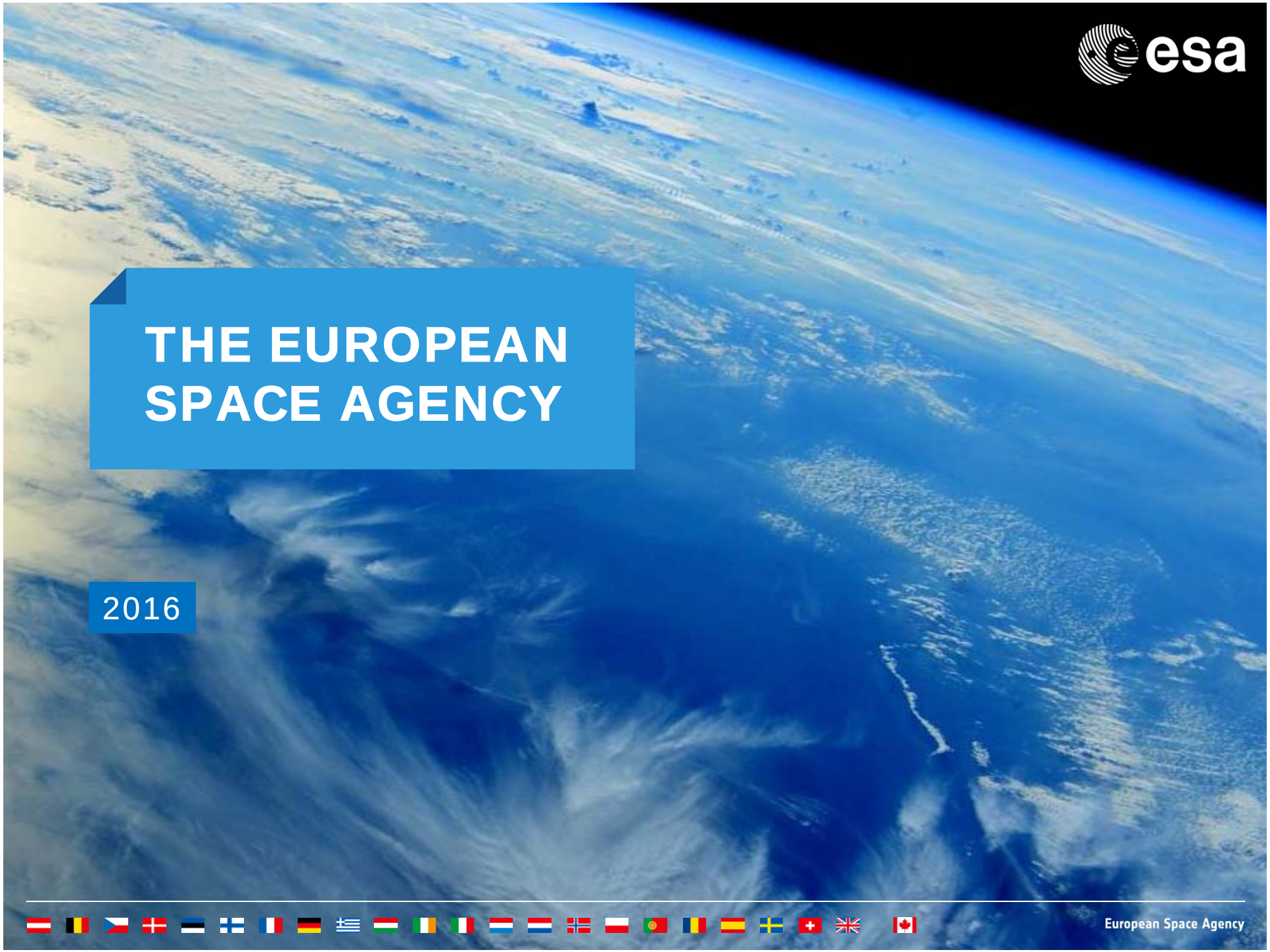

esa
THE EUROPEAN SPACE AGENCY
2016
European Space Agency

ESA facts and figures

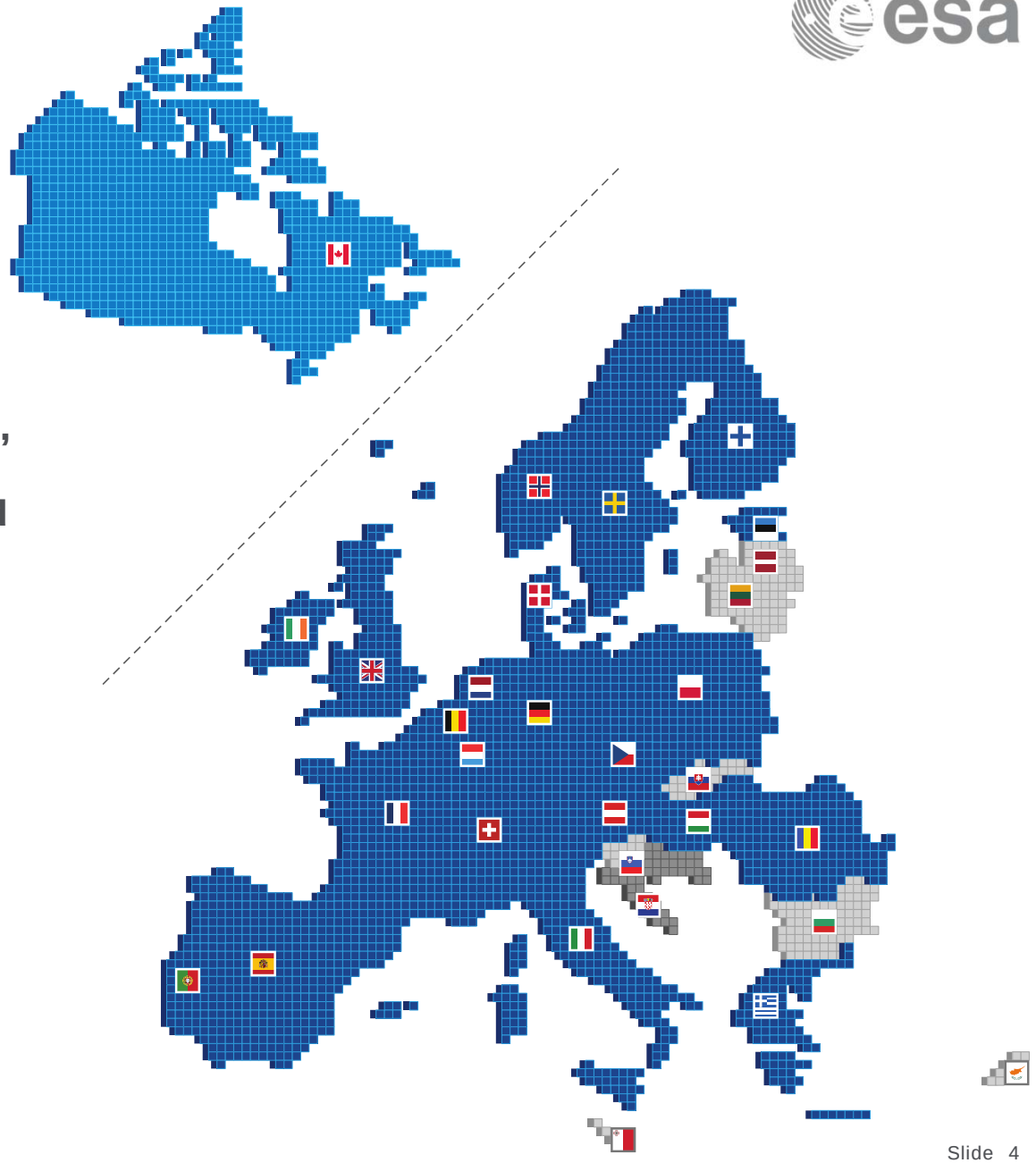
- Over 50 years of experience
- 22 Member States
- Eight sites/facilities in Europe, about 2200 staff
- 5.2 billion Euro budget (2016)
- Over 80 satellites designed, tested and operated in flight

Purpose of ESA

"To provide for and promote, for exclusively peaceful purposes, cooperation among European states in **space research** and **technology** and their **space applications.**"

Article 2 of ESA Convention

Member States



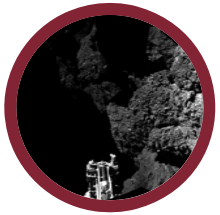
ESA has 22 Member States: 20 states of the EU (AT, BE, CZ, DE, DK, EE, ES, FI, FR, IT, GR, HU, IE, LU, NL, PT, PL, RO, SE, UK) plus Norway and Switzerland.

Seven other EU states have Cooperation Agreements with ESA: Bulgaria, Cyprus, Latvia, Lithuania, Malta, Slovakia and Slovenia. Discussions are ongoing with Croatia.

Canada takes part in some programmes under a long-standing Cooperation Agreement.

Activities

ESA is one of the few space agencies in the world to combine responsibility in nearly all areas of space activity.



space science

human spaceflight

exploration

earth observation

launchers

navigation

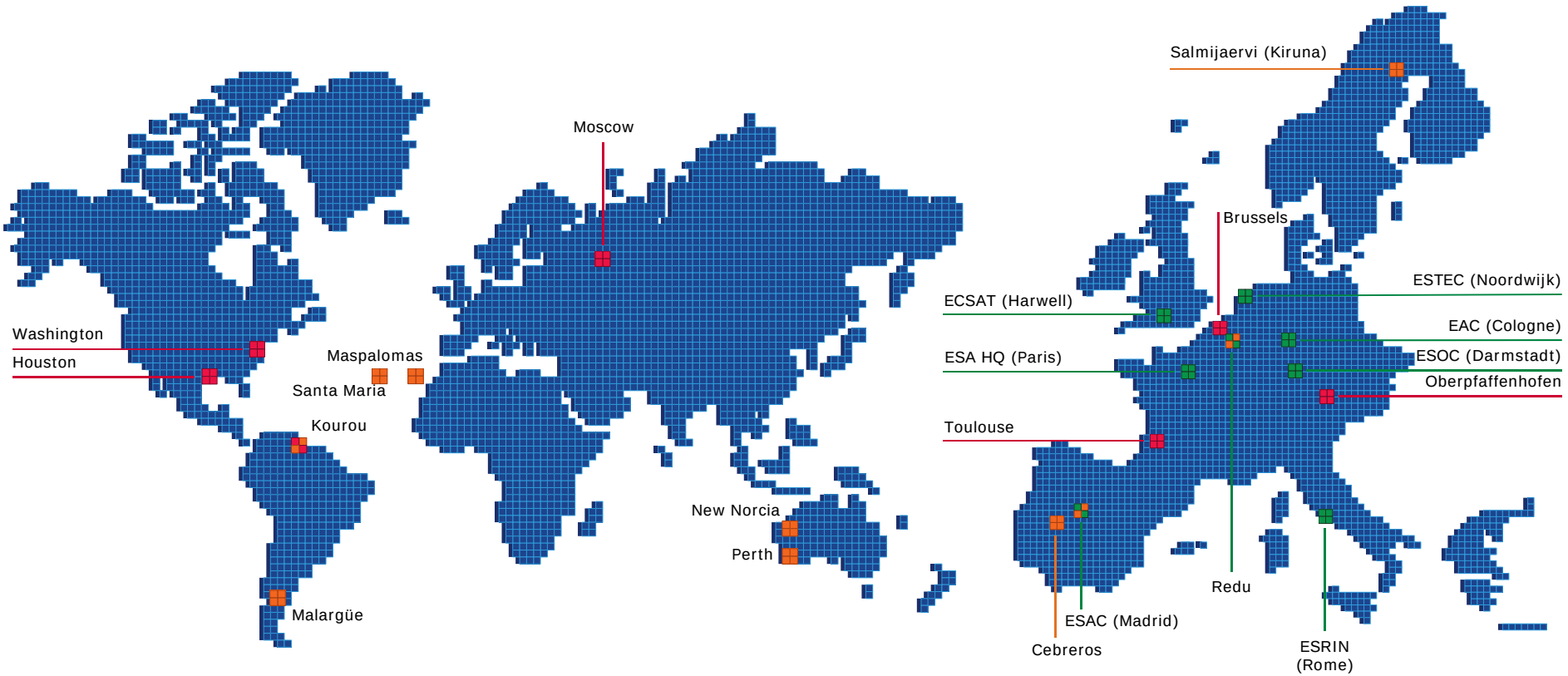
operations

technology

telecommunications

* Space science is a Mandatory programme, all Member States contribute to it according to GNP. All other programmes are Optional, funded 'a la carte' by Participating States.

