esa

estec

ESA'S TECHNICAL HEART

European Space Agency

ESA Headquarters
Seat of the ESA Council and the Director General, as well as some Directors, plus offices of human resources, legal affairs, finance, budget, internal audit, international relations and communications.

ESTEC
The European Space Research and Technology Centre in Noordwijk, The Netherlands, is ESA's largest site. This is where most ESA projects are born and guided through their phases of development.

ESOC
The European Space Operations Centre in Darmstadt, Germany, ensures the smooth working of spacecraft in orbit. Its control rooms track and control satellites via ground stations all over the world.

ESRIN
ESA's centre for Earth observation in Frascati, Italy, manages the ground segment for ESA and third-party Earth-observation satellites. It maintains the largest archive of environmental data in Europe, and hosts the project team managing the Vega small-launcher programme.

ESAC
The European Space Astronomy Centre in Villafranca del Castillo, near Madrid, Spain, is ESA's window on the Universe. It hosts the scientific operations centres for ESA's astronomy and Solar System missions, along with their scientific archives.

EAC
The European Astronaut Centre in Cologne, Germany, is a training facility and home base for the European astronauts. It is a centre of excellence for astronaut training and medical support.

Guiana Space Centre
ESA's launchers lift off from Europe's Spaceport in Kourou, French Guiana. It is jointly operated by the French space agency (CNES) and Arianespace with the support of the European Industry. ESA owns the launch infrastructures for the Ariane-5, Vega and Soyuz launchers.

The European Space Agency (ESA) is Europe's gateway to space. We guide the development of Europe's space capability and carry out pioneering research in all areas of space activity.

For over 40 years, ESA and its predecessors have been shaping and sharing space. We have been managing the research and development programmes needed to keep Europe at the forefront of space exploration and applications. We have been ensuring that investment in space delivers benefits to the citizens of Europe and the world: from jobs and economic growth, to public services, efficient communications and security.

ESA is a prime example of what can be achieved by working together – a model for multicultural and international cooperation. By pooling resources, we are able to develop fascinating projects that would not be possible for individual countries. The results of this cooperation are world-class industry, outstanding scientific discoveries and a stronger, richer European identity.

ESTEC

ESA'S TECHNICAL HEART

ESA has sites in several European countries, but the European Space Research and Technology Centre (ESTEC) in Noordwijk, the Netherlands, is the largest. ESTEC is our technical heart — the incubator of the European space effort — where most ESA projects are born and where they are guided through the various phases of development.

- Developing and managing all types of ESA missions — science, exploration, telecommmunications, human spaceflight, satellite navigation and Earth observation.
- Providing all the managerial and technical competences and facilities needed to initiate and manage the development of space systems and corresponding technologies.
- Operating an environmental test centre for spacecraft, with supporting engineering laboratories specialised in systems engineering, components and materials, and working within a network of other facilities and laboratories.
- Supporting European space industry and working closely with other organisations, such as universities, research institutes and national agencies from ESA Member States, and cooperating with space agencies all over the world.

→ THE LIFE OF A SPACE MISSION

At ESTEC, we are simultaneously working on the definition of future missions, technology development, space projects under development and spacecraft that are in operation.

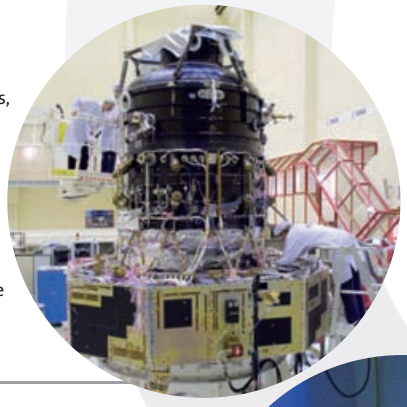
We incorporate many things into the design of spacecraft, making trade-offs between the latest technologies available, mission requirements, systems engineering activities and launcher capacities. Lessons from past experience are also some of the main design 'drivers'. This cycle has already resulted in dozens of successful missions — making space exploration in Europe a part of our daily lives.

Herschel

Launch: 2009
This cycle (right) shows, at assembly stage, the development of ESA's Herschel spacecraft. Its 3.5-metre diameter mirror makes it the largest telescope yet carried into space and it will be used to study how stars and galaxies formed.

