→ THE EUROPEAN SPACE AGENCY

POWERING EUROPE'S SPACE AMBITION

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GAIA NIR Workshop

15-16th of July 2025

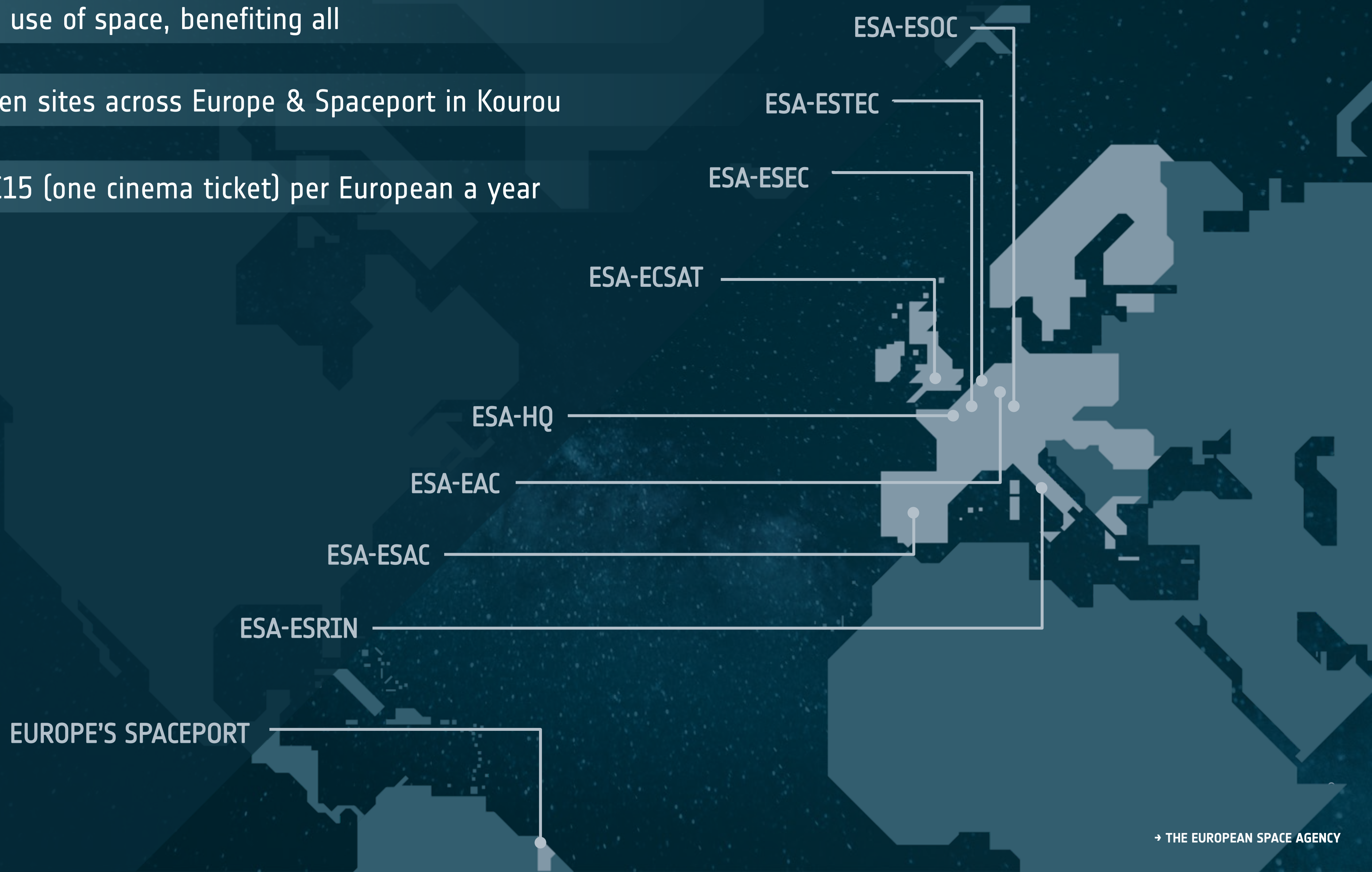
We are committed to the peaceful exploration and use of space for the benefit of people, society and our planet

WHO 23 Member States, 2500+ staff members and total workforce of 6000+

WHY For the peaceful use of space, benefiting all

WHERE HQ in Paris, seven sites across Europe & Spaceport in Kourou

BUDGET €7.79 billion = €15 (one cinema ticket) per European a year



esa

ESA-ESOC

The European Space Operations Centre, Darmstadt, Germany, tracks and controls European spacecraft.

ESA-ESTEC

The European Space Research and Technology Centre, Noordwijk, the Netherlands, the technical heart of ESA.

ESA-ESEC

The European Space Security and Education Centre in Belgium is part of ESA's ground station network and specialises in operating small satellites and sensitive, security-related operations.

ESA-ECSAT

Harwell Centre, in Oxfordshire, UK, focuses on telecommunications and business applications but also in climate change, technology and science.

ESA-HEADQUARTERS

In Paris, France, lies ESA's administrative nerve centre. It houses the Director General, the Cabinet and some of ESA's directors, driving the agency's strategic vision.

ESA-EAC

The European Astronaut Centre, Cologne, Germany, trains astronauts for missions to the International Space Station and beyond.

ESA-ESAC

The European Space Astronomy Centre, Spain, is home to ESA's astronomy, fundamental physics, solar science and planetary missions.

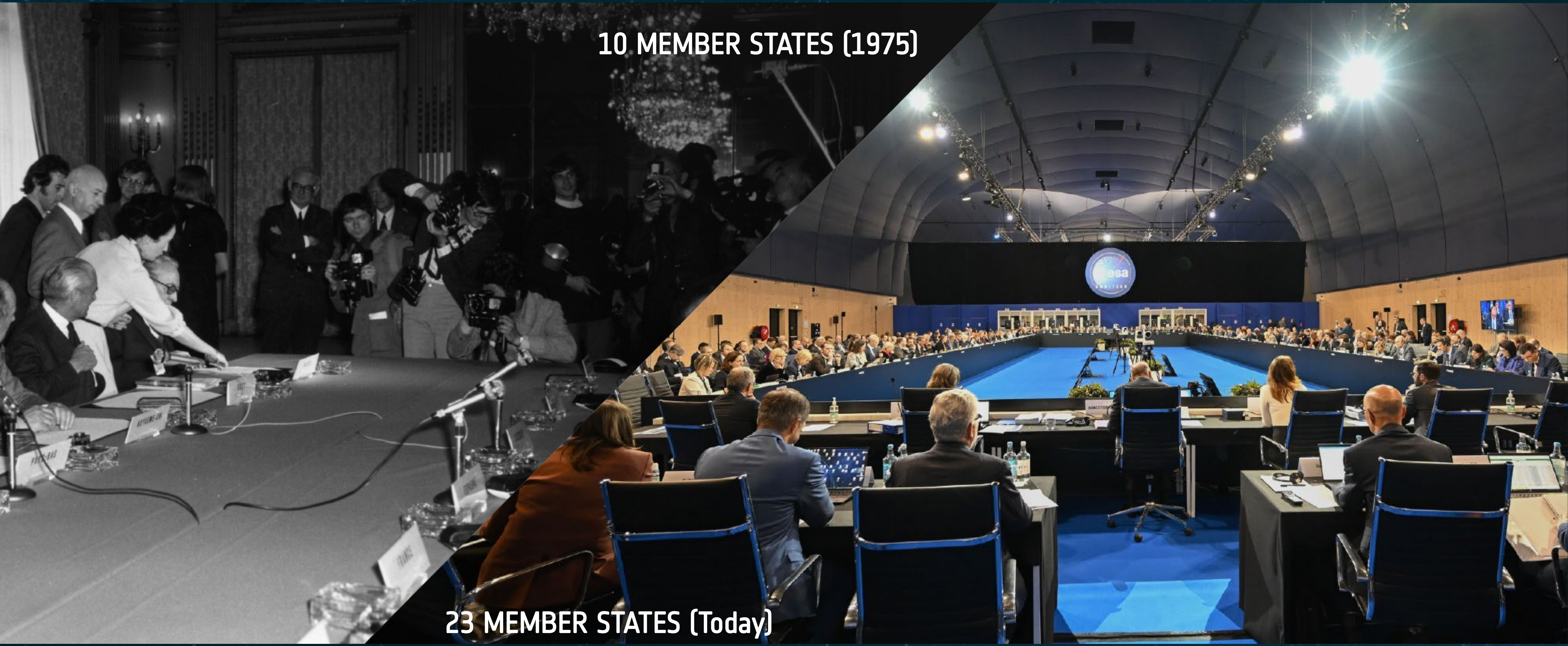
ESA-ESRIN

The European Space Research Institute in Frascati, Italy, is ESA's centre for Earth observation and home to the Vega launcher programme.