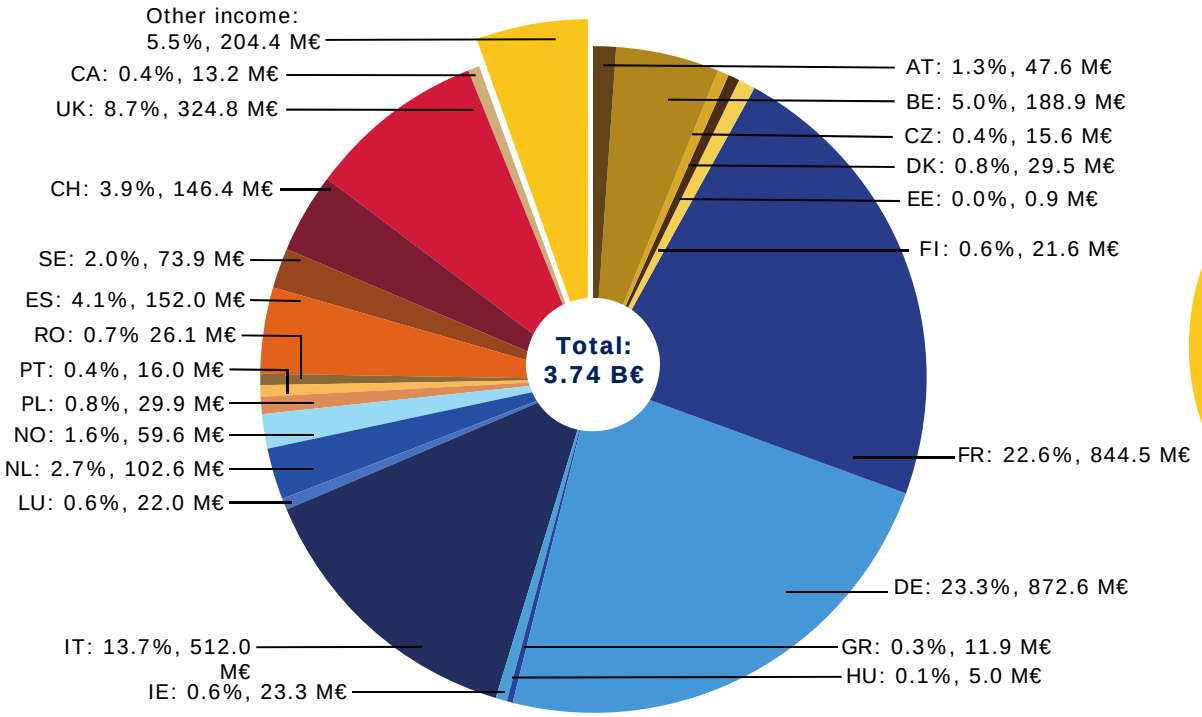
ESA's locations



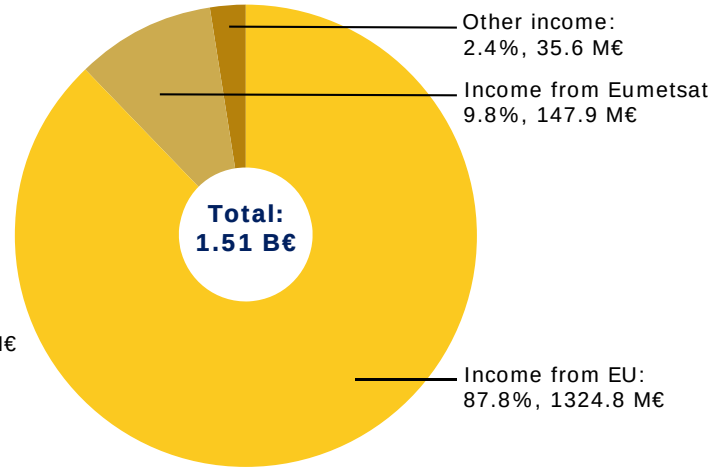
- ESA sites
- Offices
- ESA Ground Station
- ESA Ground Station + Offices
- ESA sites + ESA Ground Station

ESA budget for 2016

ESA Activities and Programmes



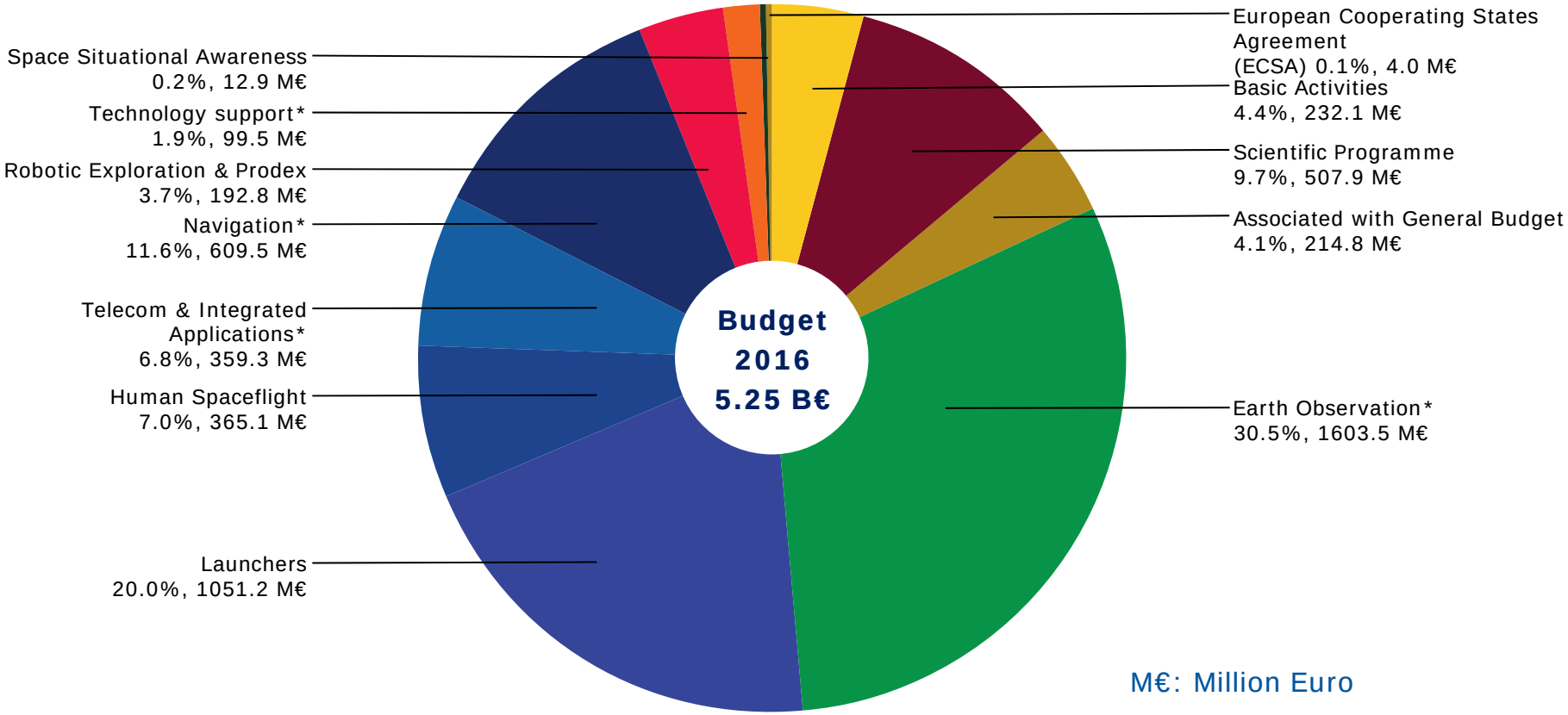
Programmes implemented for other Institutional Partners



