	**-276.7**		**-665.4**	**30.9**		**-0.2**	**-947.3**
Revaluation Reserve	a.	700.6	-114.4					-0.1	586.2
Currency Exchange Gains Reserve	b.	2.6	-0.2					-0.2	2.3
Other Reserves		-739.2	-162.0		-665.4	30.9			-1,535.8
Social security reserve	c.	51.5	11.7			3.1			66.3
Buffer Fund fair value reserve	d.	-41.2				27.8			-13.5
Barter Reserve	e.	-295.8	-173.7						-469.4
Actuarial gains and losses	f.	-453.8			-665.4				-1,119.2
Accumulated Surplus		**10,683.3**	**1,089.0**				**-5.5**	**0.2**	**11,766.9**
Accumulated Surplus ESA programmes		10,578.0	1,095.1				-5.5	0.3	11,667.7
Accumulated Surplus Third Party programmes		85.3	-5.4						80.0
Accumulated Surplus PECS		20.0	-0.8					-0.0	19.2
AMOUNTS TO BE CALLED FROM MEMBER STATES	**B**	**-3,831.3**	**-359.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-4,191.2**
Member States pension scheme receivable	g.	-3,831.3	-359.9						-4,191.2
Accumulated Deficit									
Net Surplus / (Deficit) for the Period	**C**	-1,512.6	-1,512.6	1,512.5					1,512.5
TOTAL NET ASSETS	**A+B+C**	**8,328.5**	**0.0**	**1,512.5**	**-665.4**	**30.9**	**-5.5**	**-0.0**	**8,140.9**

a. Revaluation reserve: Reserve created to record the net asset impacts of first adoption of accrual accounting / IPSAS standards

b. Currency exchange gain reserve: Reserve created to allocate annually the net currency exchange gains or losses to the General budget

c. Social security reserve: Reserve created to cumulatively record the annual result of the Social Security scheme and net asset impact of the revaluation of the financial assets at year-end

d. Buffer fund fair value reserve: Reserve created to record the net asset impact of the revaluation of the financial assets of the Pension Scheme Buffer fund at year-end

e. Barter Reserve: Reserve created to record the accumulated surplus / deficit of the Barter schemes with NASA

f. Actuarial gains and losses Reserve: Reserve created to record the Present value adjustment on the Employee Benefit Defined Benefit Obligation

g. Member States pension scheme receivable: Member States' pension scheme obligation after deduction of the financed part of the pension scheme.

		31 December 2023 million €	Allocation of audited 2023 surplus/ (deficit) million €	2024 Net Surplus million €	Change in the present value of the Employee Benefit Defined Benefit Obligation million €	Fair Value adjustments million €	Allocation of financial interests million €	Other changes million €	31 December 2024 million €
RESERVES	**A**	**10,819.6**	**1,598.9**		**384.0**	**14.4**	**-91.2**	**-0.2**	**12,725.6**
Member States Capital and Reserves		**-947.3**	**125.6**		**384.0**	**14.4**		**-0.1**	**-423.4**
Revaluation Reserve	a.	586.2	18.0					-0.1	604.2
Currency Exchange Gains Reserve	b.	2.3	3.9						6.2
Other Reserves		-1,535.8	103.6		384.0	14.4			-1,033.8
Social security reserve	c.	66.3	14.6			1.3			82.1
Buffer Fund fair value reserve	d.	-13.5				13.2			-0.3
Barter Reserve	e.	-469.4	89.0						-380.4
Actuarial gains and losses	f.	-1,119.2			384.0				-735.2
Accumulated Surplus		**11,766.9**	**1,473.4**				**-91.2**	**-0.2**	**13,149.0**
Accumulated Surplus ESA programmes		11,667.7	1,456.7				-91.2	0.1	13,033.1
Accumulated Surplus Third Party programmes		80.0	17.3					-0.2	97.2
Accumulated Surplus PECS		19.2	-0.6						18.7
AMOUNTS TO BE CALLED FROM MEMBER STATES	**B**	**-4,191.2**	**-86.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-4,277.7**
Member States pension scheme receivable	g.	-4,191.2	-86.4						-4,277.7
Accumulated Deficit									
Net Surplus / (Deficit) for the Period	**C**	1,512.5	1,512.5	1,017.3					1,017.3
TOTAL NET ASSETS	**A+B+C**	**8,140.9**	**0.0**	**1,017.3**	**384.0**	**14.4**	**-91.2**	**-0.2**	**9,465.2**

a. Revaluation reserve: Reserve created to record the net asset impacts of first adoption of accrual accounting / IPSAS standards

b. Currency exchange gain reserve: Reserve created to allocate annually the net currency exchange gains or losses to the General budget

c. Social security reserve: Reserve created to cumulatively record the annual result of the Social Security scheme and net asset impact of the revaluation of the financial assets at year-end

d. Buffer fund fair value reserve: Reserve created to record the net asset impact of the revaluation of the financial assets of the Pension Scheme Buffer fund at year-end

e. Barter Reserve: Reserve created to record the accumulated surplus / deficit of the Barter schemes with NASA

f. Actuarial gains and losses Reserve: Reserve created to record the Present value adjustment on the Employee Benefit Defined Benefit Obligation

g. Member States pension scheme receivable: Member States' pension scheme obligation after deduction of the financed part of the pension scheme.