EUROPE'S SPACEPORT

SCOPE	Active across every area of the space sector
EXCELLENCE	World leader in space science & technology
MISSIONS	100+ satellites and spacecraft since 1975
SPACEPORT	295+ launches from Kourou since 1979

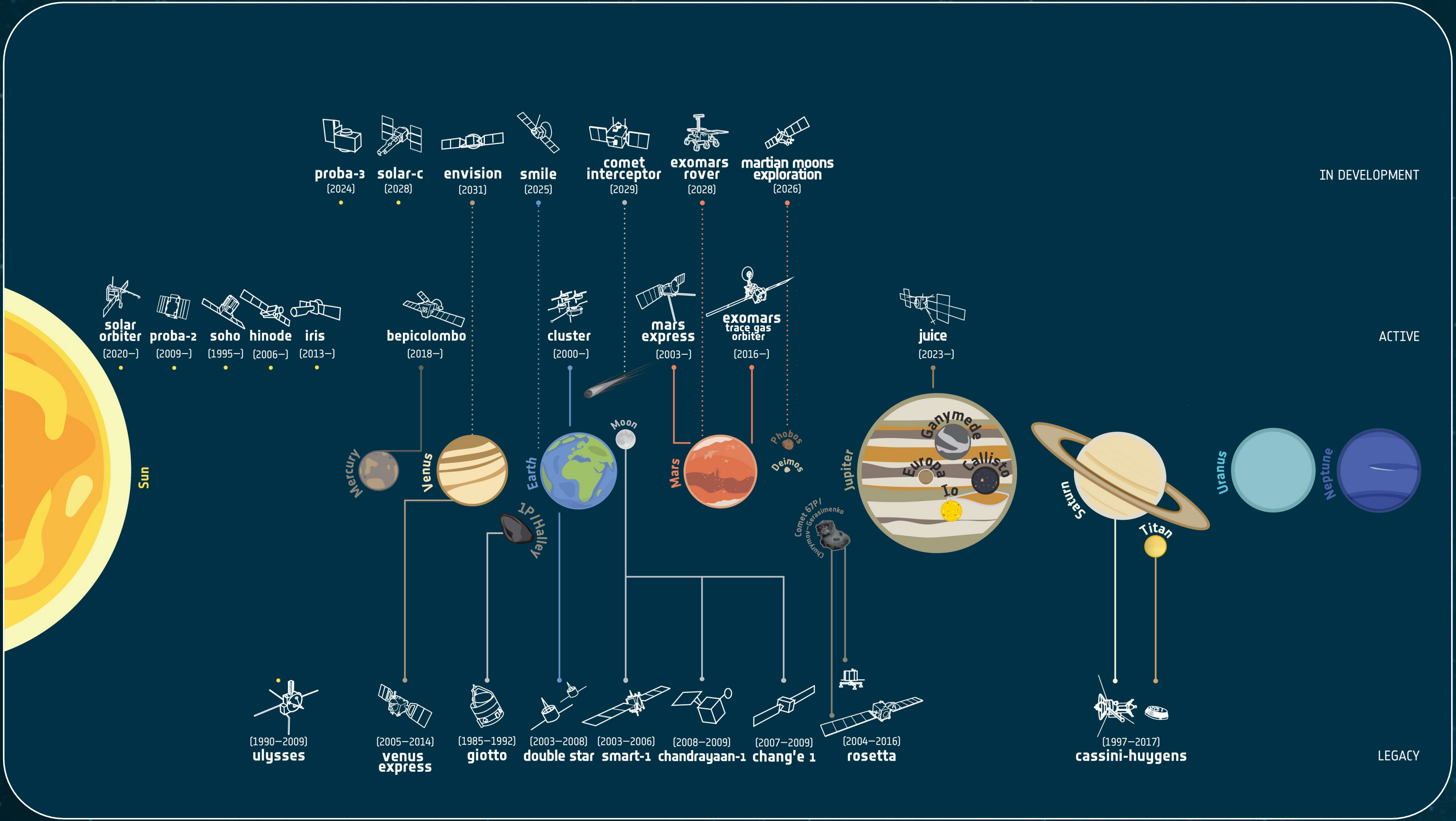
ESA evolution



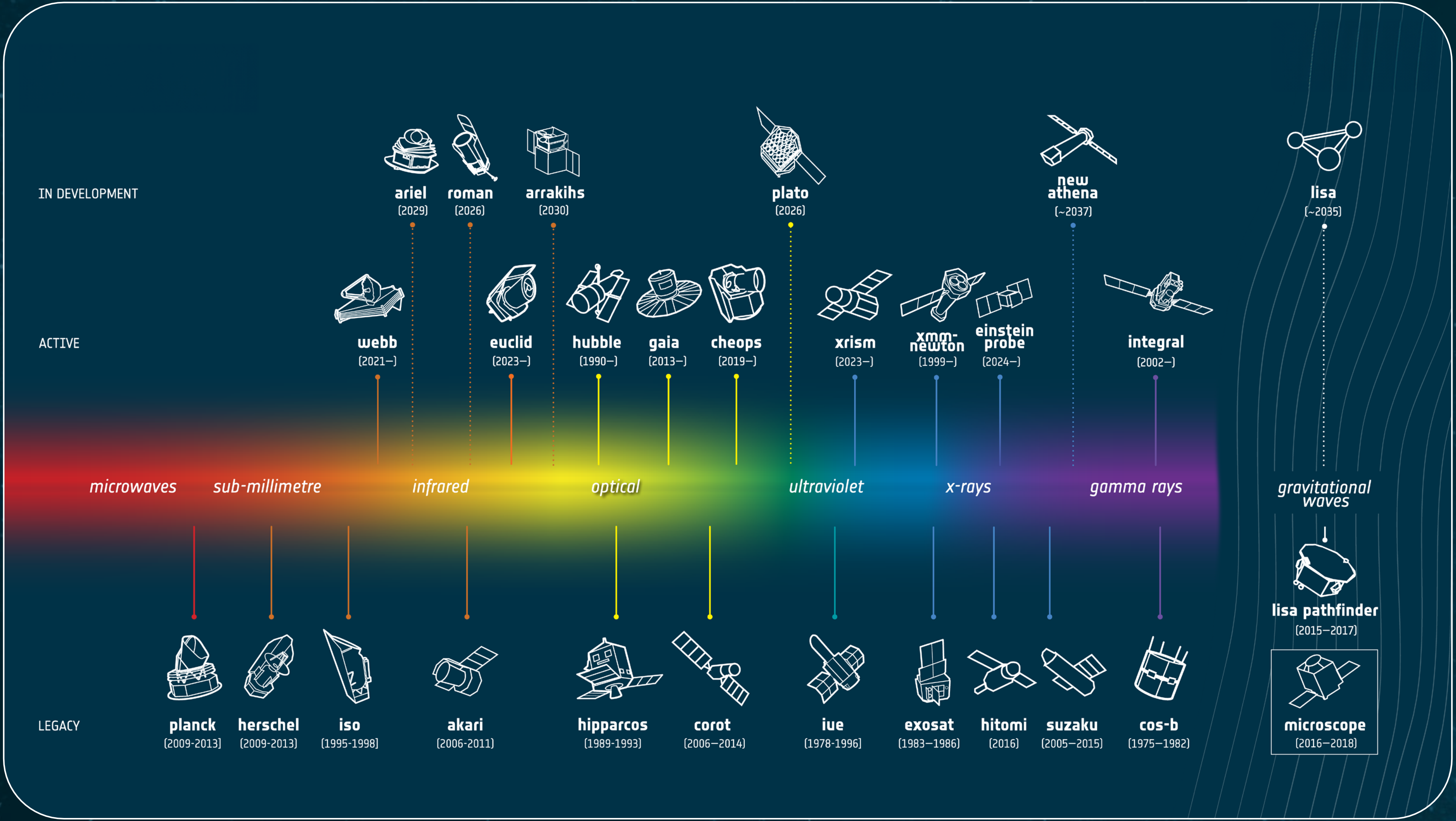
Who benefits?