B€: Billion Euro

Total ESA budget for 2016: 5.25 B€

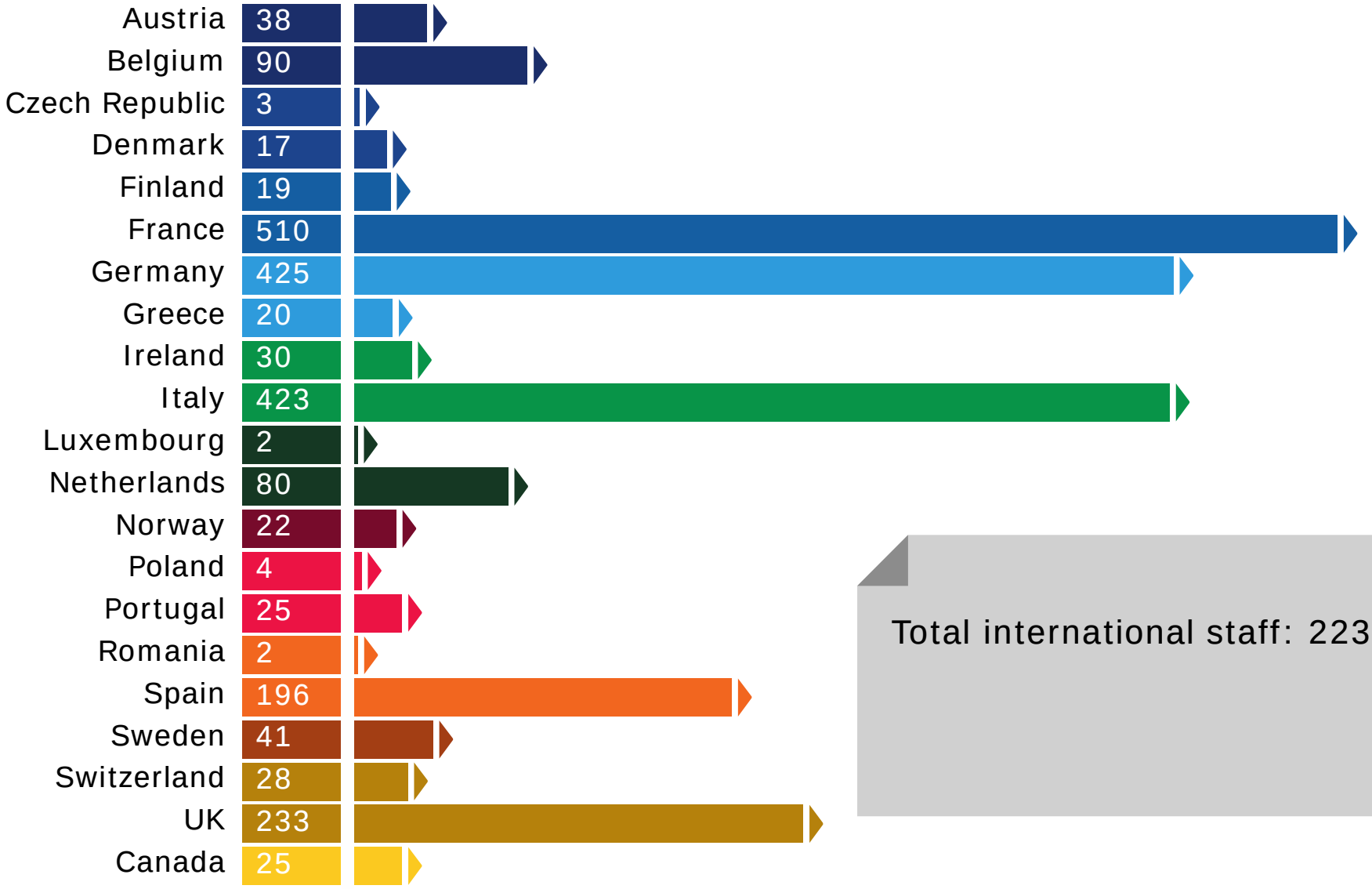
ESA 2016 budget by domain



M€: Million Euro

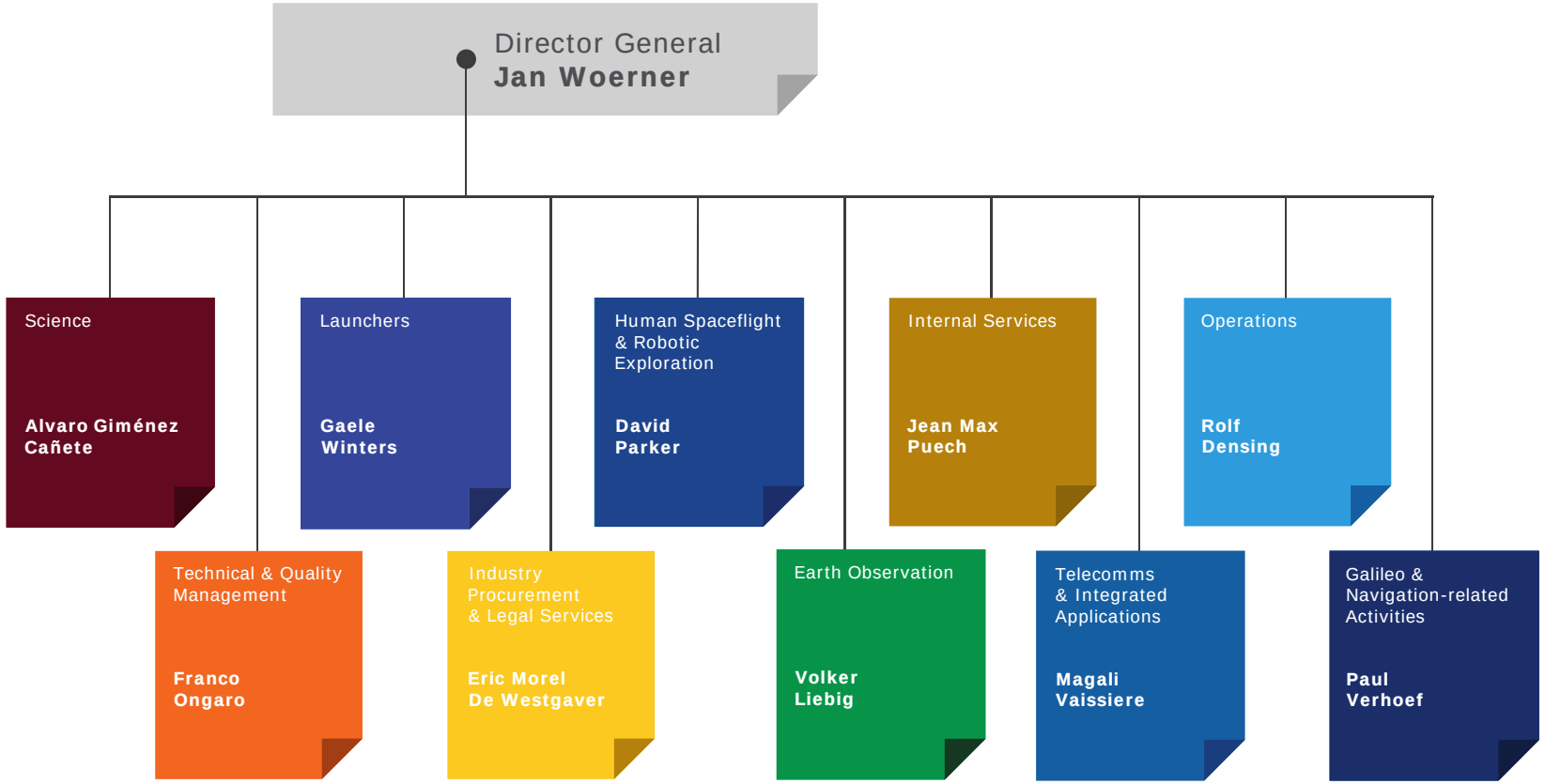
*includes Programmes implemented for other Institutional Partners

Staff by nationality in 2014



Total international staff: 2233

ESA directors



ESA and the European space sector

ESA Member States finance 50% of the total public space spending in Europe. Because of the cooperation between ESA, EC and the national space agencies:

- the European space industry sustains around 35 000 jobs;
- Europe is successful in the commercial arena, with a market share of telecom and launch services higher than the fraction of Europe's public spending worldwide;
- European scientific communities are world-class and attract international cooperation;
- research and innovation centres are recognised worldwide;
- European space operators (Arianespace, Eumetsat, Eutelsat, SES Global, etc.) are the most successful in the world.

ESA's industrial policy

About 85% of ESA's budget is spent on contracts with European industry.

ESA's industrial policy:

- ensures that Member States get a fair return on their investment;
- improves competitiveness of European industry;
- maintains and develops space technology;
- exploits the advantages of free competitive bidding, except where incompatible with objectives of the industrial policy.

Birth of commercial operators

ESA's 'catalyst' role

ESA is responsible for R&D of space projects. On completion of qualification, they are handed to outside entities for production and exploitation. Most of these entities emanated from ESA.

Meteorology: Eumetsat

Launch services: Arianespace

Telecomms: Eutelsat and Inmarsat

ESA Council

The Council is the governing body of ESA.

It provides the basic policy guidelines for ESA's activities. Each Member State is represented on the Council and has one vote.

Every two to three years, Council meets at ministerial level ('Ministerial Council') to take key decisions on new and continuing programmes and financial commitment.

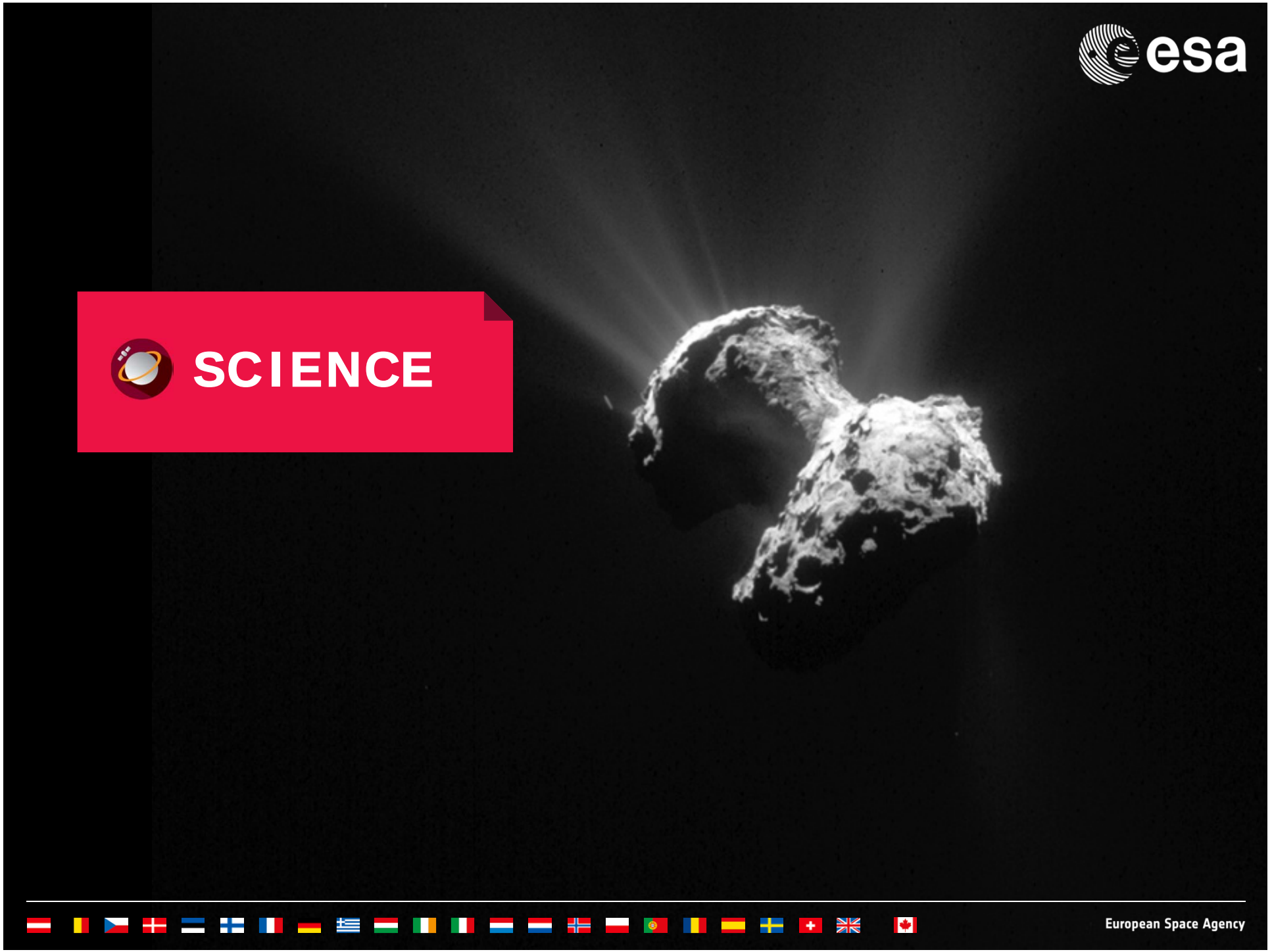
The ESA Council at ministerial level also meets together with the EU Council to form the European 'Space Council'.

Ministerial Council 2014, Luxembourg

Ministers agreed on further development of a family of new launchers, and approved funding for the International Space Station and space exploration. Ministers also set a course for ESA to remain an independent, world-class intergovernmental space organisation. The next Council at ministerial level is scheduled for the beginning of December 2016 in Lucerne, Switzerland.

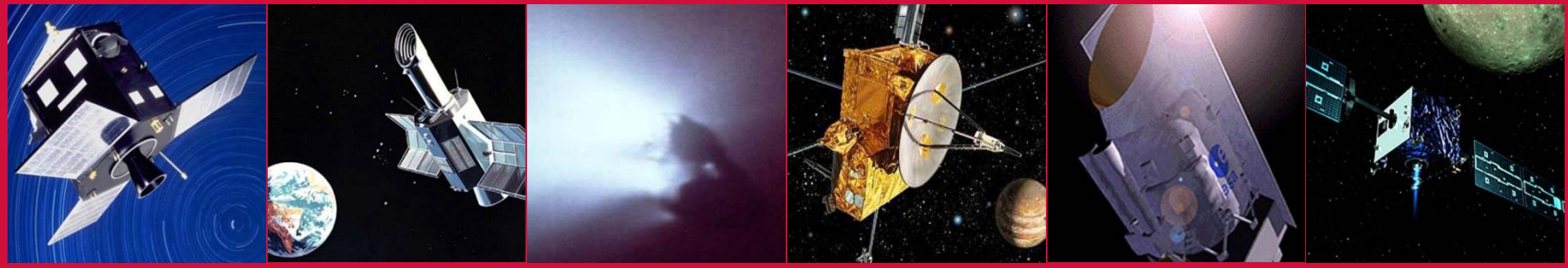
Three Resolutions were adopted:

- **Resolution on Europe's access to space**, covering Ariane 6 and Vega C;
- **Resolution on Europe's space exploration strategy**, covering Low-Earth Orbit, Moon and Mars;
- **Resolution on ESA evolution**, covering the vision for ESA until 2030.


esa
SCIENCE
European Space Agency

ESA's pioneers of space science (1)

- **Hipparcos** (1989–93) first comprehensive star-mapper
- **IUE** (1978–96) longest-lived orbital ultraviolet observatory
- **Giotto** (1986) first close flyby of a comet nucleus
- **Ulysses** (1990–2008) first spacecraft to fly over Sun's poles
- **ISO** (1995–8) first European infrared observatory
- **SMART-1** (2003–6) first European mission to the Moon

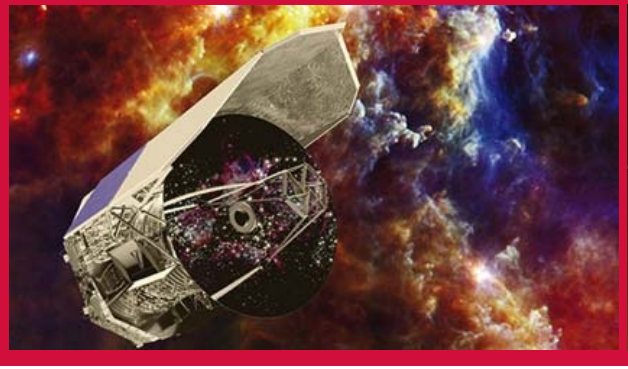


ESA's pioneers of space science (2)