IV. STATEMENT OF CASH FLOWS

	31 December 2024 million €	31 December 2023 million €
Net Cash Flows	**89.1**	**774.3**
Net Cash Flows from Operating Activities	**1,331.8**	**2,130.3**
Surplus/(deficit) from ordinary activities	1,017.3	1,512.5
Reclassification to investing activities	-32.6	**-14.9**
Non-cash movements	**686.2**	**524.1**
Depreciation and impairment	686.9	601.9
Provisions and Accruals	-3.1	-56.0
Write-downs / Adjustments inventories and fixed assets, provisions for future losses on inventories	73.5	44.4
Revaluation of financial assets at fair value	-70.8	-67.1
Effect of exchange rates on operating activities	-0.3	0.9
Decrease (Increase) in Deferrals/accruals of past or future operating cash receipts or payments	**-339.1**	**108.6**
Decrease/(increase) in inventories	-98.4	82.5
Decrease/(increase) in recoverables from Member States	100.0	-100.1
Decrease/(increase) in other receivables	-91.3	15.6
Decrease/(increase) in other current assets	336.6	-764.1
Increase/(decrease) in payable to Member/Participating States	-65.1	116.1
Increase/(decrease) in pre-financing	-389.0	331.8
Increase/(decrease) in other payables	-403.9	190.5
Increase/(decrease) in provisions for employee benefits	272.0	236.3
Net Cash Flows from Investing Activities	**-1,242.7**	**-1,356.0**
Acquisition of fixed assets	-1,178.9	-1,349.2
Proceeds from sales of fixed assets	0.1	0.1
Purchases of financial investments (portfolio)	-212.2	-169.3
Proceeds on disposal of financial investments (portfolio)	132.6	151.9
Interests received on financial assets	15.7	10.5
Net increase/(decrease) in cash and cash equivalents	**89.1**	**774.3**
Cash and cash equivalents at the beginning of the year	3,971.9	3,194.4
Effect of foreign exchange gain/loss on foreign-denominated cash & cash equivalent	1.7	-3.2
Cash and cash equivalents at year-end	4,059.2	3,971.9

Financial Highlights

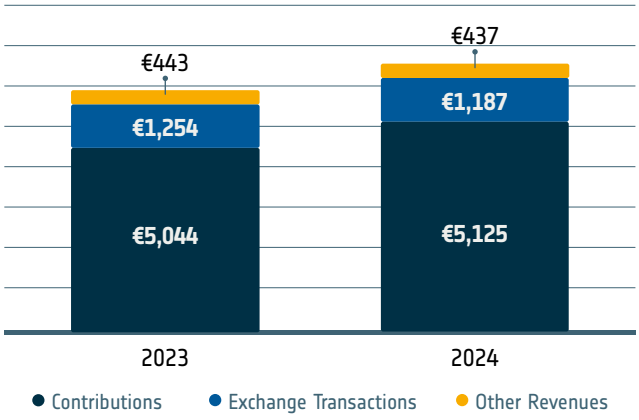
The Financial Highlights 2024 are based on the unaudited 2024 ESA Financial Statements. The ESA Financial Statements 2024 will be audited by the Audit Commission of the European Space Agency in accordance with the International Standards on Auditing (ISA).

The audited ESA Financial Statements and the Independent Auditor's report will be submitted to Council in accordance with the ESA Financial Regulations and approved at the Council Meeting on 11th June 2025.

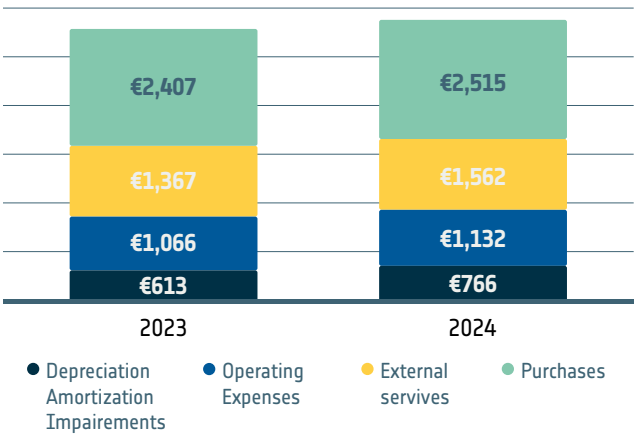
The Financial Highlights presented herewith consist of the following two components:

- Financial Position (ESA consolidated) and
- Financial Performance (ESA consolidated).

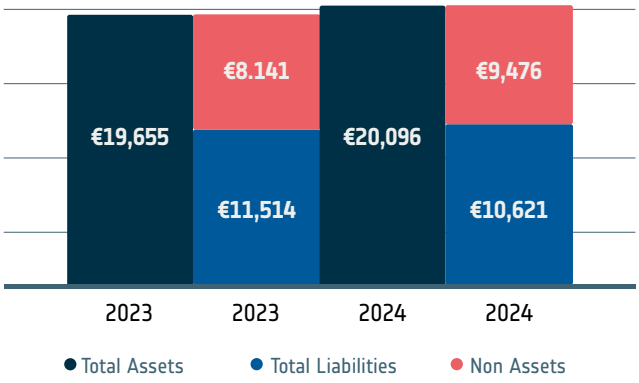
REVENUES COMPARISON 2023 & 2024 (m€)



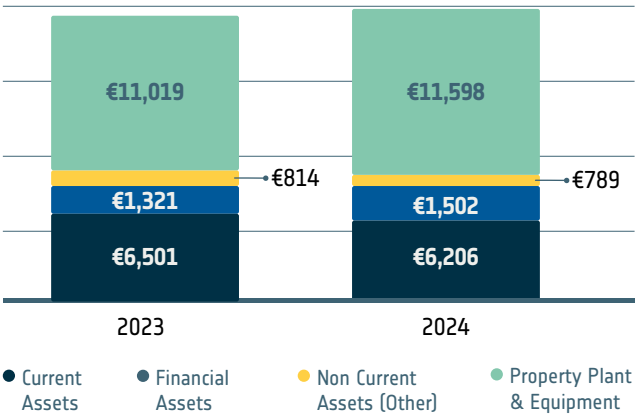
EXPENSES COMPARISON 2023 & 2024 (m€)



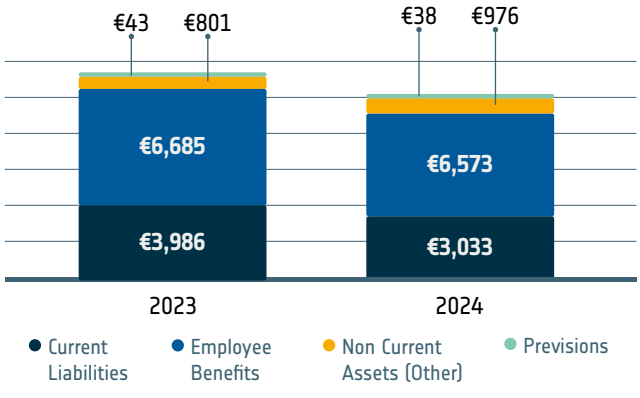
FINANCIAL POSITION 2023 & 2024 (m€)