SCIENCE & EXPLORATION

Solar System Explorers



Cosmic Observers

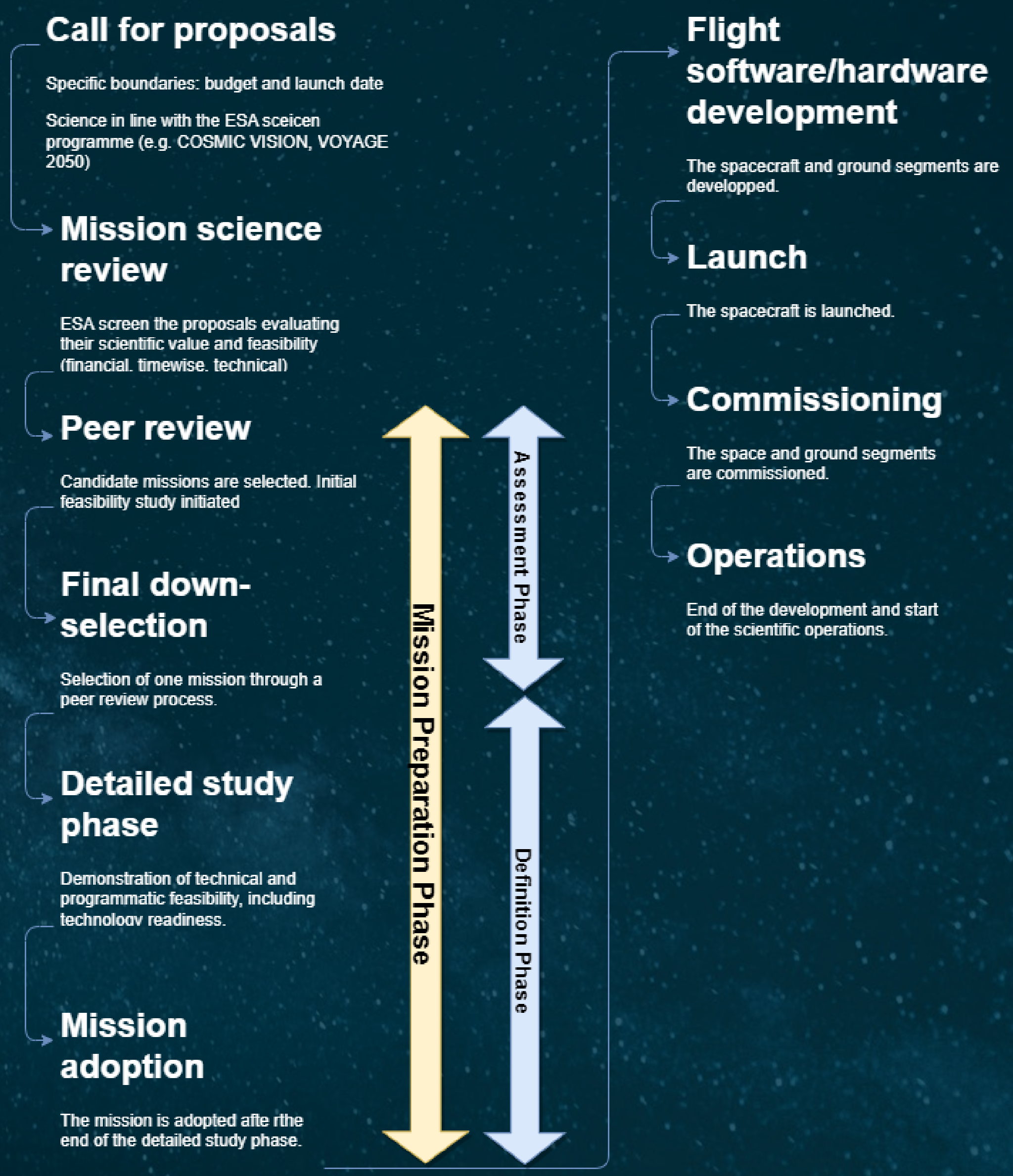


What is a spacecraft?

- Spacecraft includes
  - Service module:
    - Interface with the launcher
    - Thermal control
    - Propulsion and reaction control
    - Command and data management
    - Power generation
    - Attitude and orbit control (AOCS)
    - Communication with Earth
  - Payload module:
    - Scientific instruments and their sub-systems
      - Calibration
      - Detectors' electronics
      - House keeping sensors (temperature, etc...)

Mission phases

- More details available here
- The success of a mission is based on a successful Preparation Phase
  - Requirements definition down to sub-systems
  - Critical Technology development
  - Feasibility critically assessed
  - Definition of the Development philosophy



Interactions with Industrial partners

- Stating the obvious: industrial partners and the scientific community may not “speak” the same language
  - Science ➔ express a need
  - Industry ➔ implementation according to a set of requirements
- The Preparation Phase lead by ESA ensures:
  - Early involvement of potential industrial Primes
  - Clear definition of critical requirements and interfaces from the expressed needs
  - Common understanding on the mission objectives and its implementation during all the development phases including operations
- **Clear needs expressed as specification of clear requirements is key to ensure a successful implementation**

Valid Requirement

Valid requirement

Completeness

- All necessary aspects of the system are covered by the requirements.
- No essential functionality or behavior is missing.

Consistency

- Requirements do not contradict each other.
- There are no conflicting expectations or dependencies.

Clarity and unambiguity

- Requirements are written in a clear, concise, and understandable manner.
- There is no room for misinterpretation or multiple interpretations.

Verifiability

- Requirements can be tested or verified to ensure they have been met.
- Measurable criteria are defined to assess compliance.

Traceability

- Requirements can be traced back to their source (stakeholder needs, business goals).
- Changes to requirements can be tracked and assessed for impact.

Correctness

- Requirements accurately reflect the intended functionality and behavior of the system.
- They align with the overall system goals and user needs.

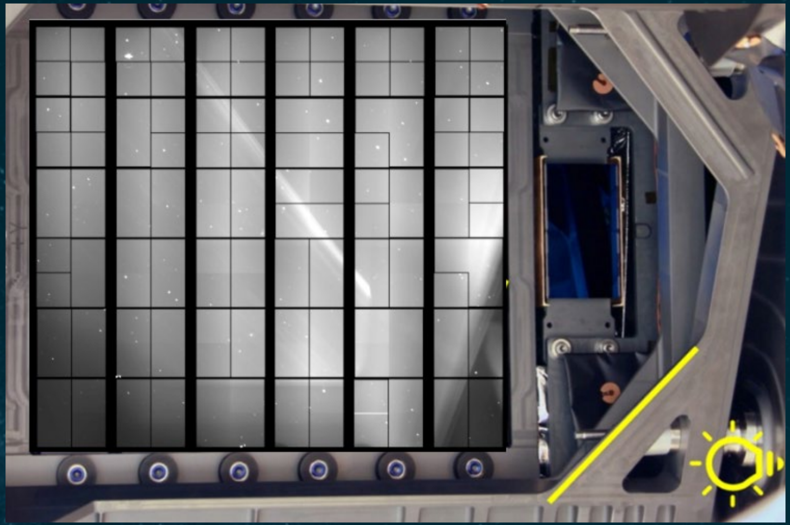
Realizability

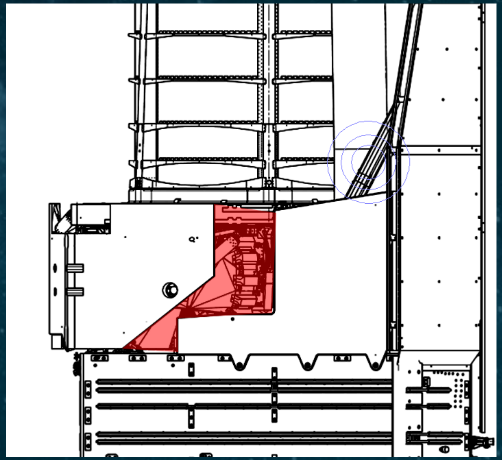
- Requirements can be implemented within the given constraints (time, budget, technology).
- The solution is feasible and practical.