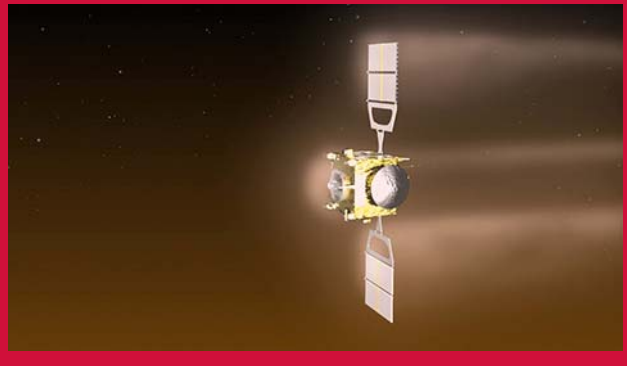
- **Planck** (2009–13) detecting first light of Universe and looking back to the dawn of time
- **Herschel** (2009–13) unlocking the secrets of starbirth and galaxy formation and evolution
- **Venus Express** (2005–15) first global investigation of dynamic atmosphere of Venus

Planck

Herschel

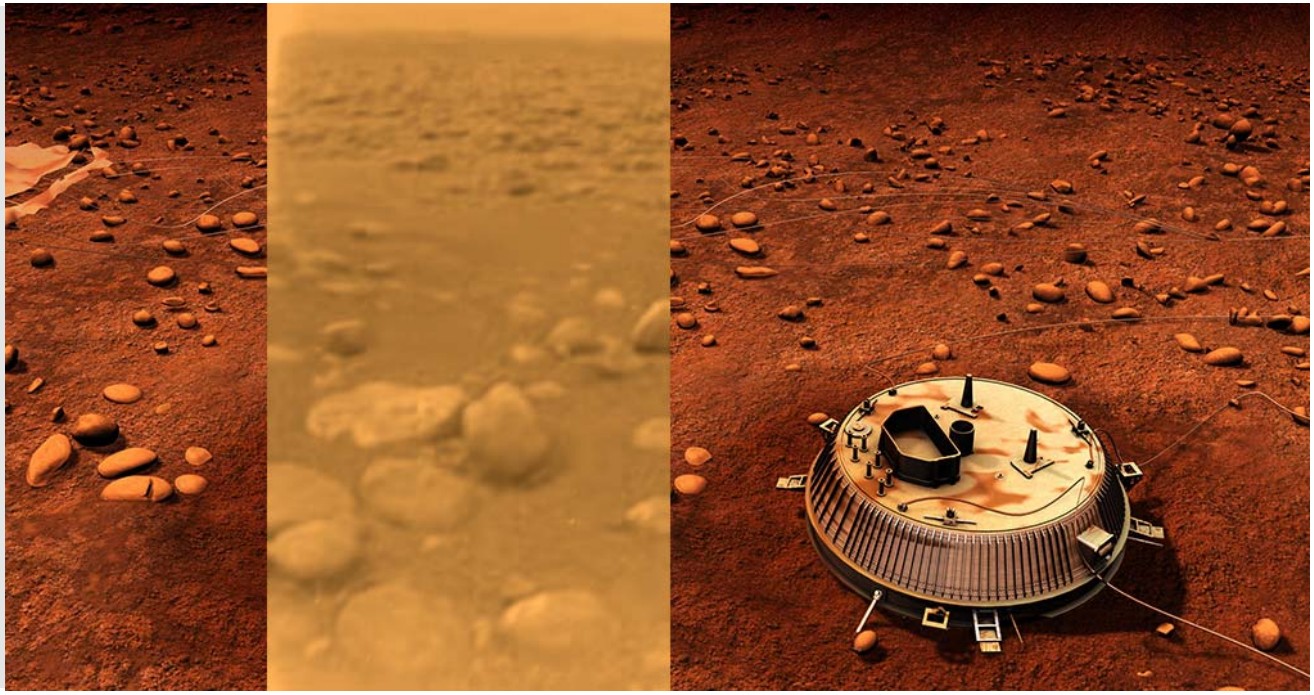


Venus Express



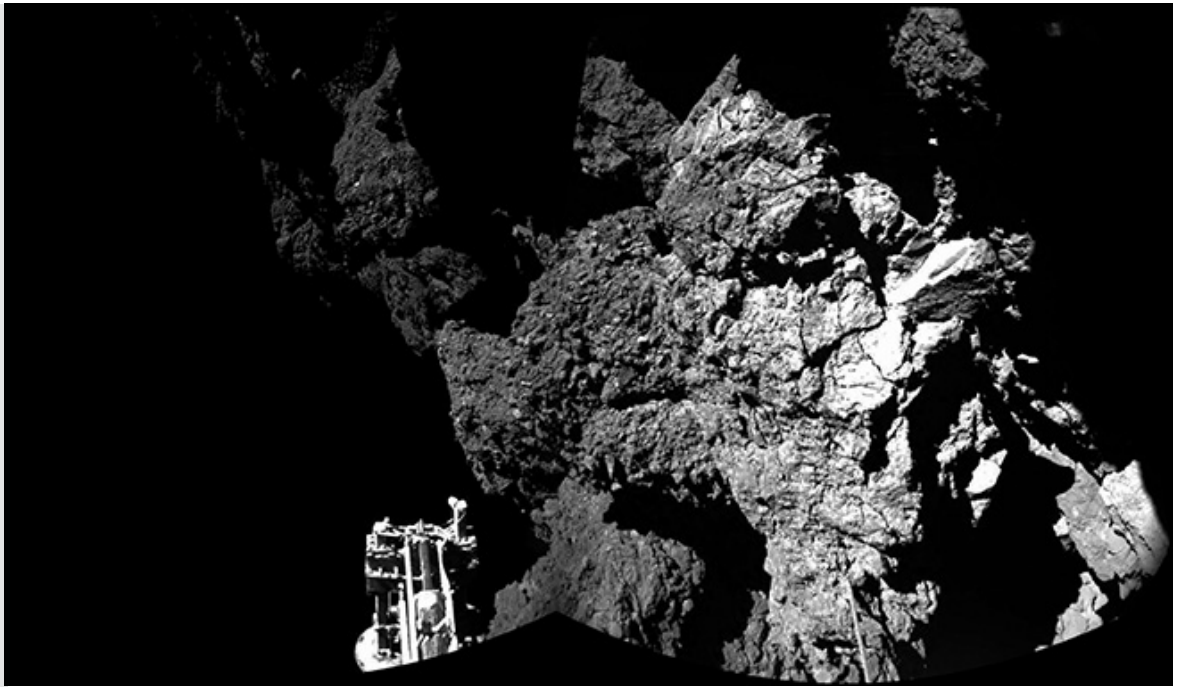
First landing on a world in the outer Solar System

On 14 January 2005, ESA's **Huygens** probe made the most distant landing ever, on Titan, the largest moon of Saturn (about 1427 million km from the Sun).



First rendezvous, orbit and soft-landing on a comet.

On 6 August 2014, ESA's **Rosetta** became the first spacecraft to rendezvous with a comet and, on 12 November, its Philae probe made the first soft-landing on a comet and returned data from the surface.

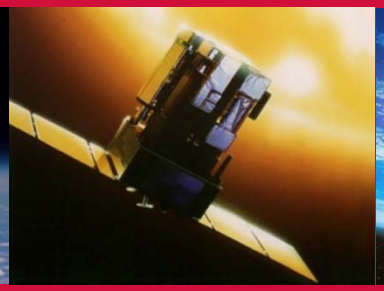


Today's Science missions (1)

- **Hubble** (1990–) orbiting observatory for ultraviolet, visible and infrared astronomy (with NASA)
- **SOHO** (1995–) studying our Sun and its environment (with NASA)
- **XMM-Newton** (1999–) solving mysteries of the X-ray Universe
- **Cluster** (2000–) studying interaction between Sun and Earth's magnetosphere
- **Integral** (2002–) observing objects simultaneously in gamma rays, X-rays and visible light

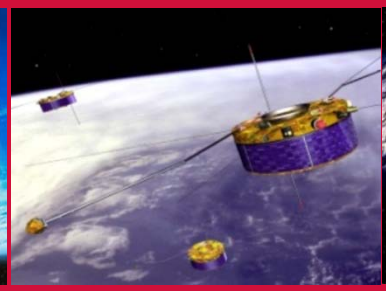
Hubble

SOHO



XMM-Newton

Cluster



Integral

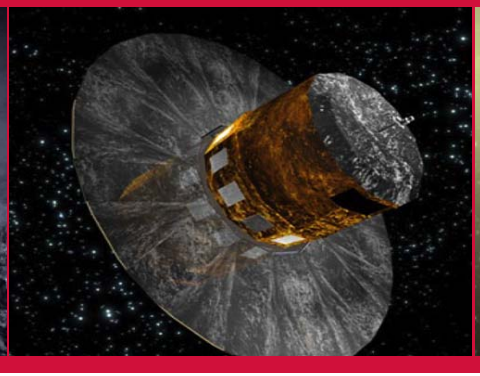
Today's Science missions (2)

- **Mars Express** (2003–) studying Mars, its moons and atmosphere from orbit
- **Rosetta** (2004–) the first long-term mission to study and land on a comet
- **Gaia** (2013–) mapping a thousand million stars in our galaxy
- **LISA Pathfinder** (2015–) testing technologies to detect gravitational waves

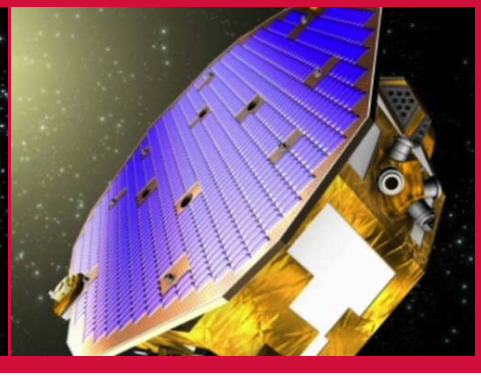
Mars Express

Rosetta

Gaia



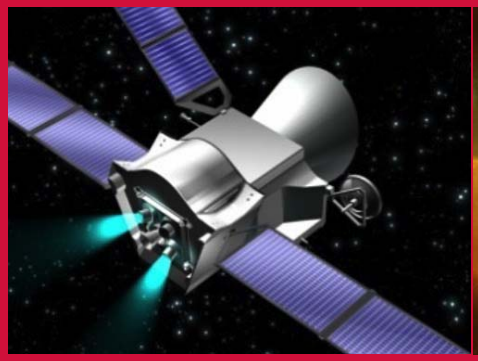
LISA Pathfinder



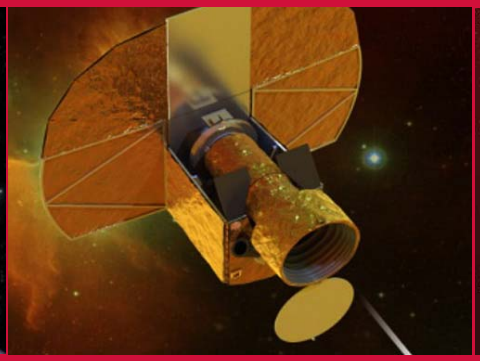
Upcoming missions (1)

- **BepiColombo** (2017) a satellite duo exploring Mercury (with JAXA)
- **Cheops** (2018) studying exoplanets around nearby bright stars
- **Solar Orbiter** (2018) studying the Sun from close range
- **James Webb Space Telescope** (2018) studying the very distant Universe (with NASA/CSA)

BepiColombo



Cheops



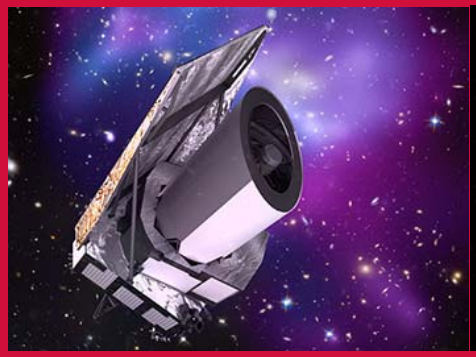
Solar Orbiter

James Webb Space Telescope

Upcoming missions (2)

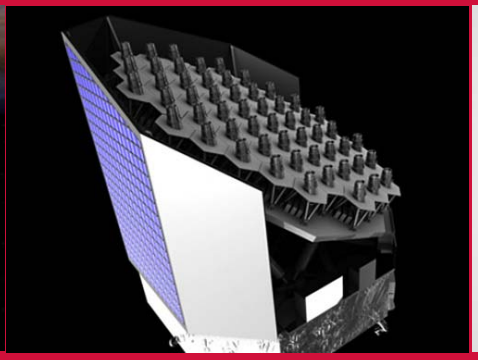
- **Euclid** (2020) probing ‘dark matter’, ‘dark energy’ and the expanding Universe
- **JUICE** (2022) studying the ocean-bearing moons around Jupiter
- **Plato** (2024) searching for planets around nearby stars
- **Athena** (2028) space telescope for studying the energetic Universe
- **Gravitational wave observatory** (2034) studying ripples in spacetime caused by massive objects in the Universe

Euclid

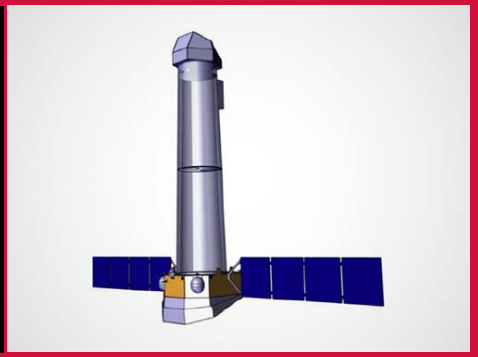


JUICE

Plato



Athena



Science operations

ESAC (near Madrid, Spain) is ESA's centre for science operations.