Birth of a mission

Every project starts with an idea for scientific research or an application. Together with industrial partners, ESTEC engineers work out preliminary designs and trade-offs for the spacecraft and the whole mission.



Developing the mission

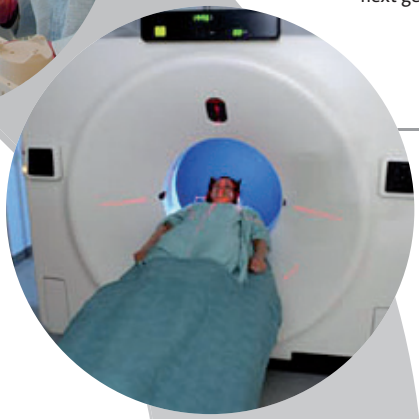
European companies build the spacecraft and related ground facilities, and are managed by an ESA project team at ESTEC that monitors progress and ensures that all requirements for performance, cost and schedule are met.

Checking the equipment

Every instrument and piece of software are tested many times, both individually and on the spacecraft, over many months, until we have verified that the spacecraft will be able to fulfil its mission and withstand environmental extremes.

Lessons learnt

A space mission may answer many questions, but it also raises new ones. The latest results or spacecraft performance can influence the design and techniques used in future missions. Updates in technology and materials are fed into the designs of the next generations of new missions and spacecraft.



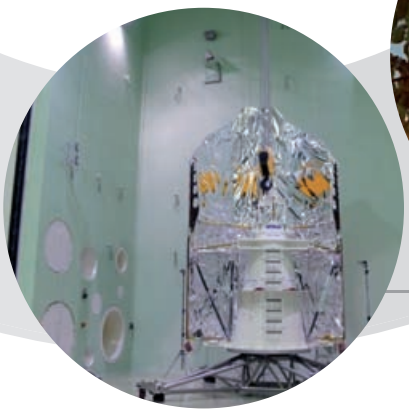
Bringing space back to Earth

Space technology is not only essential for satellites: it also leads to new products, applications and services on Earth. ESTEC activity is stimulating innovative uses of space technology for new business through the Technology Transfer Programme.

Bringing the mission alive

After launch, responsibility for the spacecraft passes to an operations team, usually at ESA's European Space Operations Centre (ESOC) in Germany — Europe's 'mission control'. Here, ESTEC specialists are involved in instrument configuration and 'orbit acceptance', and solving any problems that could occur in space.

→ LAUNCH



Testing the spacecraft

Many of the hazards of space can be simulated at ESTEC. First the spacecraft must withstand the noise and vibration of launch. Then it must be able to survive extreme temperatures, vacuum, particles and electromagnetic fields while in space.

→ BIRTH OF A MISSION

CONCURRENT DESIGN FACILITY (CDF)

Developing a space project is a complex process and often takes anything from five to ten years. Each project starts with an idea for scientific research or an application.

"Seeing a solution materialise is a deeply satisfying experience!"

– Torsten Bieler

Proposals for new space missions are examined by ESA's various committees of experts who assess the feasibility in terms of satisfying mission requirements, technology maturity, costs and planning, and performance, in particular of launch services. Once an idea is selected, engineers at ESTEC then work out the design step-by-step together with European space industry.

ESA's Concurrent Design Facility (CDF) can be used as part of the design process. 'Concurrent engineering' means all disciplines involved in the process work in parallel, maybe linked via videoconference; each working in their technical domain but following a coordinated, collaborative method. The CDF provides the ideal interdisciplinary communication infrastructure to follow the concurrent systems engineering approach. This real-time interaction between experts in the CDF not only drastically shortens the design cycle, but it also increases design quality, and offers better decision-making and risk management.

Torsten Bieler is a systems and cost engineer. In the CDF, he has to coordinate different technical and engineering disciplines and capabilities. By supporting the team leader with many other specialists, he ensures that the requirements of the project are challenged and satisfied reliably and cost-effectively, to a high quality and on schedule. "It is extremely impressive to see all the requirements that a new mission design has to meet. To work in the CDF with so many highly qualified engineers and see a solution materialise is a deeply satisfying experience!"