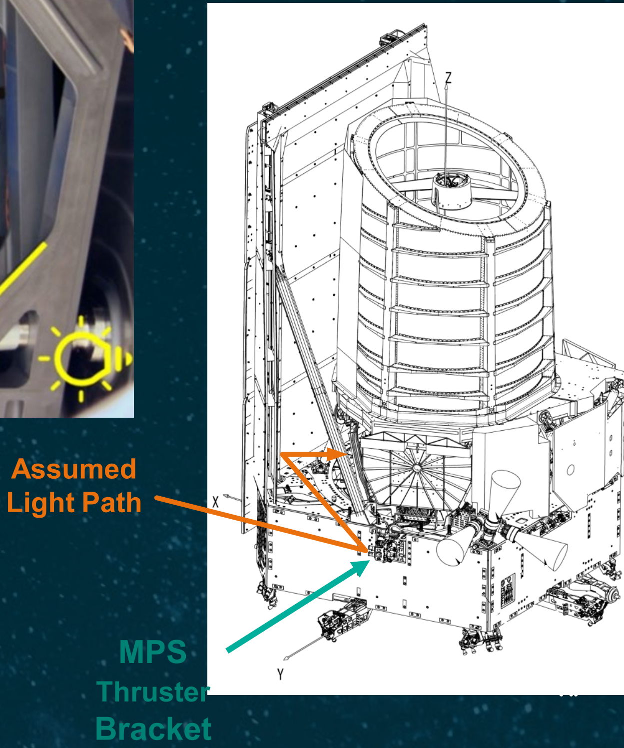
What could go wrong? Euclid Unexpected straylight

- Straylight on VIS focal plane for specific orientations of the S/C w.r.t. the sun
- Straylight is 'out-of-field', i.e. it does not come through the telescope but through an opening in the MLI around the PLM cavity
- Levels and pattern of straylight change with the spacecraft attitude.
  - Removal of straylight by post-processing is possible and complex.
  - The residuals are deemed too high and impacting the overall scientific performance.

- Original "sin": early decision in the Preparation phase to shield the instruments cavity only with MLI ➔ diffracted/reflected sunlight goes through

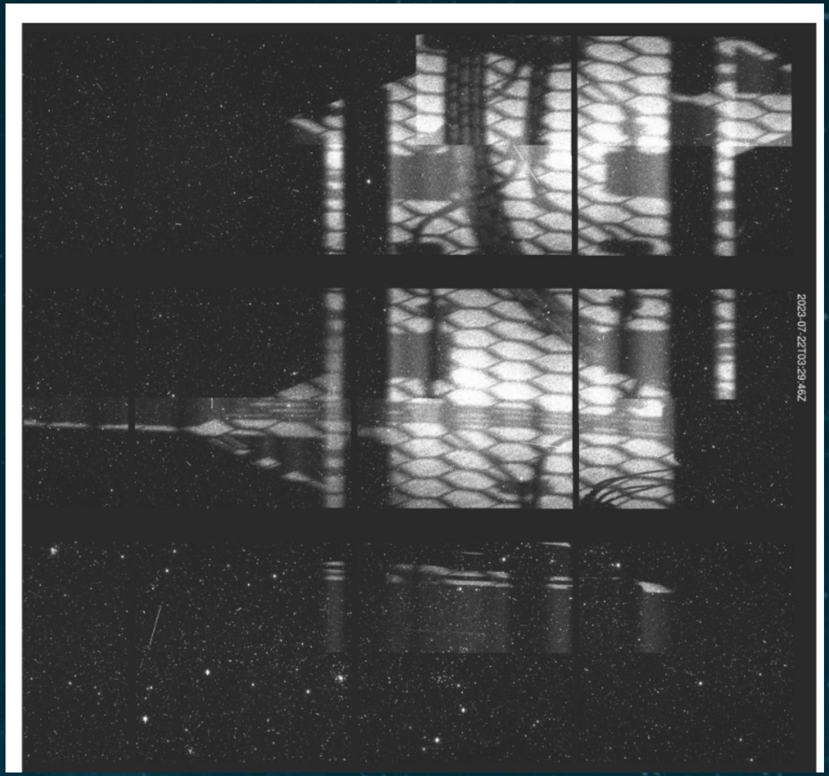






What could go wrong? Euclid as an X-ray imager

- Anomaly
  - Unexpected features on VIS focal plane appearing for short periods (typically <1h) and frequency of ~1/day
  - Feature position on FPA moves with SSA/alpha
- Root Cause
  - Not all X-Rays from Solar flares are shielded before the hit the VIS Focal Plane, CFRP used on the SSH structure not sufficient
  - A thin layer of Silicon or metal would be enough to completely block the x-rays, but there was no requirement to shield the VIS FPA from solar x-rays and therefore not dedicated shielding was placed

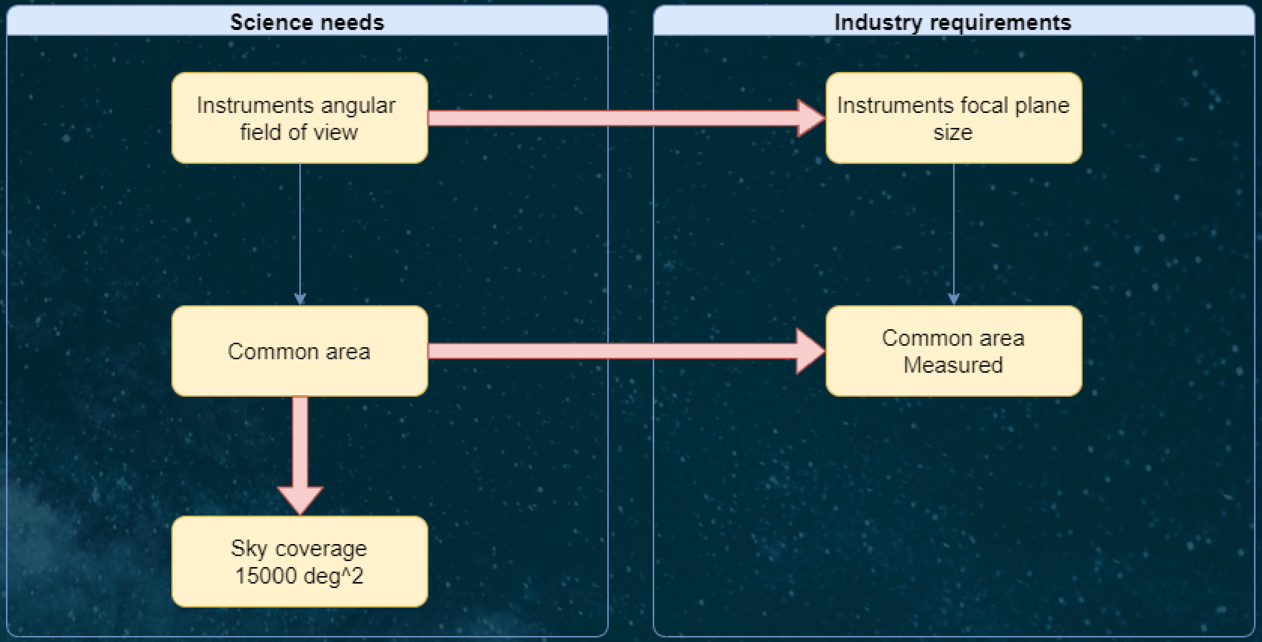


- Original "sin": although the X-ray environment was given, no explicit requirement was given to industry to shield it.