ESAC hosts ESA's Science Operation Centre (SOC) for ESA astronomy and Solar System missions.

Science operations include the interface with scientific users, mission planning, payload operations and data acquisition, processing, distribution and archiving.

The scientific archives for the majority of ESA's science missions are kept here so that researchers have a single 'entry point' for accessing the wealth of scientific data.

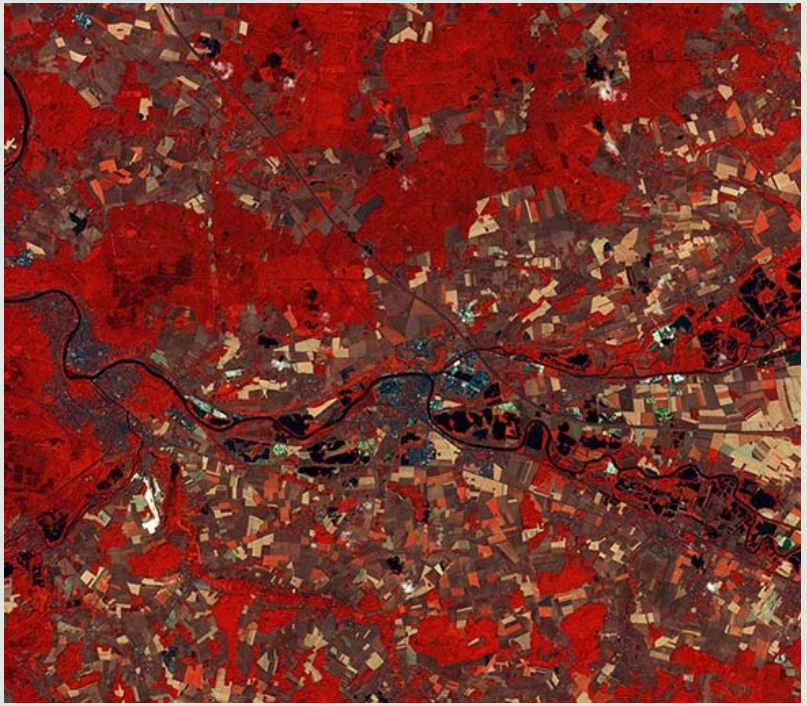

esa
EARTH
OBSERVATION
European Space Agency

Pioneers in Earth observation

ESA has been dedicated to observing Earth from space ever since the launch of its first meteorological mission, **Meteosat-1** in 1977.

ERS-1 (1991–2000) and **ERS-2** (1995–2011) providing a wealth of invaluable data about Earth, its climate and changing environment.

Envisat (2002–12) the largest satellite ever built to monitor the environment, it provided continuous observation of Earth's surface, atmosphere, oceans and ice caps.



ESA's eye on Earth

ESRIN, in Frascati, Italy, is ESA's centre for Earth Observation where operations and exploitation of Earth Observation satellites are managed.

The world's largest database of environmental data for both Europe and Africa is managed from ESRIN.

Earth Explorers

These missions address critical and specific issues raised by the science community, while demonstrating the latest observing techniques.

- **GOCE** (2009–13) studying Earth's gravity field
- **SMOS** (2009–) studying Earth's water cycle
- **CryoSat-2** (2010–) studying Earth's ice cover
- **Swarm** (2013–) three satellites studying Earth's magnetic field
- **ADM-Aeolus** (2016) studying global winds
- **EarthCARE** (2018) studying Earth's clouds, aerosols and radiation (ESA/JAXA)
- **Biomass** (2020) studying Earth's carbon cycle

Meteorological missions

Next-generation missions dedicated to weather and climate.

Meteosat Third Generation – taking over from Meteosat 11 in 2018/20, the last of four Meteosat Second Generation (MSG) satellites. MSG and MTG are joint projects between ESA and Eumetsat.

MetOp is a series of three satellites to monitor climate and improve weather forecasting, the space segment of Eumetsat's Polar System (EPS).

MetOp-A (2006–) Europe's first polar-orbiting satellite dedicated to operational meteorology.

MetOp-B launched in 2012.

MetOp-C follows in 2018.

Global monitoring for a safer world

Copernicus: an Earth observation programme for global monitoring for environment and security.

Led by the European Commission in partnership with ESA and the European Environment Agency, and responding to Europe's need for geo-spatial information services, it will provide autonomous and independent access to information for policy-makers, particularly for environment and security issues. ESA is implementing the space component: developing the **Sentinel** satellite series, its ground segment and coordinating data access.

ESA has started a **Climate Change Initiative**, for storage, production and assessment of essential climate data.


esa
TECHNOLOGY
European Space Agency

Space technology

The development of technology, along with access to space, is one of the enabling activities of ESA. ESA's technical heart is **ESTEC** (NL).

- Supporting competitiveness of European industry.
- Transferring technology from space to non-space applications ('spin-off'), and bringing innovations from outside the space sector to use in design of new space systems ('spin-in').
- Fostering innovation and enhancing European technological independence and the availability of European resources for critical technologies.
- Creating **Space Incubators** across Europe.

ESA's technical heart

ESTEC is the incubator of the European space effort, where most ESA projects are born and where they are guided through the various phases of development.

This is home to the Directorate of Technical and Quality Management, responsible for longer-term technology development for new ESA and European missions.

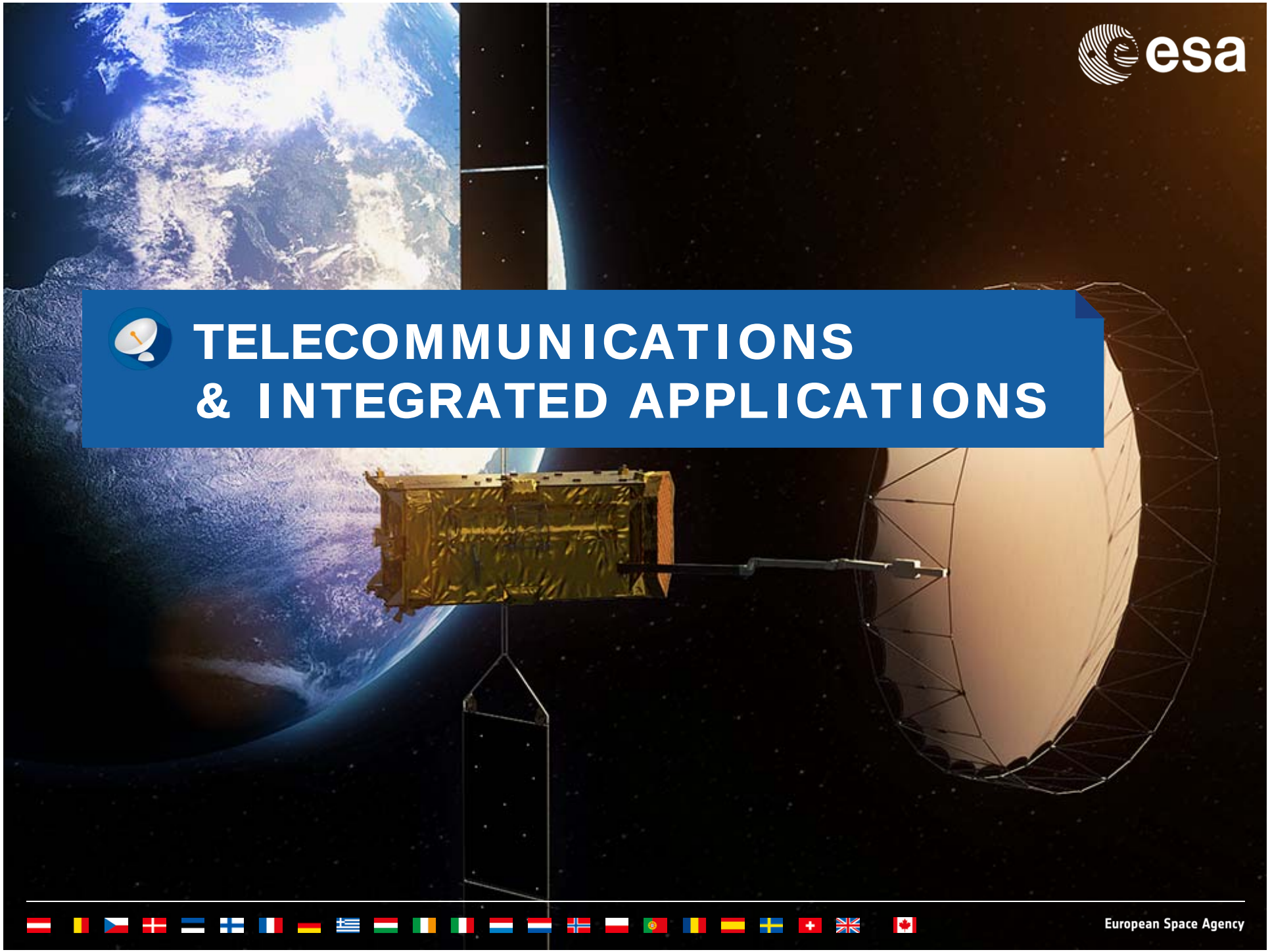
Proba

Proba satellites are part of ESA's In-orbit Technology Demonstration Programme.

New technology products need to be demonstrated in orbit, particularly when users require evidence of flight heritage or when there is a high risk associated with the use of the new technology.

Proba satellites are among the smallest spacecraft ever to be flown by ESA, but they are making a big impact in the field of space technology.

Proba-1 (2001–)
Proba-2 (2009–)
Proba-V (2013–)
Proba-3 (2018)


esa
TELECOMMUNICATIONS
& INTEGRATED APPLICATIONS
European Space Agency

A pioneer in telecoms

1968 – Europe started to develop communications satellites. The **Orbital Test Satellite** (OTS) was launched 10 years later. OTS, and its follow-up ECS, was used for more than 13 years by ESA and Eutelsat.

Olympus (1989–93) an experimental satellite, at the time of launch it was the largest civilian telecommunications satellite in the world.

Artemis (2001–) this multi-purpose telecommunications and technology demonstration satellite introduced a new range of telecommunication services to the world.

Ensuring competitive and innovative industry

ESA's **Advanced Research in Telecommunications Systems** (ARTES) programme promotes the development of technology, products and systems in partnership with industry.

- Helping European industry to compete on the world stage;
- Supporting technological R&D and pioneering developments to bring new technologies near to market readiness;
- Building partnerships capable of creating wealth, jobs and new services for the citizens of Europe;
- Improving our daily lives, from health services to civil protection and rescue operations.