→ DEVELOPING THE MISSION

ESA's space missions are developed at ESTEC under the responsibility of a project manager leading a project team and supported by engineering and scientific experts.

"A project manager prepares all elements of the system so that the mission will run smoothly after launch."

– Don McCoy

The project team prepares the mission and system specifications, evaluates the industrial proposals and manages the development contracts for work carried out by European industry and research institutes. The combination of engineering and scientific skills in these teams is a major asset for European competitiveness, and a guarantee for the success of the project.

Don McCoy is project manager for ESA's ExoMars project. He has worked on the Hubble Space Telescope, Huygens, Mars Express and Venus Express. "The launch is the defining moment between preparing for a mission and implementing the mission, but a project manager's role before that is to prepare all elements of the system for this moment so that the mission will run smoothly after launch.

During the spacecraft development there is always the question of whether the design meets the objectives of the mission. As we work through the development of the spacecraft, the design is checked through formal reviews in what ESA calls Mission and System Reviews. These are major milestones in the lifecycle of any space development."

→ TESTING THE SPACECRAFT

ESTEC TEST CENTRE

During the various phases of its development, a spacecraft and all its parts undergo extensive testing. The majority of ESA spacecraft are tested in the ESTEC Test Centre.

The first challenge for a spacecraft is its launch. To verify it will not be damaged during launch, each spacecraft is shaken on large vibrating tables and exposed to acoustic noise levels up to 156 decibels (louder than a jet aircraft taking off).

The acoustic tests are conducted in the Large European Acoustic Facility (LEAF). The biggest and heaviest spacecraft are put on HYDRA, a large hydraulic shaker, capable of generating vibrations equivalent to an earthquake of 7.5 on the Richter scale.

In the Large Space Simulator (LSS), spacecraft are exposed to vacuum conditions and extreme temperatures similar to those found in space. This checks whether the spacecraft will function properly under these extreme conditions. Jean-Luc Suchail takes care of this important test facility. "The ionised particles and heat exchanges in vacuum make space a very hostile environment. Making a machine that works reliably there is an exciting challenge. The LSS can be cooled down to –190˚C on one side and at the same time, powerful lamps can heat up a satellite to over 100˚C, simulating the sunlight and shadow of space."

"Space is a very hostile environment. Making a machine that works reliably there is an exciting challenge."

– Jean-Luc Suchail

→ LESSONS LEARNT

ENGINEERING LABORATORIES

ESTEC's specialised laboratories cover every phase of a mission. During development, these labs test that flight equipment is properly manufactured, and perform endurance tests to ensure that critical technologies will work during the lifetime of a spacecraft and satisfy mission requirements.

The engineering laboratories are involved in technology developments in the relevant fields, using a network of knowledge exchange to stay abreast of developments taking place elsewhere. Davina Di Cara works in one of these facilities, the ESA Propulsion Laboratory. This laboratory tests the electric and the cold gas thrusters now being used on our spacecraft for manoeuvring in space, and helps the space industry to develop the propulsion systems of the future.

"Electric propulsion is a key technology. We're going to use it on BepiColombo, the first European mission to Mercury. It is also important for 'formation-flying' missions, where future satellites could form a giant telescope in space. The force that these thrusters generate is low, but they last longer using very little fuel, making them very efficient. Working on these thrusters feels like I'm making science fiction really happen."

"Electric propulsion is a key technology for ESA's future. I feel like I'm making science fiction really happen."

– Davina Di Cara

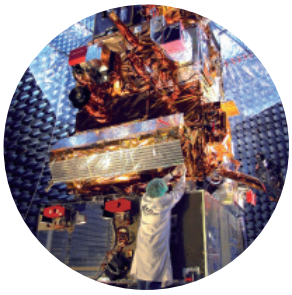
→ WHAT SPACE MISSIONS ARE WE WORKING ON?

At any time, we are working on about 50 space projects, at various stages of development or operations. They cover the fields of space science, Earth observation, telecommunications, navigation and human spaceflight and exploration. Here are some examples...

In operation: Rosetta

Launched: March 2004, en route to target
Rosetta's task is to study comets, which are considered the primitive 'building blocks' of the Solar System. This will help us to understand if life on Earth began with the help of 'comet seeding'. Rosetta is one of the most challenging space missions ever attempted – it will be the first mission ever to land on a comet. After its lander reaches the comet in 2015, the main spacecraft will follow the comet for many months as it heads towards the Sun.