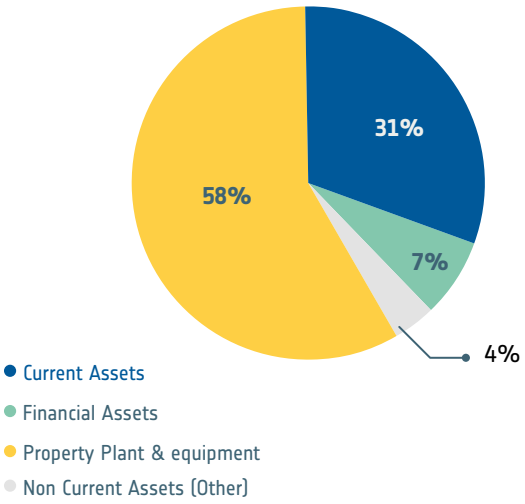
ASSETS COMPARISON 2023 & 2024 (m€)



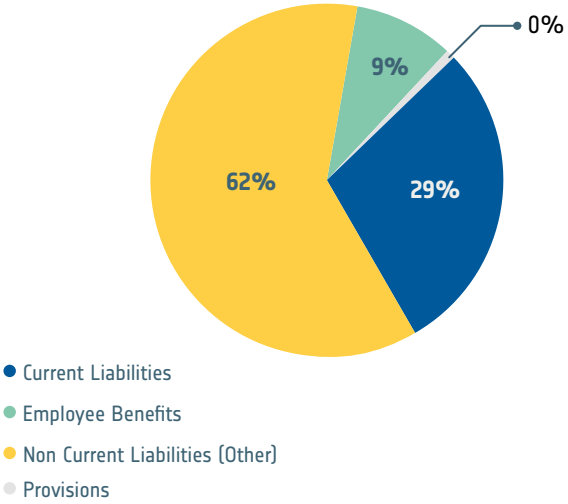
LIABILITIES COMPARISON 2023 & 2024 (m€)



ASSET CATEGORIES 2024 (€m)



LIABILITY CATEGORIES 2024



Income

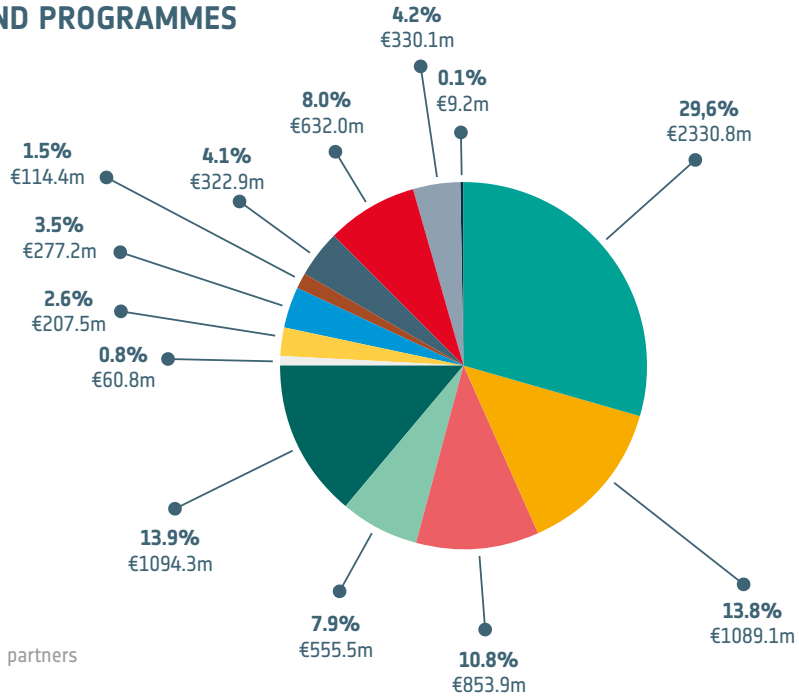
ESA Mandatory Activities (including the General Budget and Scientific Programme) and activities associated with the General Budget are financed by Member and Participating States' contributions. ESA Optional Programmes are financed by Member and Participating States' contributions, and for some programmes, also by other entities, including the European Union and EUMETSAT. For Optional Programmes, Participating States declare a voluntary subscription on a multi-annual basis. Third-Party Programmes, managed by ESA, are fully financed by third parties.

FUNDING FOR ESA ACTIVITIES AND PROGRAMMES

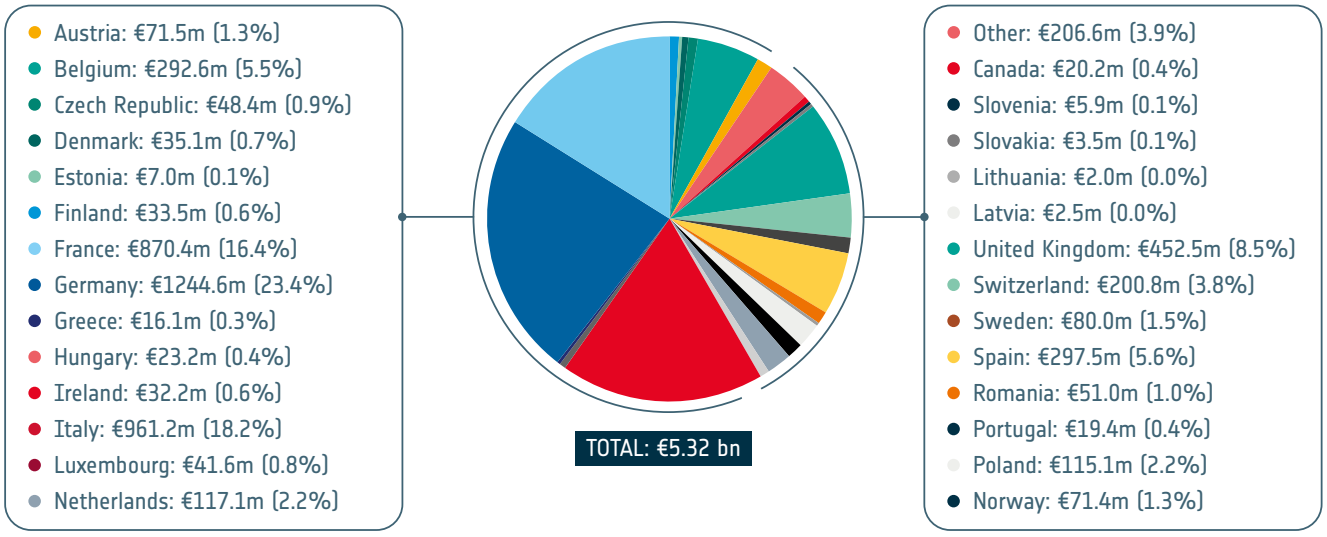
Final budget by domain for 2024: 7.88 B€*