ARTES partnerships (1)

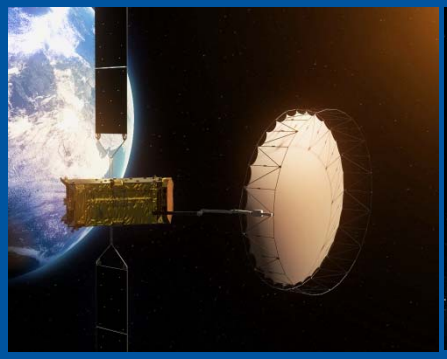
The platform family giving Europe the edge:

Alphabus – for the 6-tonne market, with Thales Alenia Space/Airbus D&S (first launch on Inmarsat's Alphasat, 2013)

SmallGEO – for the under 3-tonne market, with OHB (first launch on Hispasat AG1, 2016)

Spacebus Neo and **Eurostar Neo** – for the 3- to 6-tonne market, with Thales Alenia Space/Airbus D&S (first launches in 2019)

Alphabus

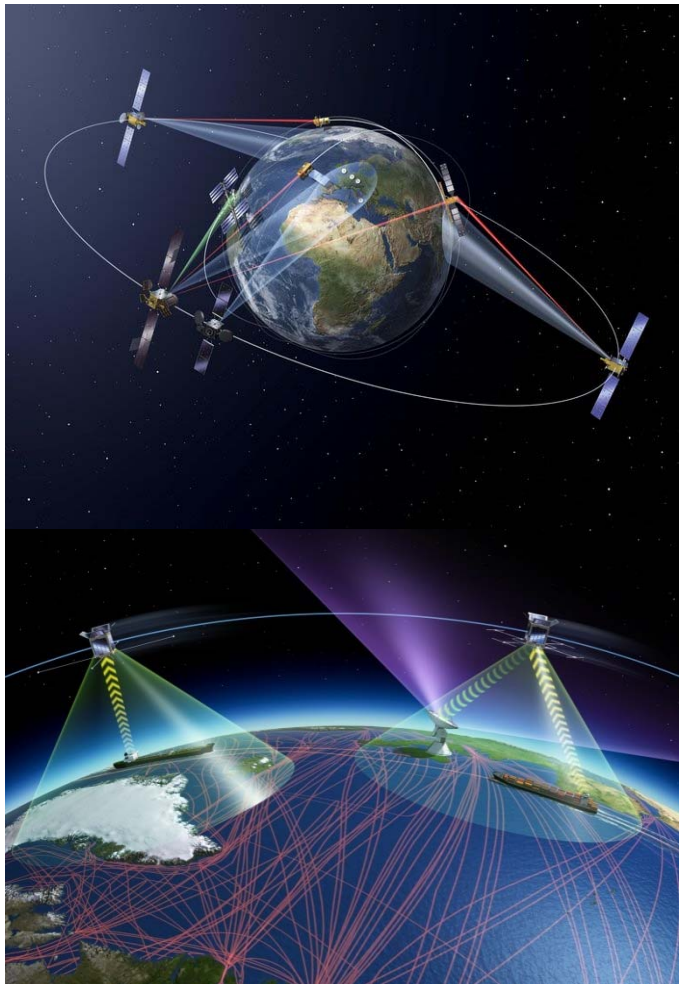


SmallGEO

Spacebus Neo

Eurostar Neo

ARTES partnerships (2)



Instant data from space: any place, any time

EDRS – the European Data Relay System, or ‘SpaceDataHighway’, an independent space and ground infrastructure that will help to make data gathered anywhere on Earth available in quasi-real time – with Airbus D&S (first launch, 2016; second launch, 2017)

SAT-AIS – Data-processing centres and microsatellites equipped with Automatic Identification System (AIS) receivers will make it possible to track seafaring vessels anywhere on Earth, beyond the current limitations of coastal reach – with European Maritime Safety Agency (first launch, 2016)

ARTES partnerships (3)

The gamechangers

Electra – first fully electric propulsion satellite, with SES (2021)

Quantum – in-orbit reprogrammable ‘chameleon’ satellite, with Eutelsat/Airbus D&S (2018)

Iris – a new satellite-based aviation communication system, with Inmarsat

Indigo – ground-segment innovations, with Intelsat/Newtec

ICE – expanding the range of mobile satellite services, with Inmarsat

Electra

Iris

Quantum

ECSAT: European Centre for Space Applications and Telecommunications

- At Harwell, near Oxford (UK), ESA teams work on telecommunications, integrated applications, climate change and exploration.
- An opportunity for ESA to enhance transfer of innovative R&D activities to a commercially oriented community.
- ECSAT is built around maximum benefit from cooperation with organisations located on or linked to the Harwell Campus.

NAVIGATION

European Space Agency

Galileo: “made in Europe”

Putting Europe at the forefront of this strategically and economically important sector, **Galileo** will provide a highly accurate, guaranteed global positioning service under civilian control. The full Galileo system will consist of 30 satellites and the associated ground infrastructure. Galileo is a joint initiative between ESA and the European Union.

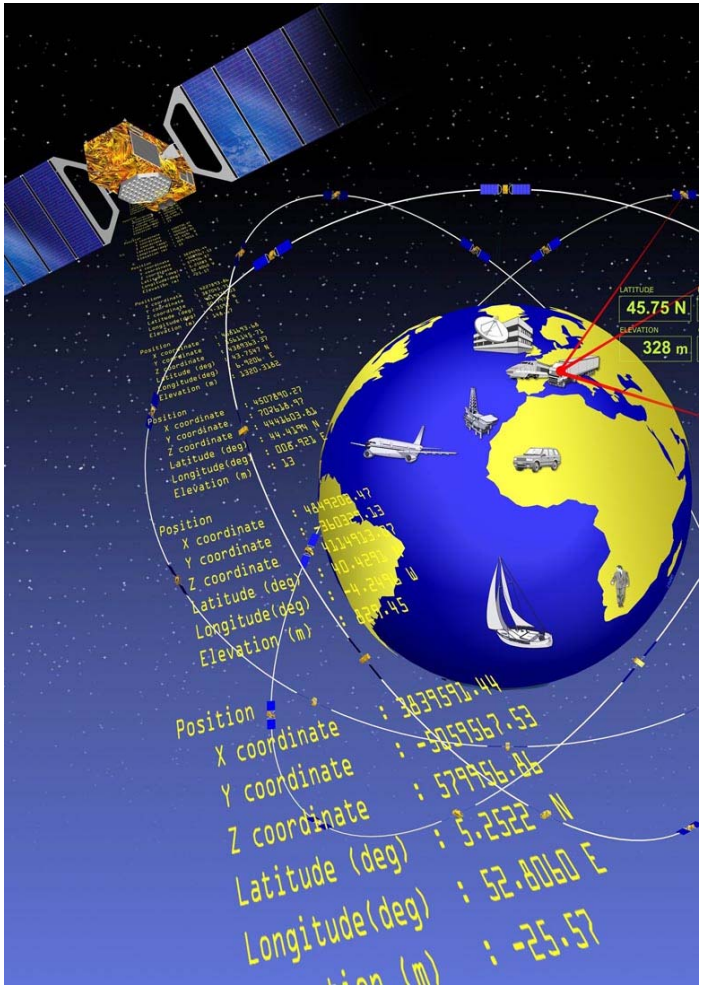
GIOVE-A (2005–12) Galileo test satellite

GIOVE-B (2008–12) validated technologies

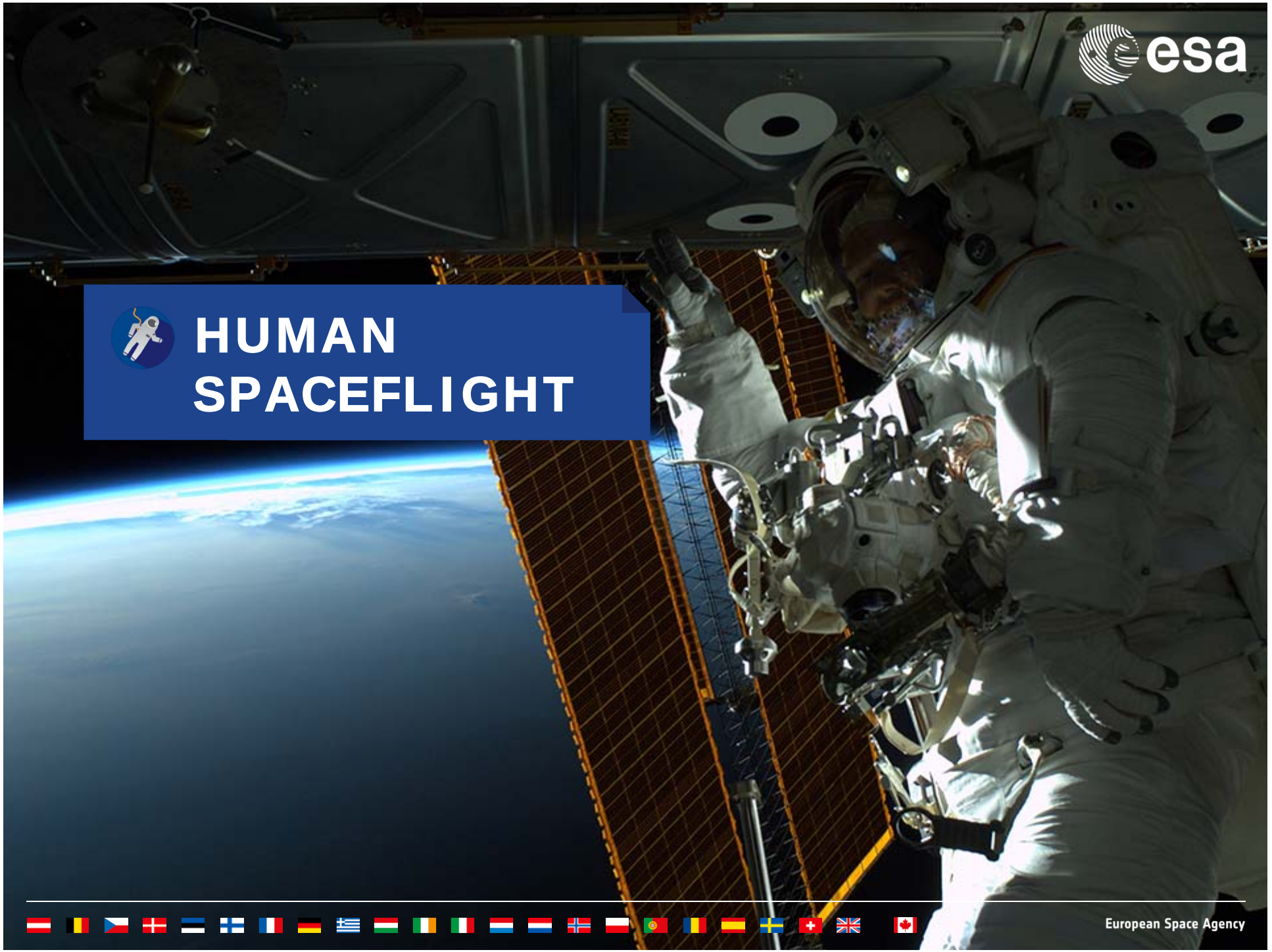
Galileo IOV (2011/12) In-orbit Validation satellites (2+2 satellites)

FOC (2014 –) Full Operational Capability (30 satellites). Early services available from 2016.

EGNOS and Galileo applications



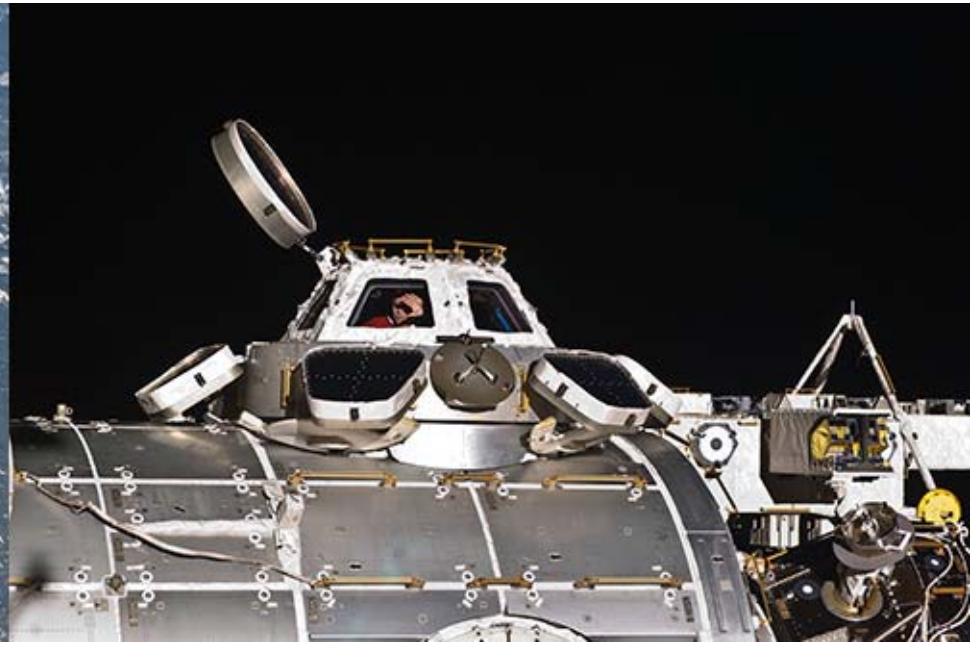
- Since 2010, **EGNOS** has been improving accuracy and augmenting GPS, offering safety-critical applications for aviation users.
- **Galileo** is expected to spawn a wide range of applications, based on positioning and timing for transport by road, rail, air and sea, infrastructure and public works management, agricultural and livestock management and tracking, e-banking and e-commerce.
- It will be a key asset for public services, such as rescue operations and crisis management.
- In November 2012, the **European GNSS Evolution Programme** for 2013–15 was approved, for the next versions of EGNOS, Galileo satellites and preparing future services.


esa
HUMAN
SPACEFLIGHT
European Space Agency

International Space Station (ISS)

The ISS unites USA, Russia, Japan, Canada and Europe in one of the largest partnerships in the history of science. Crews of up to six astronauts conduct research into life and physical sciences and applications, and prepare for future human exploration missions.