What could go wrong? Euclid's Field of view smaller than expected

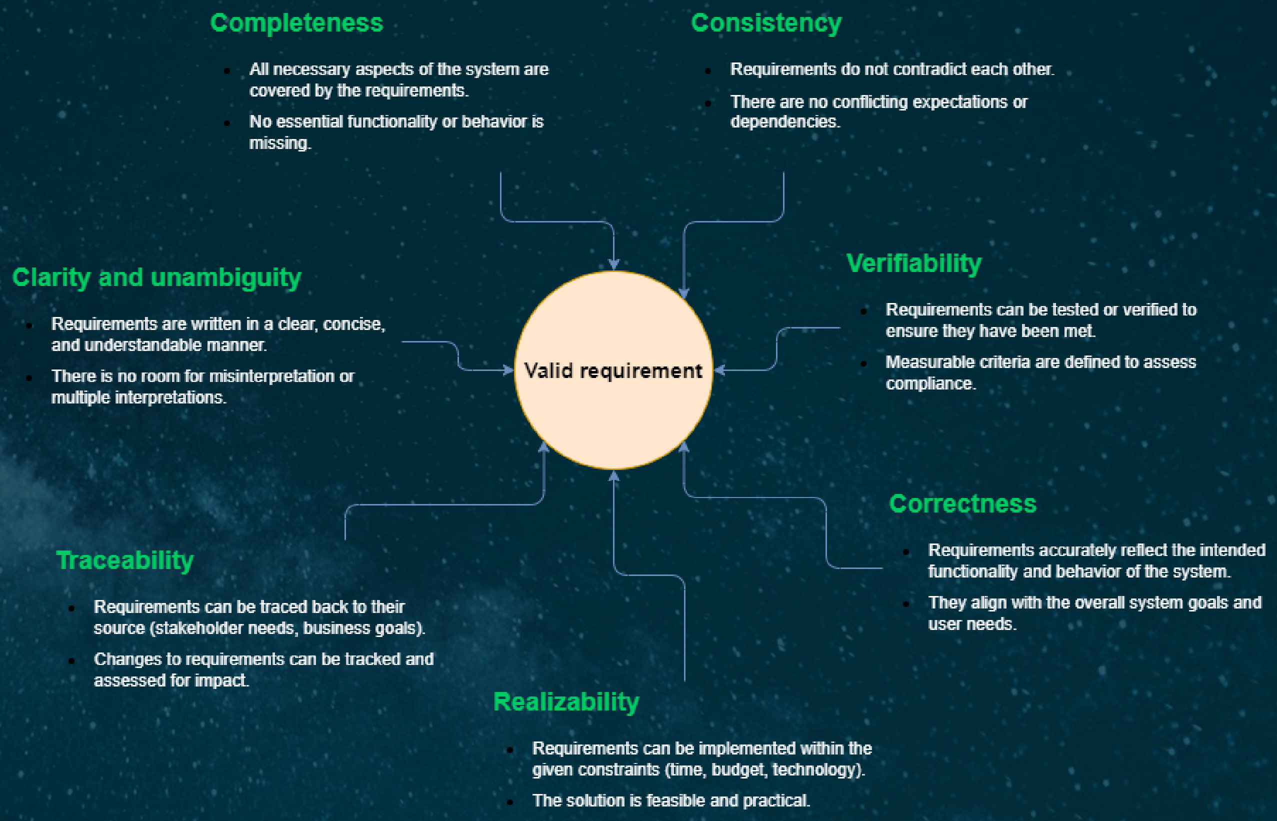
- Measured Common area is SMALLER than the value specified.
- Still the results of industry are COMPLIANT with their requirements

- Original "sin": the specified focal plane sizes are smaller than the actual focal planes manufactured. This is to be expected since the actual sizes were not known when the requirements were defined.



Conclusions

- Ambiguities and mis-communication are often the root causes of the issues encountered in the implementation phase.
- The Preparation Phase is key to clarify the needs and expressed them in terms of requirements to industry.
- BE VALID!



ESA astronauts

Eleven career astronauts:

- Flying missions to the International Space Station (ISS)
- Artemis missions to the Moon

International Space Station

- An international partnership of Europe, Japan, Russia, Canada and the US
- One of the greatest joint scientific endeavours in history and a hallmark of peaceful cooperation
- A scientific laboratory in microgravity
- Close to half the modules of the ISS have been built in Europe
- Since 2008, Europe's ‘place in space’ has been the Columbus lab
- ESA, with European industry, will develop a commercial service to transport cargo to and from the ISS by 2030

Europe is the no. 1 partner to the US in the Artemis programme:

- Building the European Service module for the Orion vessel
- Building three of the Gateway's five modules

ExoMars Rosalind Franklin Mission:

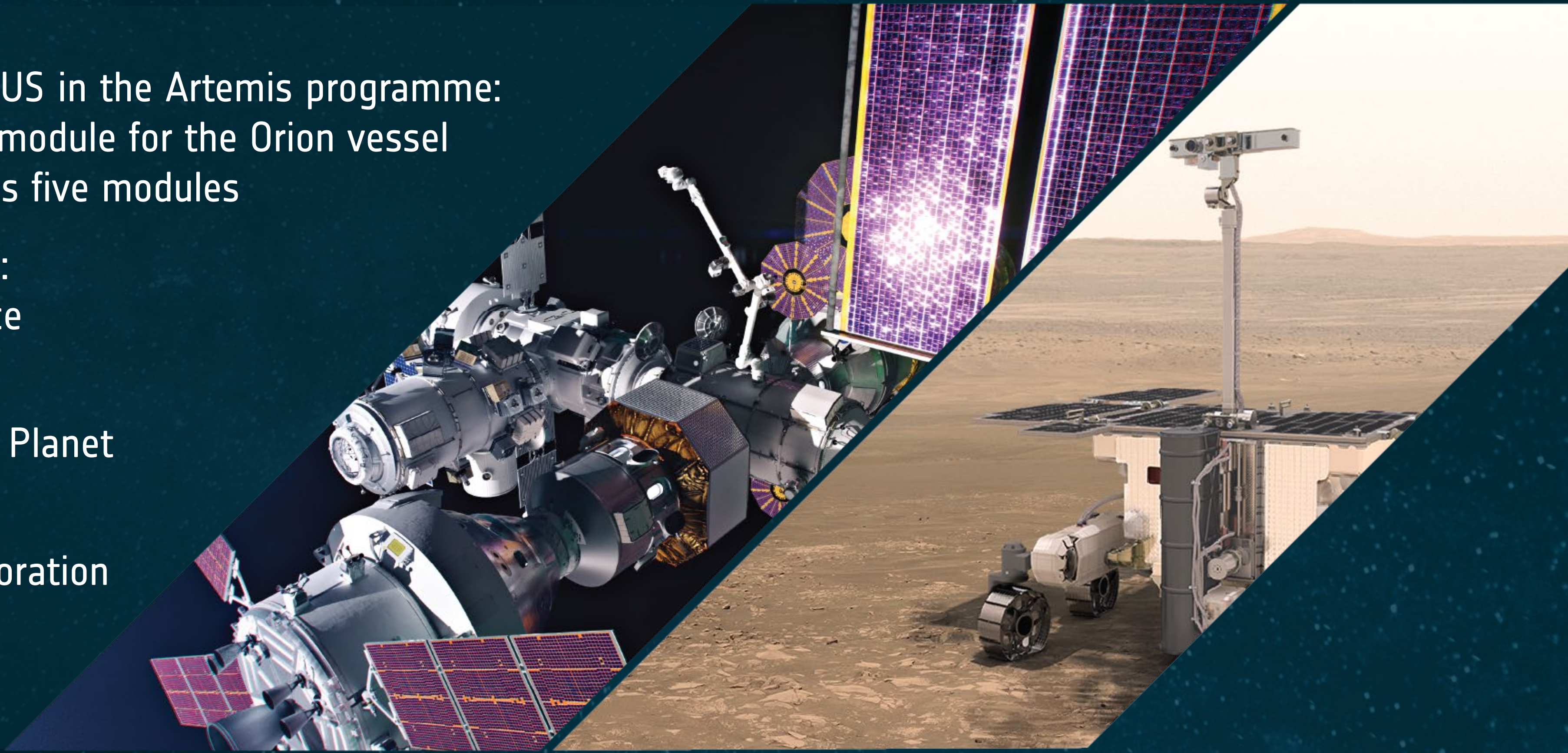
- Drilling into the Martian surface

Mars Sample Return:

- The first round-trip to the Red Planet

Argonaut:

- Will support international exploration on the Moon's surface



ENABLING & SUPPORT

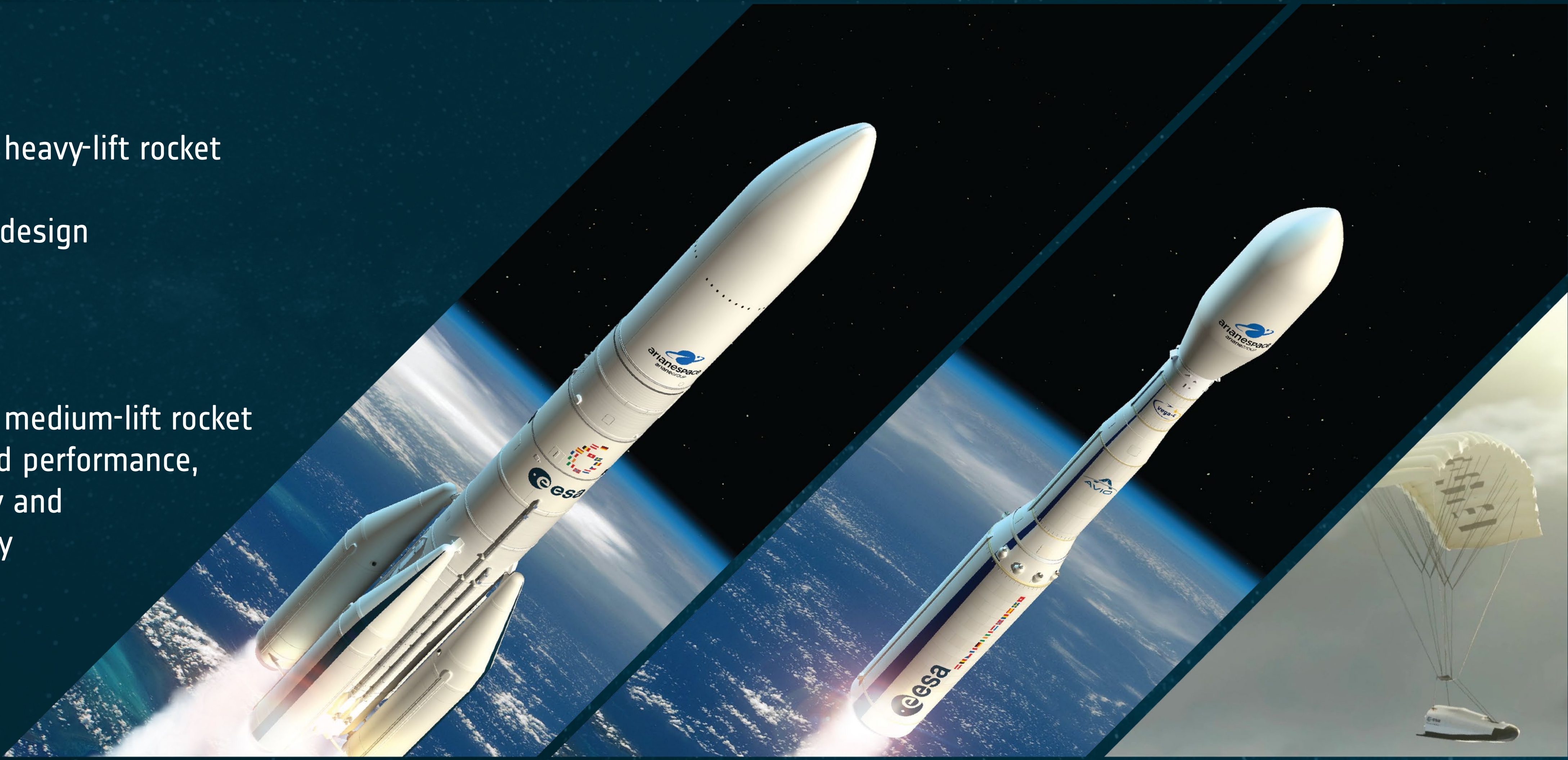
Powering Europe into space

Ariane 6

- Europe's heavy-lift rocket
- Versatile
- Modular design

Vega-C

- Europe's medium-lift rocket
- Improved performance, efficiency and versatility



Mission control

- ESA's mission controllers fly spacecraft that watch our planet, voyage in our Solar System, study the cosmos or observe our active Sun.
- Spacecraft dynamics experts ensure spacecraft stay on track and reach their final destination, sometimes millions of kilometres away.
- Engineers develop cutting-edge ground software systems to enable secure operation and exploitation of even the most complex missions.

ESA ground stations

- Our core network includes nine dish antennas in seven countries, connecting satellites with ESA mission control.
- We constantly evolve the network to support the rapidly growing amount of scientific data from future missions.
- These antennas reliably communicate and deliver science data to and from spacecraft both in Earth's orbit and far beyond.
- Our Space Cyber Security Operations Centre protects our missions against cyber-attacks.

Space technology

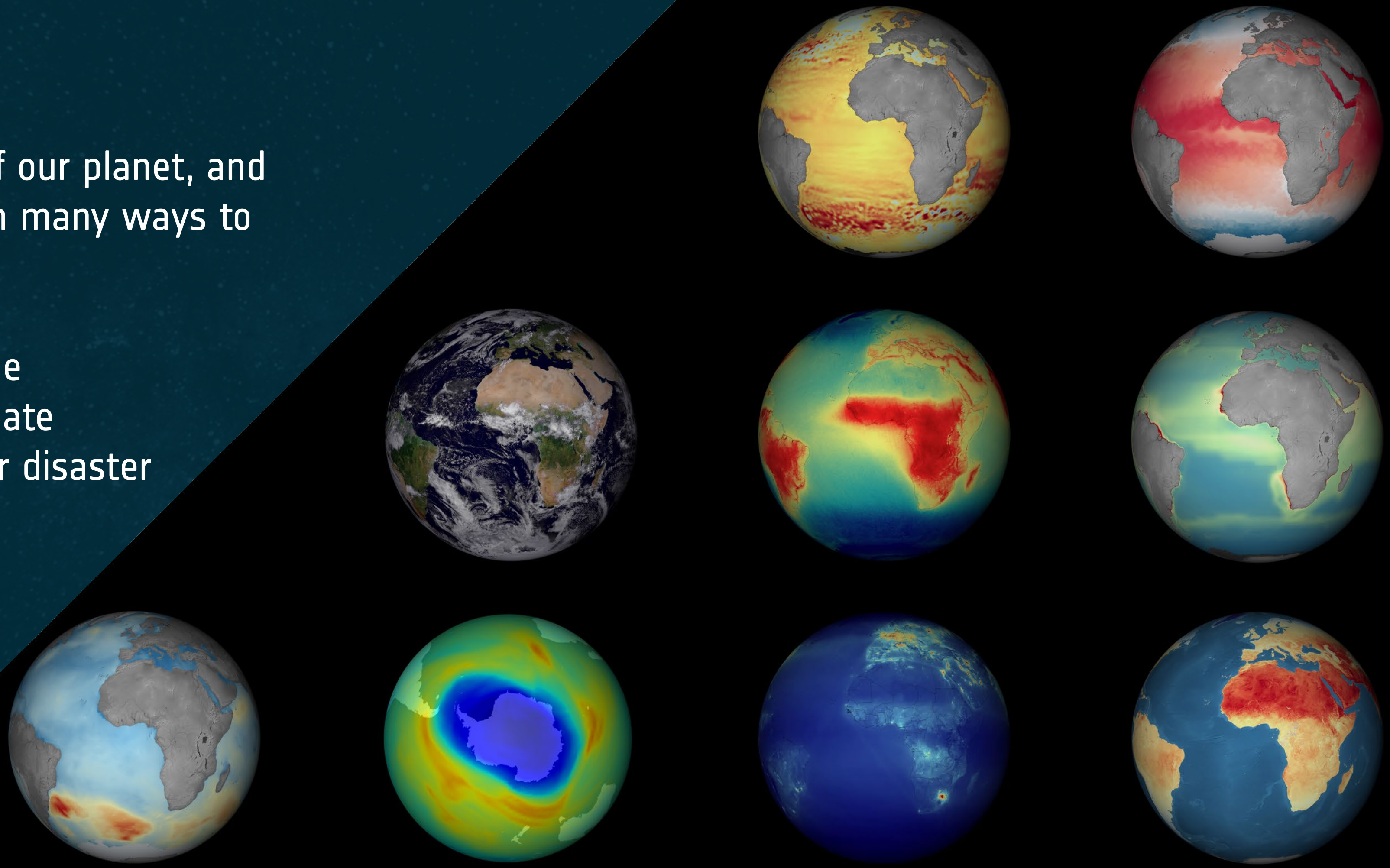
- Europe's leadership in space comes from ongoing innovation through ESA's research and development programmes, preparing technologies for future missions.
- **35 technical labs** and a **3000 m² test centre** ensure readiness for space products.
- ESA combines expertise in spaceflight with testing capabilities while training Europe's next generation of space engineers through education initiatives.