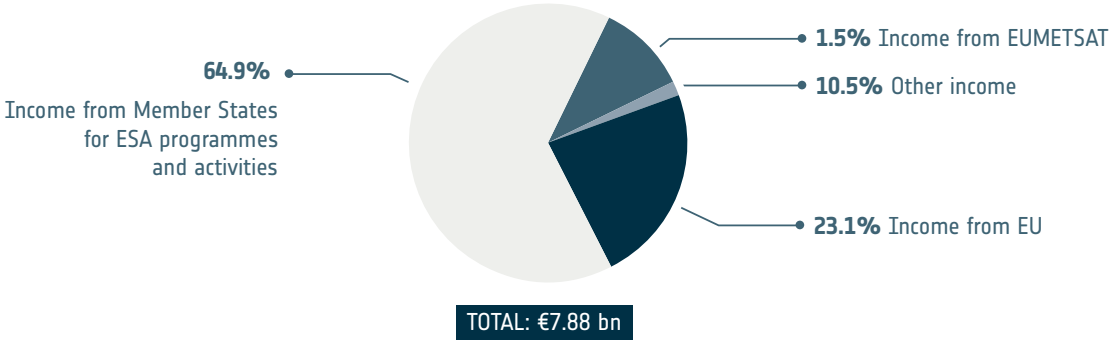
- Scientific Programme
- Human and Robotic Exploration
- Space Transportation
- Technology Support
- Commercialisation
- Connectivity and Secure Communications
- Earth Observation
- Navigation
- Space Safety
- European Cooperation States Agreememts
- Basic Activities
- Associated with General Budget
- Prodex

* Includes activities implemented for other institutional partners



ESA 2024 BUDGET BY FUNDING SOURCE





Cost (6.915 €m)

ESA's total cost in 2024 amounted to €6,915m, of which €4,925m related to ESA programmes and activities and €1,990m to Third-Party activities.

Mandatory Activities represented 12% (€827m), 57% was accounted for by Optional Programmes (€3,916m), 2% by activities associated to the General Budget (€134m), 29% by programmes financed by Third Parties (€1,990m).

Most of the cost accrued in 2024 by domain is provided below.

Basic Activities: Discovery, Preparation & Technology Development (48%), Mission Operations Infrastructure (15%), Sites & Common IT Investment (21%) and Engineering Labs & Test Centres (16%)

Scientific Programme: Plato (26%), Missions in Operation (24%), Mission Preparation (12%)

Space Transportation: Ariane 6 and P120C Transition (16%), Ariane 6 Development (8%) and PA / P120C (7%)

Earth Observation: Future EO Period-1 Segment 2 (10%), EE9 / FORUM (7%), CSC-4 / CO2M (7%), Future EO Period-1 Segment 1 (5%), CSC-4 / CIMR (5%).

Human and Robotic Exploration: Mars Sample Return (20%), European Service Module (ESM) (15%), ExoMars - Rosalind Franklin Mission (13%).

Connectivity and Secure Communications: Core Competitiveness (46%), PARTNER (26%) and IAP/BASS (15%)