Europe's two key contributions are the **Columbus** laboratory and the **Automated Transfer Vehicle** (ATV). Columbus provides a substantial part of the ISS's research capability, specialising in fluid physics, materials science and life sciences. Europe has also provided almost 50% of the pressurised part of the ISS, including **Cupola, Node-2** and **Node-3**.



European Service Module

The **European Service Module (ESM)** is ESA's contribution to NASA's **Orion** spacecraft that will send astronauts to the Moon and beyond. The spacecraft comprises the ESM and the US Crew Module.

The ESM resembles ESA's **Automated Transfer Vehicle**, from which it evolved. Between 2009 and 2014, five Automated Transfer Vehicles delivered supplies to the International Space Station and helped to keep the outpost in orbit.

The first mission for the complete **Orion** spacecraft will be an unmanned flight to the Moon and back (first launch, 2017)

Europeans in space

The first ESA astronauts were selected in 1978:

Ulf Merbold
(DE)

Wubbo Ockels
(NL)

Claude Nicollier
(CH)

The European Astronaut Corps was formed in 1998, uniting astronauts of several Member States, including

Michel Tognini
(FR)

Jean-Pierre
Haigneré (FR)

Umberto Guidoni
(IT)

Maurizio Cheli
(IT)

Claudie Haigneré
(FR)

Gerhard Thiele
(DE)

Flight-experienced astronauts

Currently active or on other assignment:

Christer Fuglesang (SE)

Reinhold Ewald (DE)

Jean-François Clervoy (FR)

Pedro Duque (ES)

Léopold Eyharts (FR)

Hans Schlegel (DE)

Thomas Reiter (DE)

Frank De Winne (BE)

Paolo Nespoli (IT)

Roberto Vittori (IT)

André Kuipers (NL)

Next generation: flown and in training

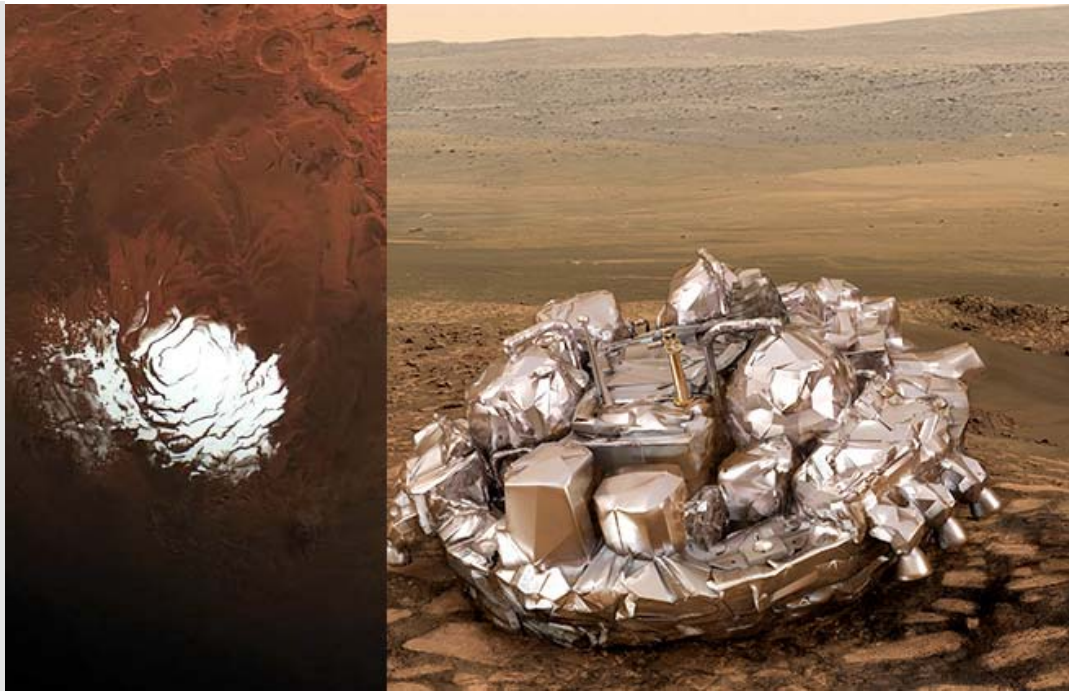
Based at the **European Astronaut Centre** (EAC), Cologne, Germany:

Luca Parmitano (IT), Alexander Gerst (DE) and Samantha Cristoforetti (IT) flew to the ISS in 2013, mid-2014 and end-2014 respectively.
Andreas Mogensen (DK) flew in 2015, Tim Peake (UK) is flying in 2015/16, and Thomas Pesquet (FR) will fly in 2016.

Back: Tim, Andreas, Alex, Luca; front: Samantha, Thomas

Robotic exploration

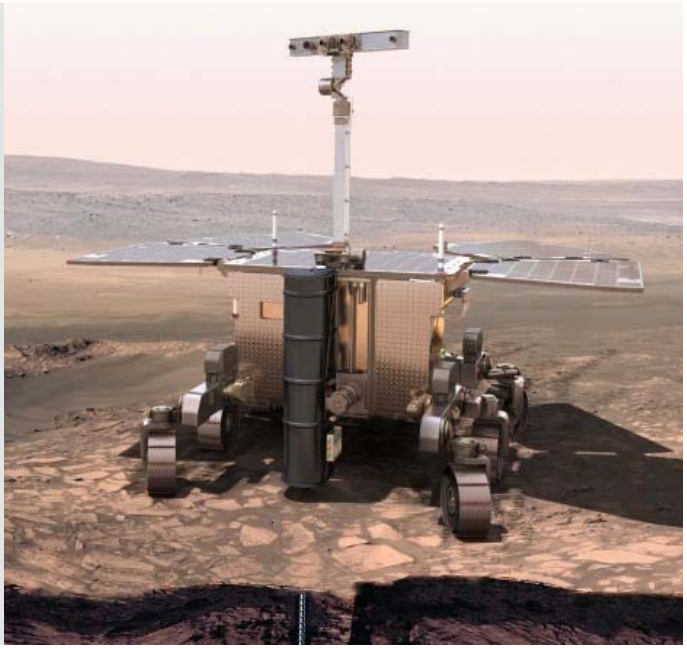
In cooperation with Roscosmos (Russia), two **ExoMars** missions (2016 and 2018) will investigate the martian environment, particularly astro-biological issues, and develop and demonstrate new technologies for planetary exploration with the long-term view of a future Mars sample return mission.

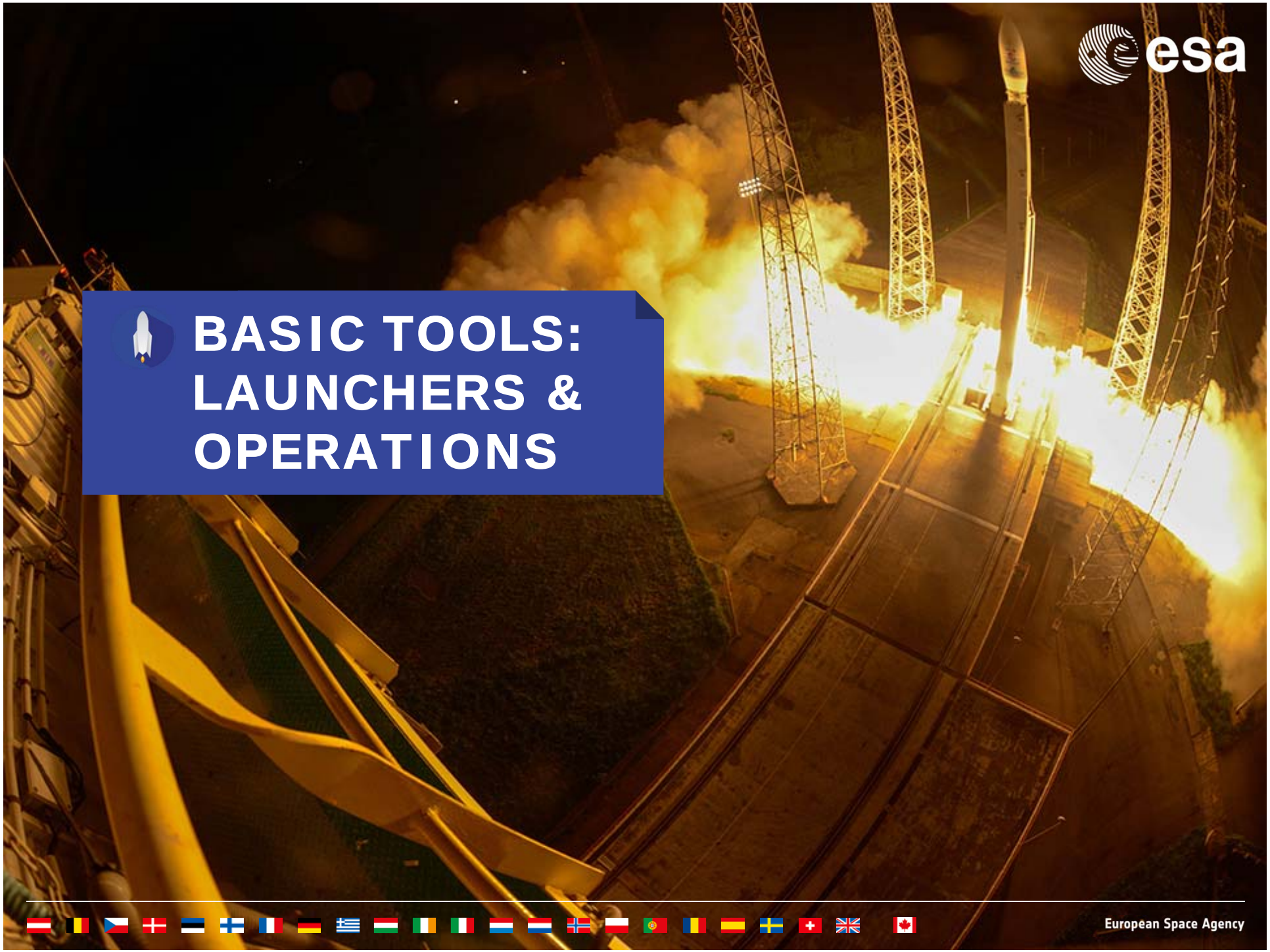


ExoMars

ESA will provide the **Trace Gas Orbiter** and the **Entry, Descent and Landing Demonstrator Module** in 2016, and the **carrier** and ExoMars **rover** in 2018.

Roscosmos will be responsible for the 2018 descent module and surface platform, and will provide Proton launchers for both missions. Both partners will supply scientific instruments and will cooperate closely in the scientific exploitation of the missions.




esa
BASIC TOOLS:
LAUNCHERS &
OPERATIONS
European Space Agency

The European launcher family

The **Ariane** and **Vega** launchers developed by ESA guarantee European autonomous access to space.
Their development and successful exploitation is an example of how space challenges European industry and provides precious expertise.

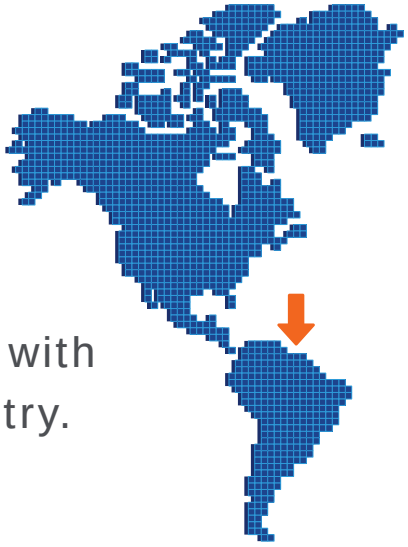
Ariane is one of the most successful launcher series in the world.
Complemented since 2011 by **Vega** and **Soyuz**, they are all launched from Europe's Spaceport in French Guiana.