APPLICATIONS

esa

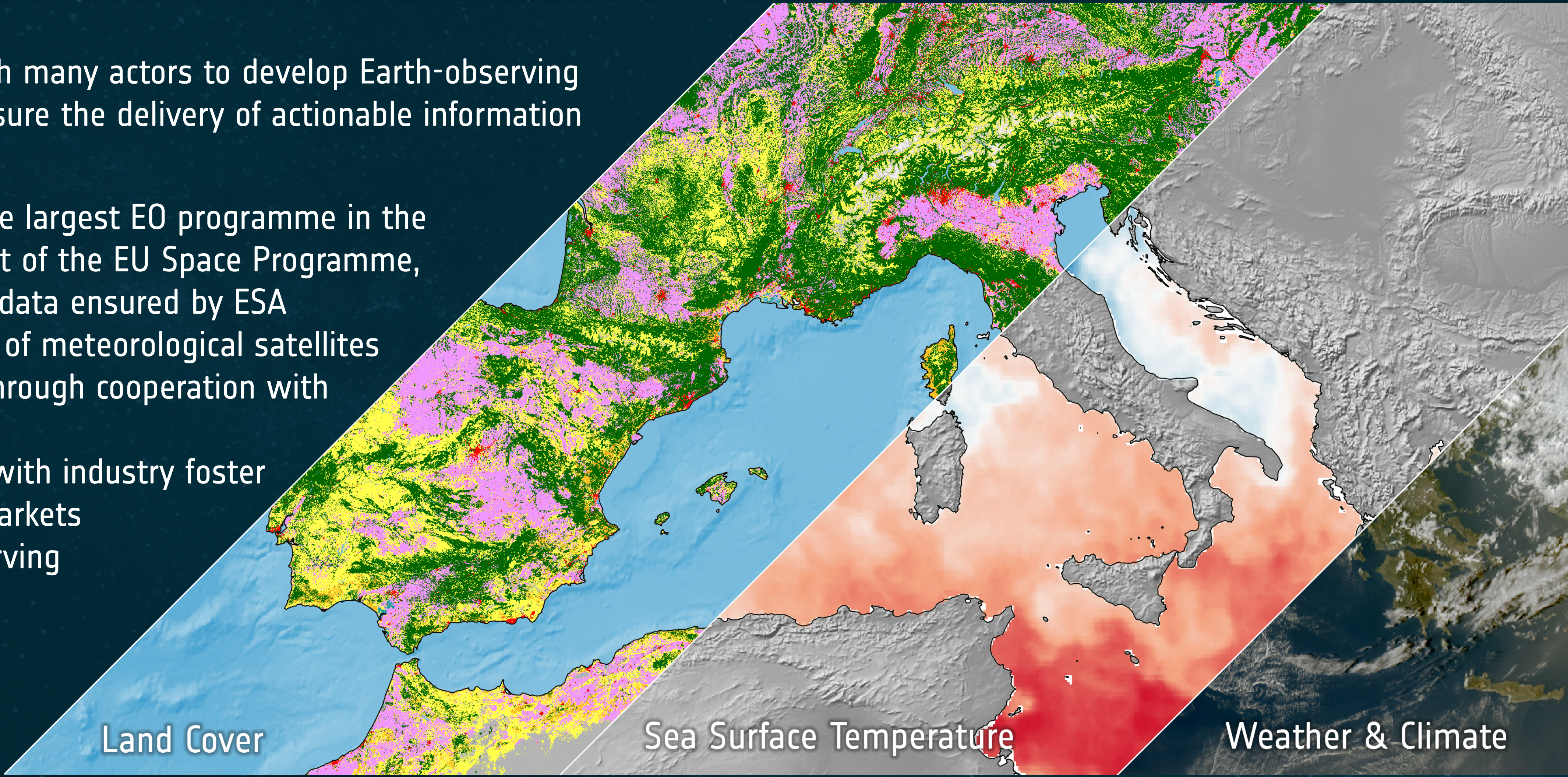
Satellites offer an unparalleled view of our planet, and enable us to observe and contribute in many ways to sustainable life on Earth including to:

- Provide essential information on the environment and our changing climate
- Help plan rescue and aid work after disaster
- Forecast weather patterns
- Answer important questions on Earth's systems



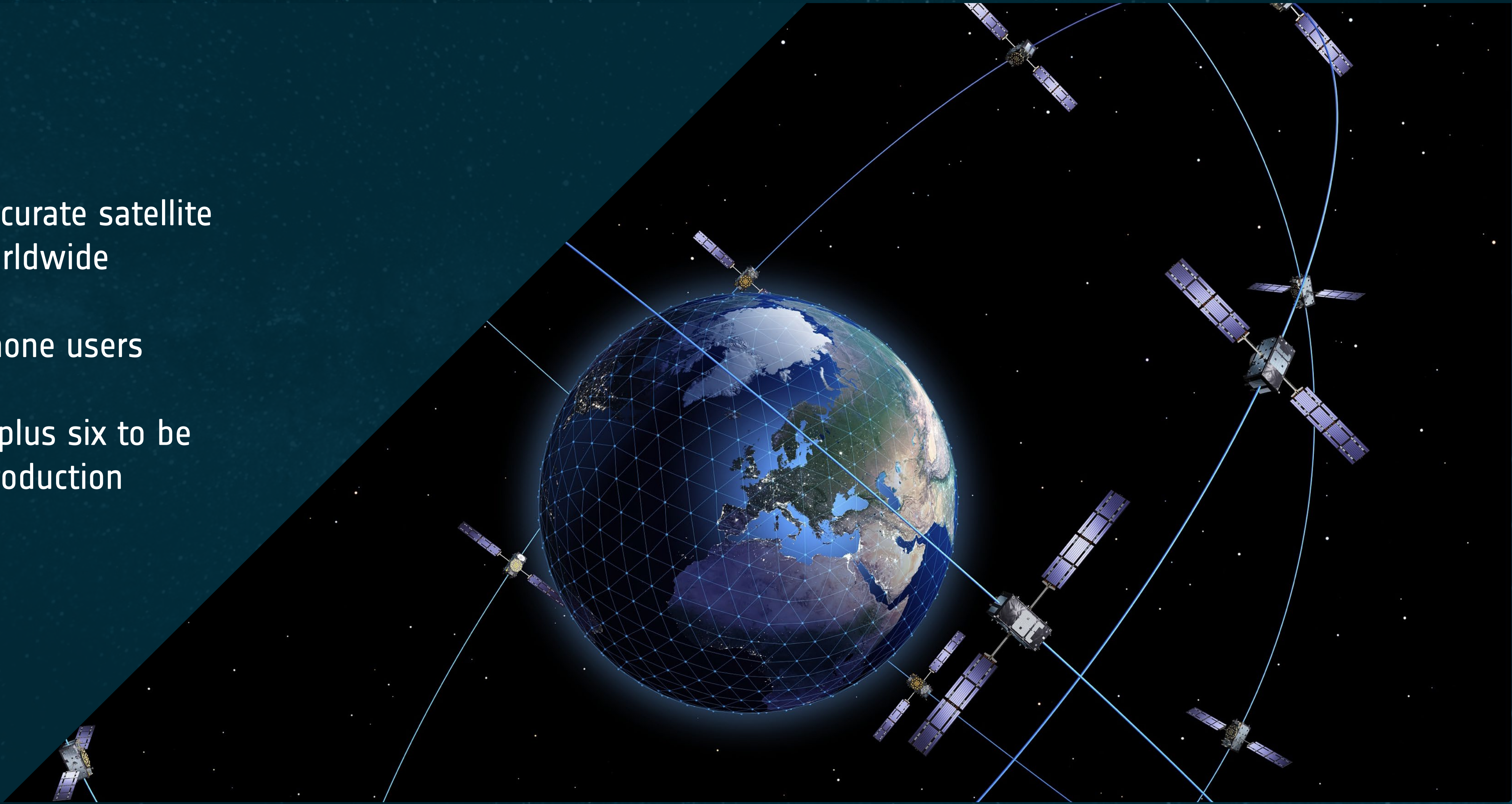
ESA partners with many actors to develop Earth-observing satellites and ensure the delivery of actionable information from the data.