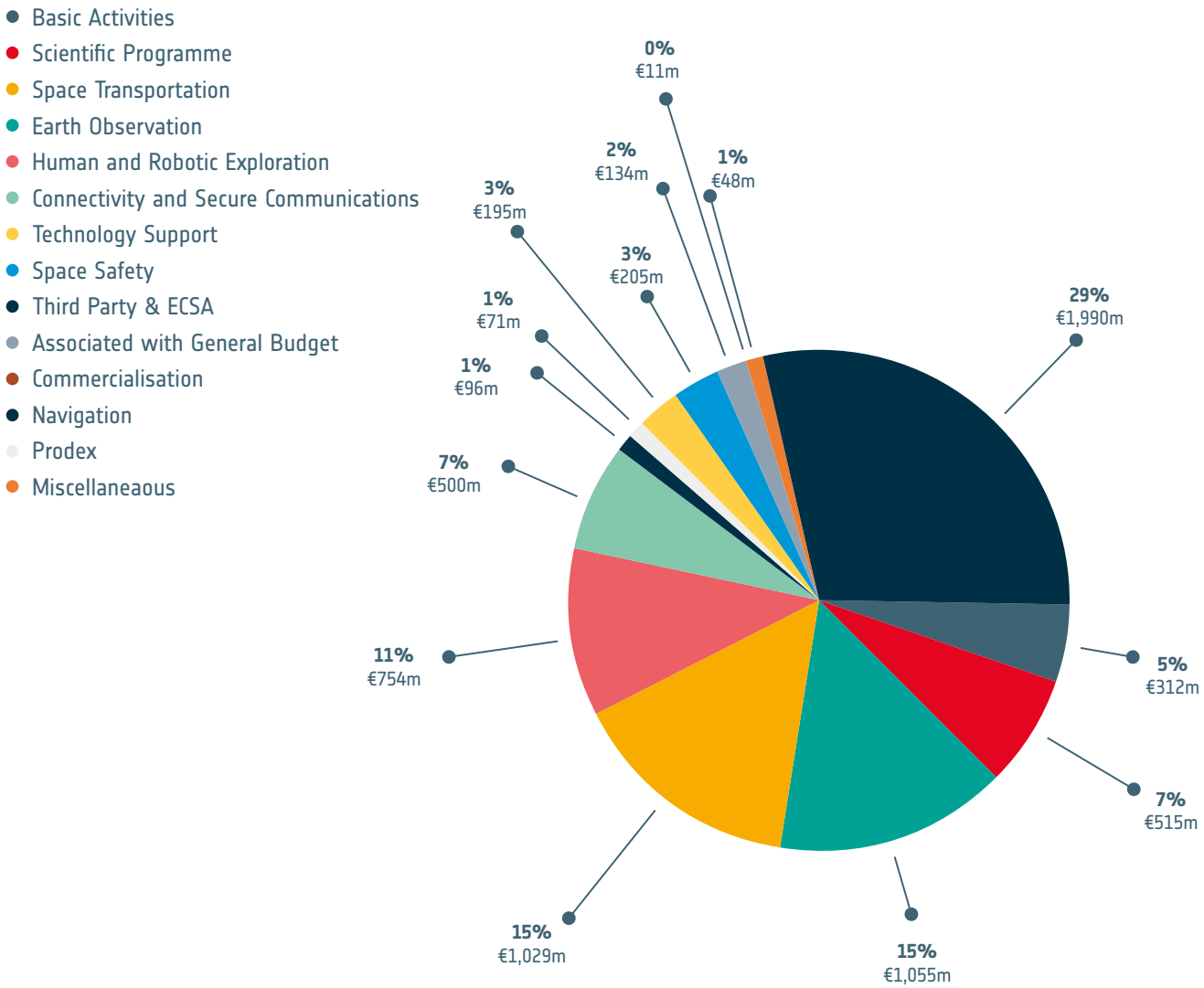
Technology Support: General Studies Technology Programme R&D (78%) and Proba-3 (21%)

Space Safety: Hera Mission (43%) and Vigil (22%)

Navigation: LEO -PNT (50%), NAVISP (36%)

Third-party: Galileo FOC DC - GSA – EUSPA (39%) in Navigation and Copernicus MFF (30%) in Earth Observation

Associated to General Budget: CSG 2023-2027 (93%)



DIVERSITY AND INCLUSIVENESS

In 2024, ESA made further progress towards achieving the Diversity and Inclusiveness (D&I) objectives set forth as part of the ESA Transformation. In the course of the year, ESA directors were tasked with designing and implementing effective measures supporting diversity and inclusiveness both at Agency and at directorate level, allowing for broader engagement and Agency-wide coordination. In parallel, guidelines were developed to assist managers in the proper application of agreed D&I principles.

Another step forward was achieved in terms of greater female representation. Data for 2024 confirmed the upward trend of recent years, with women representing 29.3% of the total workforce and women in top management positions reaching a record level of 21%. The percentage of female recruits (29%) continued to outpace the share of applications from women (24%), and an ESA-wide Women's Network was set up following the example of the Out in Space network for LGBTQIA+ people at ESA.

In addition, the Agency renewed its collaboration with EIROforum and the partnership with Women in Aerospace (WIA) and extended its involvement in D&I initiatives outside ESA by joining the Equal Pay International Coalition (EPIC) and the UN Gender Focal Points Group.

ESA showcased its efforts on accessibility by hosting a panel on Accessibility in Human Spaceflight at the International Astronautical Congress (IAC), with panellists from ESA, NASA and the UK Space Agency joining together to discuss the latest achievements of the "Fly! Feasibility Study". 2024 also marked the first ESA participation in a Pride Parade, cementing the Agency's commitment to expressing support for the LGBTQIA+ community.

STRATEGY AND FORESIGHT

2024 was a defining year for ESA's Strategy Department – a year marked by transformation and foundational progress. The groundwork was laid for ESA Strategy 2040, a forward-looking roadmap developed in close collaboration with Member States. This strategy will guide ESA's trajectory over the next 15 years, positioning space as a key driver of societal progress, integrating emerging technologies, and aligning directorate strategies with future ministerial Council planning.

Closely linked to ESA Strategy 2040 is the ESA Long-Term Plan (LTP). In 2024, the LTP was enhanced with a comprehensive framework of strategic objectives and priorities designed to address both internal and external challenges. This updated plan ensures greater adaptability in a rapidly evolving global landscape. Further evolution of the LTP is planned for 2025, with the aim of incorporating risk-adjusted programmatic and financial planning.

A significant milestone in 2024 was the creation of the Tripartite Tiger Team (TTT) – a joint effort between Member States, industry, and the ESA Executive. For the first time, this collaborative approach tackled critical implementation challenges and offered targeted recommendations to improve programme performance. Supporting the TTT Chair, the Director of Strategy, Legal and External Affairs, the Strategy department played a central role in integrating strategic perspectives throughout the process. In December, a resolution to implement the TTT's recommendations was unanimously adopted by Council, reinforcing ESA's commitment to improved delivery and governance.

Strategic foresight efforts were also expanded in 2024 through the Strategic Foresight and Planning Office. The flagship initiative "A Journey into the Future of ESA" explored the long-term impact of climate change, AI, regulatory developments, and shifting public–private dynamics. Published in October, the report examined three distinct scenarios to stress-test ESA's assumptions and helped define the strategic goals for Strategy 2040, aimed at ensuring greater resilience in the face of future uncertainties.

To support long-term preparedness, the Office also introduced the Foresight Toolbox – a serious game designed to help teams navigate uncertainty and future-proof their work. Additional tailored foresight projects were carried out in support of ESA programmes, building on a growing body of futures intelligence and further reinforcing strategic resilience across the Agency.

2024 not only set the stage for Strategy 2040 – it redefined ESA's strategic direction for the decades ahead. The initiatives launched and strengthened during this transformative year have firmly positioned ESA to navigate complexity, seize new opportunities, and lead Europe's future in space.