In operation: MetOp



Launched: October 2006
MetOp is Europe's first polar-orbiting satellite for operational meteorology. A series of three satellites to be launched over 14 years, it is the space segment of Eumetsat's Polar System (EPS) for monitoring climate and improving weather forecasting. MetOp carries a new generation of European instruments that offer improved remote sensing capabilities to meteorologists and climatologists.

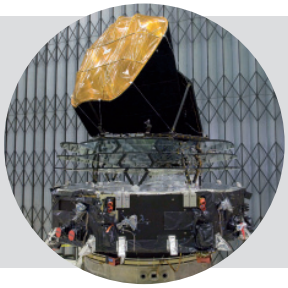
In operation: Columbus

Launched: February 2008
Columbus is one of Europe's main contributions to the International Space Station. With a projected 10 years in orbit, Columbus creates space history as the first European laboratory dedicated to long-term experimentation in 'weightlessness'.

In operation: ATV

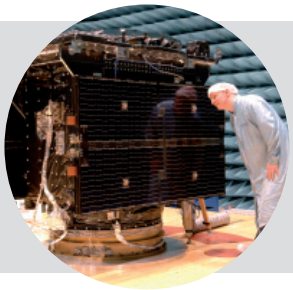
Launched: March 2008
From 2008, the Automated Transfer Vehicle (ATV) is one of the main supply spacecraft for the International Space Station. It will make regular deliveries of experiments and spare parts, as well as food, air and water for the permanent crew. ATV and other major European contributions to the ISS, such as Columbus, have shared much of their development at ESTEC.

Ready for launch: Planck



Launch: 2009
Planck will help provide answers to one of the most important sets of questions asked in modern science - how did the Universe begin, how did it become how we see it today, and how will it evolve in the future? Planck will analyse, to the highest accuracy ever achieved, the remnants of the radiation that filled the Universe immediately after the Big Bang, and that we see today as Cosmic Microwave Background radiation. Planck will be launched on an Ariane-5 rocket together with ESA's Herschel observatory.

In development: Galileo

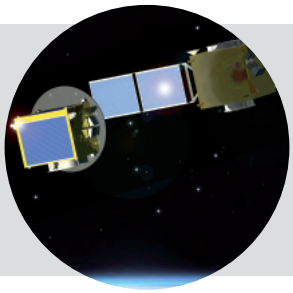


Launches: 2006–13
In a joint effort with the European Commission, ESA is building the Galileo satellite navigation network. Galileo will provide a highly accurate, guaranteed global positioning service under civilian control. Galileo needs a constellation of 30 satellites and an associated network of ground stations spread around the globe, each satellite carrying atomic clocks for precise navigation signals.

In development: Sentinels

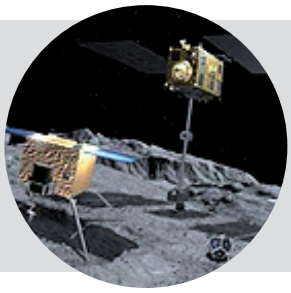
Launches: 2011–15
The Sentinels will be the first series of operational ESA satellites dedicated to the Earth observation needs of GMES. GMES (Global Monitoring for Environmental Security) is a joint initiative of the European Commission and ESA. ESA is also working on multi-mission facilities and ground segment operations for GMES.

Under study: Proba-3



Launch: 2012
The Project for On-Board Autonomy (Proba) spacecraft are some of the most advanced small satellites ever flown in space. Proba-3 will be the third in this series of ESA missions for validating developments in space systems. Proba-3 will demonstrate the technologies required for formation flying of multiple spacecraft. Formation-flying techniques will make new types of missions possible and provide a leap in the performance of future science, Earth observation and application missions.

Under study: Marco Polo



Launch: 2017–18
At ESTEC, we study many candidates for future space missions with European space industry. One of these is Marco Polo, a sample-return mission to an asteroid (Near-Earth Object). A collaboration with the Japanese space agency JAXA, the mission will include approaching and landing on an asteroid, taking samples and returning them safely to Earth. These samples will help us to understand the origins of the Solar System, the role of minor bodies in the process, the evolution of Earth and of life itself.