- Copernicus, the largest EO programme in the world and part of the EU Space Programme, with satellite data ensured by ESA
- Europe's fleet of meteorological satellites are enabled through cooperation with EUMETSAT
- Partnerships with industry foster commercial markets of Earth-observing satellites



Navigating on Earth and beyond

- Galileo is the most accurate satellite navigation system worldwide
- Over 4 billion smartphone users
- 32 satellites in orbit, plus six to be launched and 12 in production



European Geostationary Navigation Overlay Service:

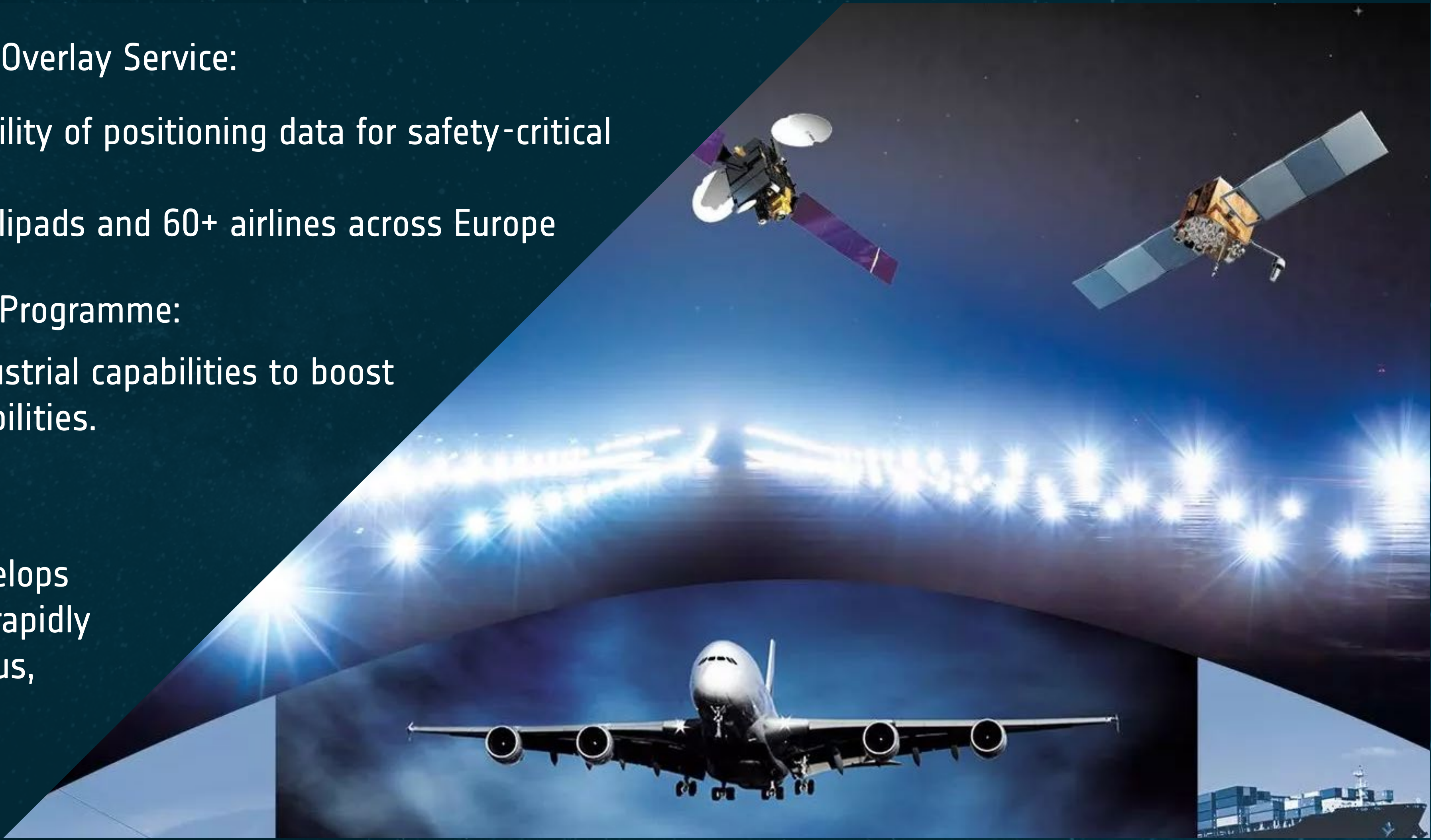
- Enhances the accuracy and reliability of positioning data for safety-critical applications.
- In use by over 670 airports & helipads and 60+ airlines across Europe

Navigation Innovation and Support Programme:

- NAVISP cultivates European industrial capabilities to boost current satellite navigation capabilities.

FutureNAV:

- ESA's FutureNAV programme develops new missions to respond to the rapidly growing needs for more ubiquitous, resilient and reliable positioning, navigation and timing.



- Connectivity is the invisible fabric that binds our increasingly digital world together.
- Through partnerships with industry and institutions, ESA is driving innovation and leading next-generation connectivity. We are improving security and resiliency by integrating satellites with everyday communications on Earth, the Moon and beyond.
- Our goal is to elevate Europe by connecting everyone, everywhere, at all times.

- IRIS² will be Europe's own multi-orbit constellation of satellites for secure and resilient internet and communication services worldwide.
- In collaboration with industry partners and the EU, IRIS² will involve satellites that integrate with ground networks and provide communications based on 5G and future 6G standards to European citizens, businesses and governments.

Supporting the competitiveness of the European space industry

Supporting the industrialisation and the commercialisation of space products and services

Elaborating and implement ESA's industrial policy and manage procurement for all ESA activities and programmes

Creating an environment for industry to deliver commercial opportunities based on space for the benefit of society

Our goal is to make Europe a hub for companies with global ambitions in the space sector.

Enabling and accelerating space commercialisation

Delivering commercial opportunities based on space for the benefit of society:

- Increase the competitiveness of Europe's space industry
- The ScaleUp programme supports 'new space' innovation
- ESA Investor Network supports access to finance for European companies
- Business applications and space solutions are used in all areas of our economy and are crucial for climate action
- ESA's Accelerators are speeding up the use of space to solve today's biggest challenges, including climate, resiliency and space safety.

SPACE SAFETY

ESA's Space Safety programme protects our planet, infrastructure in space and on the ground, and ensures a sustainable future in space:

- Planetary defence: Early warning of asteroids and the capacity to deflect hazardous objects
- Space debris: Technology to monitor space debris for insights and to protect infrastructure in space
- Clean space: Getting and keeping space clean, achieving ESA's Zero Debris ambitions
- Space weather: Monitoring the Sun to forecast space weather events to protect vital infrastructure on Earth and in space

Follow us and discover more!

Visit www.esa.int