CORPORATE SOCIAL RESPONSIBILITY

Published in September, the ESA Responsibility and Sustainability Report 2022–2023 highlights the Agency's commitment to maximising the societal benefits deriving from space missions while minimising the impacts. ESA continues to refine its own approach while influencing the international space sector, addressing sustainability across three key environments: Earth, Earth's orbit, and the Moon and deep space.

On Earth, the ESA Green Agenda (EGA) programme advances sustainability by integrating space programme benefits and impact reduction efforts. A Sustainability Maturity Assessment tool now helps proposal managers preparing for the 2025 Council meeting at ministerial level (CM25) to communicate programme benefits in a coherent manner. Environmental impacts reduction is also embedded through an updated Life Cycle Assessment (LCA) handbook, due to be finalised in 2025, and a new ecodesign and LCA training programme that was piloted at the end of the year. Sustainability guidelines support the development of sustainability narratives for proposals and clarify the need to allocate a budget for eco-design, so as to ensure sustainability is integrated from the start of all programmes approved at CM25. To cut greenhouse gas (GHG) emissions at ESA facilities, 24 "green" projects have been completed or are nearing completion, with reductions being tracked using a digital tool, Cority, since July. To ensure more sustainable procurement, a new supplier code of conduct and regulation have been introduced.

Covering all environments, the Statement for a Responsible Space Sector continues to shape a strong community of sustainability leaders – with 78 signatory organisations by the end of 2024 – demonstrating ESA's efforts as a role model for space sustainability.

COMMUNICATION

In 2024, the inaugural flight of ESA's new Ariane 6 launcher and the return to flight of Vega-C were of the greatest importance to ESA. Together with its primary partners CNES, ArianeGroup, Avio and Arianespace, ESA's Communication Department implemented communication campaigns to convey the key message that Europe has regained autonomous access to space. One outcome was that the Ariane 6 communication campaign garnered the greatest visibility of all ESA communication campaigns in 2024.

In addition, fully fledged communication campaigns were also implemented for the launches of EarthCARE, Hera, Sentinel-1C, and Proba-3 featuring multiple launch events at the launch sites as well as at ESA ESOC in Darmstadt, combined with national events in various Member States. Based on the live ESA WebTV broadcasts, VIPs could witness the launch, and journalists could report on them. Dedicated merchandising sets, brochures, media kits, videos and infographics were also made available.

On the occasion of the 11th Space Council in Brussels, ESA and the EU celebrated the 20th anniversary of their Framework Agreement and ESA Communication provided extensive proof of the leading role played by ESA for Europe in space: Two ESA astronauts were assigned to their missions to the International Space Station, the winners of the LEO Cargo Return Challenge were announced, and the first scientific images from Euclid were presented. These activities, communicated via media relations and social media postings, positioned ESA as leader in the discussions regarding space matters around the Space Council. ESA's presence implemented by the Communication Department at the Berlin International Airshow (ILA), the Farnborough International Air Show

Visit of German Chancellor Olaf Scholz to the joint BDLI/DLR/ESA stand at ILA in Berlin.

The Ariane 6 inaugural flight communication campaign was ESA's most impactful communication campaign in 2024 and was implemented in close partnership with ArianeGroup, Arianespace and CNES.

and the International Astronautical Congress (IAC) provided many high-quality touchpoints for engagement with the general public and political decision makers.

Seven ESA Days were organised in 2024 in cooperation with Member States through the Advisory Communication Committee . Denmark, Spain, Poland, Germany, the United Kingdom, the Netherlands and Italy, together with ESA each developed a programme combining political networking, edutainment/entertainment for the general public and information for media and implemented these days together at national locations/venues.

The impact of ESA communication activities returned to normal after the outstanding impact achieved in 2023. Global reach in external traditional and social media amounts to 67.4 billion.

RELATIONS WITH MEMBER STATES

In 2024, the Director General visited and exchanged with Member States, using major events as opportunities. In particular, he met ministers and politicians responsible for space matters and related fields, delegations, and addressed parliaments, industry, the press, academic institutions, and the general public whenever possible. Some of these interactions were conducted remotely. Additionally, the ESA Executive maintained regular contact with relevant national entities.

President of the Italian Republic Sergio Mattarella with ESA astronaut Samantha Cristoforetti at the opening ceremony of the 75th International Astronautical Congress in Milan.

EXTERNAL RELATIONS

Relations with the European Union

2024 was a significant year for the development and strengthening of ESA's relations with the EU. In February, ESA, the European Commission and EUSPA held a joint seminar to strengthen coordination and discuss future developments. During the Space Council in May, the Resolution on Strengthening Europe's competitiveness through space was adopted by the ESA Council and debated during a joint formal meeting with the EU. Alongside the Space Council, ESA and the EU also celebrated the 20th anniversary of the Framework Agreement between the two organisations. In December, the EU appointed the first Commissioner for Defence and Space, Andrius Kubilius, in a move that highlighted the growing importance of the space sector. The Director General has held productive bilateral meetings with Commissioner Kubilius, and these high-level meetings are set to continue in 2025. To prepare for 2025 and ESA's CM25, as well as the start of the EU's Multi-Annual Financial Framework process, synergies and interaction with EU partners have been intensified.

International Relations

ESA and Slovenia, in the presence of the Slovenian Prime Minister, signed the Accession Agreement to the ESA Convention on 18 June, setting Slovenia on course to become ESA's 23rd Member State on 1 January 2025.

Mid-term reviews of the association with Latvia, Lithuania and Slovakia were either performed or prepared. The Slovak GRBBeta CubeSat was launched aboard Ariane 6 on 9 July.

The Programme for European Cooperating States (PECS) Committee now comprises Bulgaria, Croatia, Cyprus and Malta. An agreement on the exchange and mutual protection of classified information was negotiated with Cyprus and approved by Council in October. The European Cooperating State Agreement with Malta entered into force on 12 September.