Europe’s spaceport

European launchers lift off from the Centre Spatial Guyanais (CSG), Kourou, in French Guiana.

The CSG launch range is co-funded by ESA and France and is operated by the French space agency CNES.

The launch infrastructure for the **Ariane 5**, **Vega** and **Soyuz** launchers at CSG is owned by ESA, maintained and operated by Arianespace, with the support of European industry.



Launchers and technologies of the future: Ariane 6 and Vega C

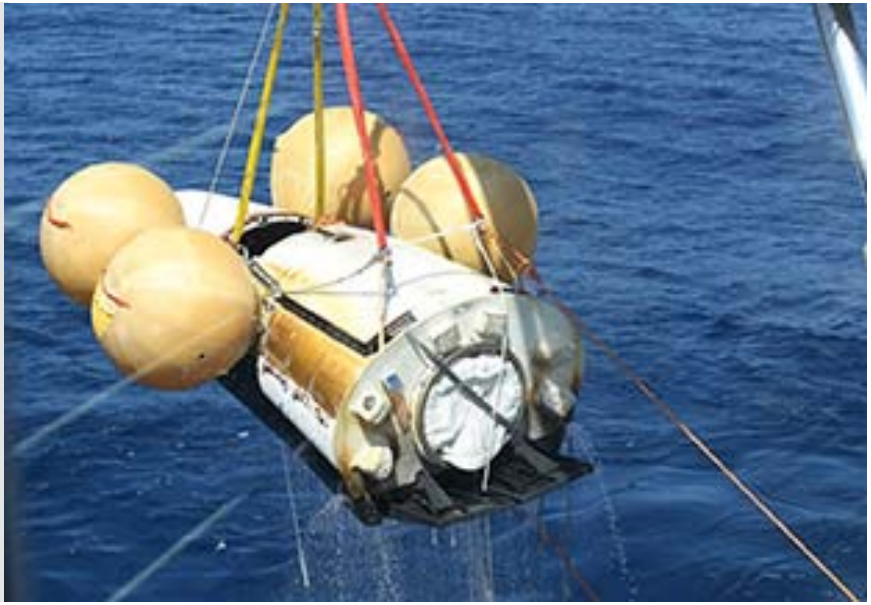
European Ministers agreed at the Ministerial Council 2014 to develop **Ariane 6** and **Vega C.** These launchers will provide guaranteed access to space for Europe at a competitive price without requiring public sector support for commercial exploitation.

- Ariane 6 - modular three-stage launcher with two configurations, using two (A62) or four boosters (A64);
- Vega C - evolution of Vega with increased performance and same launch service cost;
- Common solid rocket motor for Ariane 6 boosters and Vega C first stage;
- New governance for Ariane 6 development and exploitation allocating increased roles and responsibilities to industry;
- Vega C and Ariane 6 first flights - 2019 and 2020.

Launchers and technologies of the future: IXV and PRIDE

The **Intermediate eXperimental Vehicle** (IXV) project:

- Tackles the basic needs for reentry from Low Earth Orbit, consolidating the knowledge necessary for the development of any future European reentry system.
- Launched on a Vega rocket in 2015. After reentering Earth's atmosphere and being slowed down by air drag, IXV descended by parachute and landed successfully in the Pacific Ocean for recovery and post-flight analysis.



PRIDE, a follow-on mission is in preparation: an integrated space transportation system based on Vega C, to enable a European independent capability to routinely access and return from low Earth orbit with a reusable system.

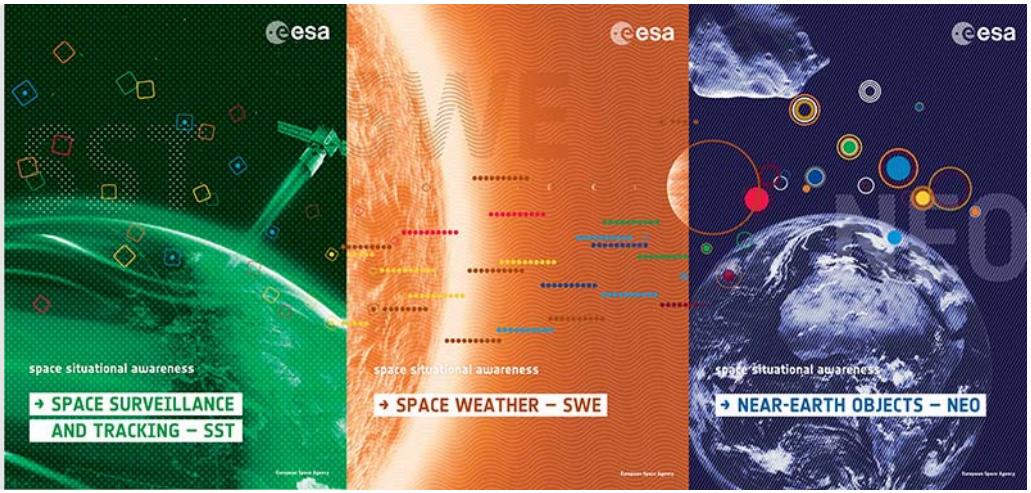
Mission operations

ESOC (Darmstadt, Germany) is ESA's centre for mission operations and ground systems engineering.

- Preparation and execution of combined ground- and space-segment operations
- Mission control systems, ground stations and operational communication and computer systems
- Operation of spacecraft and ground facilities, mission analysis, flight dynamics, navigation and space debris

Space Situational Awareness

The **Space Situational Awareness (SSA)** initiative aims to provide Europe with services to protect satellites and Earth.



The initiative supports Europe's independent utilisation of space, through provision of timely and accurate information about the space environment. SSA will strengthen reliability, availability and security of Europe's space-based services. It will be coordinated with international partners and the institutions of the European Union.

European industry will benefit from new contracts and world-class competitive capabilities gained through development of the SSA infrastructure and services.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ESA AND ITS
INTERNATIONAL PARTNERS
European Space Agency

Strong ties all over the world

Partnership: one of ESA's key words

As a European research and development organisation,
ESA is a programmatically driven organisation, i.e. the international cooperation is driven by programmatic needs and rationale.

- **Strategic partnerships** with: USA, Russia and China
- **Long-standing cooperation** with Japan, India, Argentina, Brazil, Israel, South Korea, Australia and many more…
- **EU Members, but not ESA Member States**: enhanced cooperation and joint activities. European Cooperating States (ECS): Bulgaria, Latvia, Lithuania, Slovakia and Slovenia. Cooperating States: Cyprus and Malta. Discussions are ongoing with Croatia.


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ESA AND
THE EUROPEAN UNION
European Space Agency

Space for Europe

The European Union and ESA share a common aim: to strengthen Europe and benefit its citizens.

Closer ties and an increased cooperation between ESA and the EU bring substantial benefits to Europe by:

- guaranteeing Europe's full and unrestricted access to services provided by space systems for its policies,
- encouraging the increasing use of space to improve the lives of its citizens,
- increasing political visibility of space and taking full benefit from its economic and societal dimension.

Cooperation with the EU

- The Lisbon Treaty of 2009 reinforces the case for space in Europe and strengthens the role of ESA as an R&D space agency. Article 189 of the Treaty gives the EU a mandate to elaborate a European space policy and take related measures, and provides that the EU should establish appropriate relations with ESA
- ESA/EU Framework Agreement in force and extended to 2016
- ESA/EU Space Council ministerial-level meetings and related resolutions provide directions and guidelines

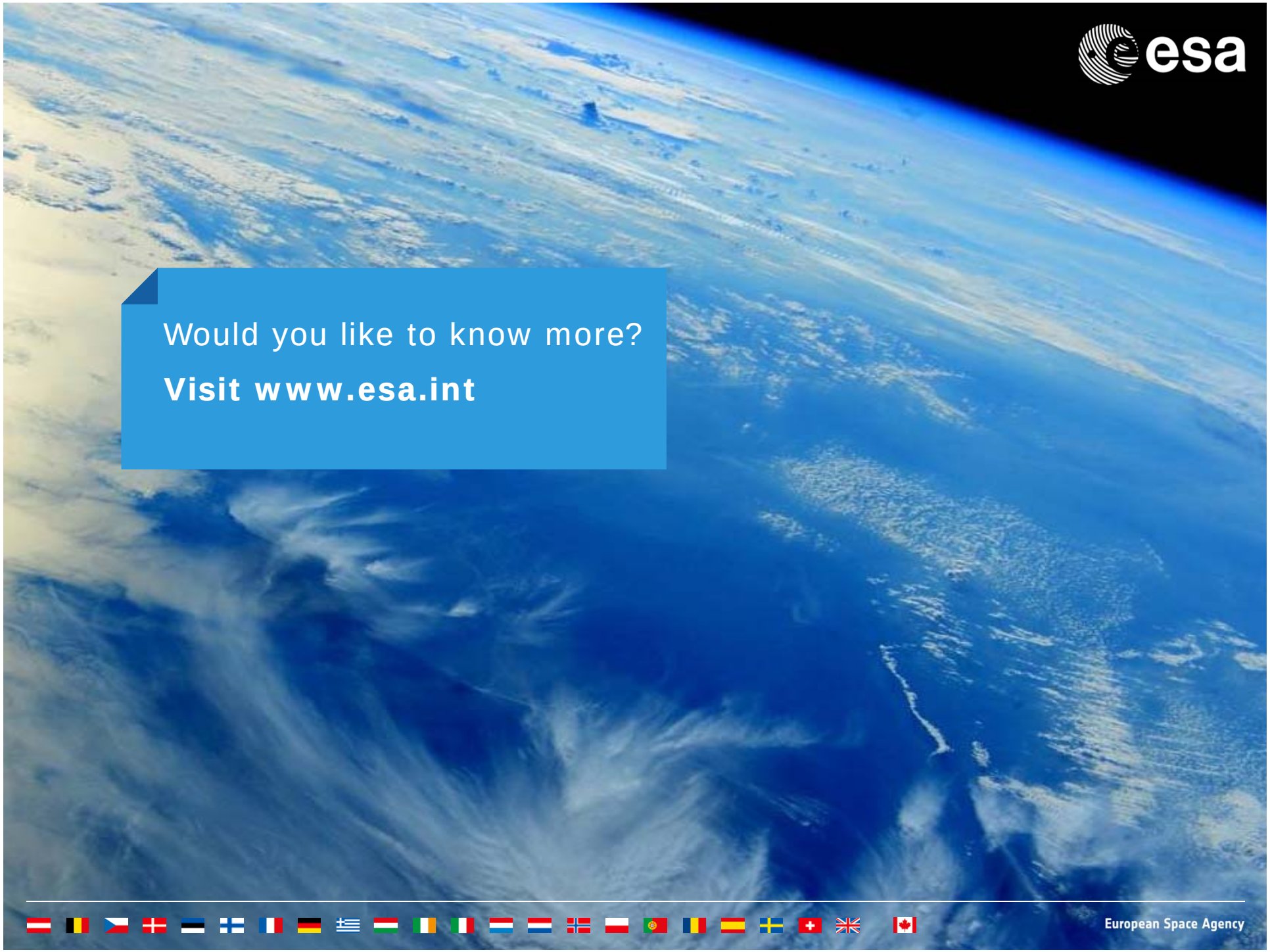
- Two flagship programmes: Galileo, Copernicus
- Arrangement with the European Defence Agency for cooperation on space and security
- Political Declaration by Ministers in November 2012 gave ESA DG the mandate to reflect ‘towards the European Space Agency that best serves Europe’, starting a process for the further evolution of ESA
- Resolution on ESA evolution, covering the vision for ESA until 2030, as agreed at ESA Ministerial Council 2014

European space policy

Strategic objectives of space for Europe:

- develop space applications to serve Europe's public policies, enterprises and citizens;
- meet Europe's security and defence needs;
- foster competitive and innovative industries;
- contribute to the knowledge-based society;
- secure access to technologies, systems and capabilities for independence and cooperation.

In May 2007, 29 European countries (17 Member States of ESA and 27 Member States of the EU) adopted a Resolution on the European Space Policy, adding a new dimension to European space activities.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