ESA and the Canadian Space Agency (CSA) met twice at Heads of Agency level to review the status of their bilateral cooperation and participation in multilateral undertakings. A mid-term review kick-off meeting was held at ESA Headquarters on 19 June, as stipulated in the 2019 Cooperation Agreement. The Copernicus Space Component Technical Operating Arrangement was signed on 18 June (contingency plan Sentinel-1/RADARSAT Constellation missions). On 16 October, ESA and Kepler Communications, selected as prime contractor for HydRON Demonstration System Element #1, signed the contract for this first phase (ScyLight, ARTES). The Agreement between the Government of Canada and ESA on the Protection of Classified Information was approved by the ESA Council in October. A letter of agreement with Canada regarding the Ariel mission was signed.

A joint statement concerning lunar cooperation signed by the Director General and the NASA Administrator, reiterating potential ESA contributions, such as Argonaut and Moonlight, and NASA's interest in additional ESA capabilities that could support needs identified in NASA's "Moon to Mars" Architecture, as well as those in accordance with ESA's exploration strategy, Explore2040. ESA launched the NASA-sponsored Cubesat Radio Interferometry Experiment (CURIE) on the inaugural flight of Ariane 6. The Agency also delivered to NASA's Kennedy Space Center (KSC) a third European Service Module (ESM-3) for integration with the Orion capsule. Several agreements between ESA and NASA were formalised including implementation arrangements concerning the provision by ESA of the European Service Modules (ESM-2 and ESM-3), the Materials International Space Station Experiment Sample Exchanges (MISSE) and Cooperation on the Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) mission. Memoranda of Understanding (MoUs) entered into force on the LISA mission, Hubble Space Telescope and for cooperation on the ExoMars/Rosalind Franklin mission. The existing MoU on the 2016 ExoMars mission was extended until 2033. A statement of intent for cooperation on the Mass Change and Geoscience International Constellation (MAGIC) was signed.

In view of the finalisation of the joint ESA-China Solar wind Magnetosphere Ionosphere Link Explorer (SMILE) mission, ESA ESTEC set up a special integration hall where the European and Chinese parts of the spacecraft would be assembled by joint teams. SMILE is a joint mission between ESA and the National Space Science Centre of the Chinese Academy of Sciences.

ESA and the Japanese Aerospace Exploration Agency (JAXA) celebrated the successful launch, of their joint EarthCARE mission at the end of May and on 7 October, of the ESA Hera mission, carrying TIRI, a thermal infrared imager provided by JAXA. An ESA-JAXA joint statement on future major cooperations was signed on 20 November by the Director General and the President of JAXA. This joint statement highlights future joint projects building a path forward for the two agencies beyond the current two joint ESA-JAXA missions, namely BepiColombo and EarthCARE. These identified joint projects, intended to progress at a different pace, address planetary defence, Earth observation, Low Earth Orbit and exploration activities, and space science. The joint statement was the culmination of very productive work carried out by teams from both agencies throughout the year. The Director General participated in the Nihonbashi Space Week in Tokyo and was able to meet four European start-ups which had won a competition to participate in the event with ESA's support.

On 27 March, the Chairman of the Indian Space Research Organisation (ISRO), Shri Somanath, addressed ESA Council Heads of Delegation at ESA Headquarters at the invitation of the Director General. Mr Somanath presented ISRO's current programmes and India's space ambitions, as well as his views on the ever-growing cooperation between ESA and ISRO. The Director General and ISRO Chairman had previously called for a reinforcement of ESA-ISRO cooperation in 2022 and, to that end, dedicated joint working groups met in 2024 to identify concrete cooperative projects in space science, Earth science, human spaceflight, operations, navigation and planetary defence. ESA participated in the Bengaluru Space Expo 2024 on 17–20 September. On 19 December, the Director General and the Chairman of ISRO signed an agreement to deliver the richest results possible from the upcoming Axiom-4 mission featuring an ESA and an ISRO astronaut.

In December, ESA and the United Arab Emirates Space Agency signed a framework Memorandum of Understanding allowing for collaboration across all space domains.

Latin American and Caribbean companies attended for the first time the ESA Industry Space Days held at ESTEC in September. European companies took the opportunity to forge new ties with those entities.

An Open Week for the Deep Space Antenna in Malargüe, Argentina, including the inauguration of a Gaia booth at the local planetarium, was held between 28 October and 2 November, gathering representatives from the municipality, the Province of Mendoza, the Ministry of Foreign Affairs and the Argentinian space agency, CONAE.

ESA History Project

Under the ESA History Project was published, in French and English, *From Space to Paris, The History of the European Space Agency Headquarters* (Paris, Autrement/Flammarion, 13 December 2024).

An ESA-JAXA Joint Statement on Future Major Cooperations was signed on 20 November by the President of JAXA and the Director General of ESA

ANNEX

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ANNEX 1

Advisory bodies

ESA advisory groups can be divided into two categories: advisory groups to ESA delegate bodies and advisory groups to the ESA Director General.

ADVISORY GROUPS TO ESA DELEGATE BODIES

Council Advisory Group

- Oversight Committee (OC)

AFC Advisory Group

- Pension Buffer Fund Management Board (PBF-MB)

IPC Advisory Groups

- Technology Harmonisation Advisory Group (THAG)
- Technology Advisory Working Group (TA-WG)
- Industrial Policy Evolution Working Group (IPE-WG)

JCB Advisory Groups

- 5G Advisory Committee (5JAC)
- Space Systems for Safety and Security (4S) Advisory Committee
- Optical Communication - ScyLight Advisory Committee (SCOTT)

PB-EO Advisory Group

- Data Operations Scientific and Technical Advisory Group (DOSTAG)

PB-HME Advisory Group

- Exploration and Utilisation Board (EUB)

SEC Advisory Groups

- ESA INFOSEC Panel
- ESA Industrial Security Panel

ADVISORY GROUPS TO THE ESA DIRECTOR GENERAL

Science Advisory Committees

- Space Science Advisory Committee (SSAC)
- Advisory Committee for Earth Observation (ACEO)
- GNSS Science Advisory Committee (GSAC)
- Human Spaceflight and Exploration Science Advisory Committee (HESAC)
- Space Situational Awareness Advisory Group (SSA-AG)

Science Working Groups

- Astronomy Working Group (AWG)
- Life Sciences Working Group (LSWG)
- Physical Sciences Working Group (PSWG)
- Solar System Exploration Working Group (SSEWG)

Other Advisory Groups

- Advisory Communication Committee (ACC)
- Advisory Committee on Education (EXP-ACE)

ANNEX 2

International Agreements signed in 2024

The following international agreements and acts between the Agency and third parties were concluded or entered into force in 2024, issued in the ESA/LEG series accordingly:

LEG/571: The Letter of Agreement between the European Space Agency (ESA) and the Canadian Space Agency (CSA) regarding the Ariel Mission

LEG/572: The Administrative Arrangement between the ESA and the European Union Satellite Centre concerning their continued Cooperation

LEG/573: The Agreement between the European Space Agency and the European Union on the Security and Exchange of Classified Information

LEG/574: The Memorandum of Understanding between ESA and NASA concerning the Laser Interferometer Space Antenna (LISA) Mission

LEG/575 : The Memorandum of Understanding between NASA and ESA concerning Cooperation on the ExoMars/Rosalind Franklin Mission

LEG/577: The Memorandum of Understanding between NASA and ESA concerning the Envision Mission

LEG/578: The Implementing Arrangement between ESA and NASA for cooperation on the Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) Mission

LEG/579: The Implementing Arrangement between the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the European Space Agency (ESA) concerning cooperation on the Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) Mission

LEG/580: The Implementing Arrangement between The European the Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the European Space Agency (ESA) concerning cooperation on the Copernicus Imaging Microwave Radiometer ("CIMR")

LEG/581: The European Cooperating State (ECS) Agreement between the European Space Agency and the Government of the Republic of Malta

LEG/581, add. 1: The Plan for European Cooperating State (PECS) Charter between the European Space Agency and the Government of the Republic of Malta

LEG/582: The Agreement between the European Space Agency and the Government of the Republic of Slovenia regarding the Accession of the Republic of Slovenia to the ESA Convention and related terms and conditions

LEG/583: The Memorandum of Understanding between the European Space Agency and the UAE Space Agency concerning Space Cooperation for Peaceful Purposes

LEG/584: The Contribution Agreement between the European Union, represented by the European Commission, and the European Space Agency on the SCOPE (EU-ASEAN Sustainable Connectivity Package) Digital

LEG/585: The Contribution Agreement between the European Union, represented by the European Commission, and the European Space Agency on the Africa-EU Space Partnership Programme

LEG/586: The Agreement between the European Space Agency and the Indian Space Research Organisation concerning Cooperation on Activities related to Astronaut Training, Mission Implementation and Research Experiments

ANNEX 3

List of Communication events organised in 2024

MONTH	EVENT
9 January	Einstein Probe launch
11 January	Director General's annual press conference
17 January	Axiom-3: Muninn mission (Marcus Wandt) launch, Florida
23–24 January	16th European Space Conference, Brussels
26 & 30 January	Media events Ariane 6, Airbus Bremen and Les Mureaux
6 February	Axiom-3: Muninn mission (Marcus Wandt) return
7 February	Advisory Communication Committee Meeting
21 February	ERS-2 atmospheric re-entry
12 March	Huginn mission (Andreas Mogensen) return
20 & 22 March	Media event Ariane 6, European Spaceport, Kourou
3 April	Media event Proba-3, Antwerp
4 April	Media event Arctic Weather Satellite, Stockholm
22 April	Astronaut class 2022 graduation, ESA EAC, Cologne
23 April	Advisory Communication Committee Meeting
27 April	Einstein Probe, first images
28 April	Galileo Launch 12, Florida
22 & 23 May	Space Council, Brussels, Belgium
28 May	EarthCare launch, Vandenberg
5 June	Ariane 6, Pre-launch press conference
5–9 June	ILA, Berlin
9 July	Ariane 6 inaugural flight, European Spaceport, Kourou
19 July	Media briefing Fly! Study, John McFall

MONTH	EVENT
22–26 July	Farnborough International Airshow
16 August	Arctic Weather Satellite and Phisat-2 launch, Vandenberg
19 & 20 August	Juice first ever lunar-Earth FlyBy
4 September	Sentinel-2C launch, Vega, European Spaceport, Kourou
6 September	Cluster targeted re-entry
18 September	Galileo Launch 13, Florida
24 September	Media visit Sentinel-1C, Thales Alenia Space, Cannes
24 September	Media visit Hera, ESA ESTEC, Noordwijk
25 September	Inauguration of LUNA astronaut training facility, EAC, Cologne
30 September	Association of Space Explorers Planetary Congress, ESA ESTEC
2 October	King of the Belgians at EAC, Cologne
3 October	Vega-C test of Zefiro 40, Salto di Quirra, Sardinia
7 October	Hera launch, Florida
14–18 October	International Astronautical Congress, Milan
16 October	Advisory Communication Committee Meeting
29 October	Proba-3 Media event, Spain
29 October	MetOp media event, Airbus, Toulouse
4–8 November	Parabolic Flight Days with members of the Astronaut Reserve
28 November	Advisory Communication Committee Meeting
4 December	Proba-3 launch, India
5 December	Sentinel-1C launch, Vega-C return to flight, Kourou

ANNEX 4

List of ESA Publications in 2024

The following publications were produced for the ESA Communication Department:
ESA impact Q1, Q2, Q3, Q4 plus 2 special editions for Council
ESA Highlights 2024 (print and interactive version)
ESA Christmas Cards 2024
Ariane 6 paper model brochures, 1st and 2nd edition
Vega-C paper model brochure
Space Rider paper model brochure
Muninn mission book
Ariane 6 launch kit
ESA Annual Report 2023
ESA Strategy 2040
ESA Responsibility and Sustainability Report 2022–2023

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Focus on programmes, activities and directorates

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04	DIRECTOR GENERAL'S FORWORD	*© ESA*

Science and exploration

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Applications

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Snapshot of a peculiar spiral.

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