ESTEC is located in Noordwijk on the Dutch coast, about 35 kilometres south-west of Amsterdam. Around 2000 people work on this site, developing the spacecraft and technologies needed for European space systems.

Science and Robotic Exploration
To expand our knowledge of space and explore the Universe, we must push back the frontiers of science and technology and think far ahead of our times. Our teams take each new scientific satellite from concept to launch, and provide the scientific and technical expertise that later generates maximum scientific benefit.

Human Spaceflight
Here we shape the European contribution to human spaceflight, through exploitation of the International Space Station, and studies and developments for the longer-term exploration of the Moon, Mars and beyond. These developments will benefit people on Earth and prepare Europe for a future in space.

Earth Observation
Observing Earth from space is crucial for understanding of how our planet works, especially with respect to climate change, environmental protection and security. Through numerous missions developed at ESTEC, we realise the innovative technologies in space to enhance many Earth science and meteorological applications.

Telecommunications and Integrated Applications
In the fast-moving world of telecommunications, the latest trends are all-important. In addition to monitoring the performance of ESA telecomms satellites in orbit, we are responsible for managing telecommunications projects and developing technologies for potential integrated applications in fields such as security, health, energy and development.

Navigation
ESTEC offers a number of tools and facilities to external projects to support the development of navigation applications. One of the main facilities is the Radio Navigation Laboratory, a test and simulation facility that supports projects such as EGNOS and Galileo – Europe's global satellite navigation system.

Outreach and communication
Several dedicated teams of specialists involved in outreach and communications are also based at ESTEC, as is the Education Office, which coordinates all ESA's education activities.

Engineering laboratories and Concurrent Design Facility (CDF)
17 laboratories specialising in electrical engineering, mechanical engineering, software and systems engineering, and quality and product assurance.

ESTEC Test Centre
The facilities needed to verify spacecraft performance during launch and simulate the extreme conditions found in space. The size and capabilities of these facilities, for example the HYDRA six-axis hydraulic shaker, offer testing opportunities not available elsewhere in Europe.

Space Expo
ESA's official visitor centre in The Netherlands.

→ WORKING WITH ESA

Doing business with ESA

The ESA Industry Portal is the entry point to ESA when looking for industry news, business opportunities or information on how to do business with ESA. Here you will find the EMITS system, the ESA Electronic Mail Invitation to Tender System that provides online information on the Intended and Current Invitations to Tender from ESA programmes.

Look at www.esa.int/business

Use of ESTEC facilities

The primary role of ESTEC is to manage ESA's space projects and develop the technologies needed in those projects. Our project teams are supported by technical and scientific experts, but ESTEC also makes this same support available to universities, research institutes and national agencies from ESA Member States. In some cases, client organisations are able to perform their own tests using ESTEC facilities, with the assistance of ESA personnel.

Look at www.esa.int/techresources
Email: **contacttec@esa.int**

Networking and Partnering Initiative (NPI)

While technologies developed for space have significant spin-offs for non-space applications, some very advanced technologies developed by universities and research institutes for industrial or domestic applications often have potential 'spin-in' for use in space. We invite universities and research organisations from our Member States to submit innovative proposals that extend their research activities into any technical field relevant to space, and make a vital contribution to Europe's space programme.

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Technology Transfer

Technologies that result from the various European space programmes and are being developed by European industry are made available on the Technology Forum website supported by ESA's Technology Transfer Programme Office. For business incubation or other technology transfer enquiries, please send us an email.

Look at www.esa.int/ttp
Email: **ttp@esa.int**

Young Graduate Trainees

ESA's Young Graduate Trainee (YGT) programme offers recently graduated men and women, a one-year non-renewable training contract designed to give valuable work experience and to prepare for future employment in the space industry and/or research. Opportunities are advertised on the ESA web site in November/December. Candidates should apply via the online application form.

Look at www.esa.int/careers

→ CONTACTING US

If you want to know more about ESTEC, please have a look at our web site, www.esa.int/estec

If you want to get in touch with ESTEC and ESA, please send your question to **contactesa@esa.int**

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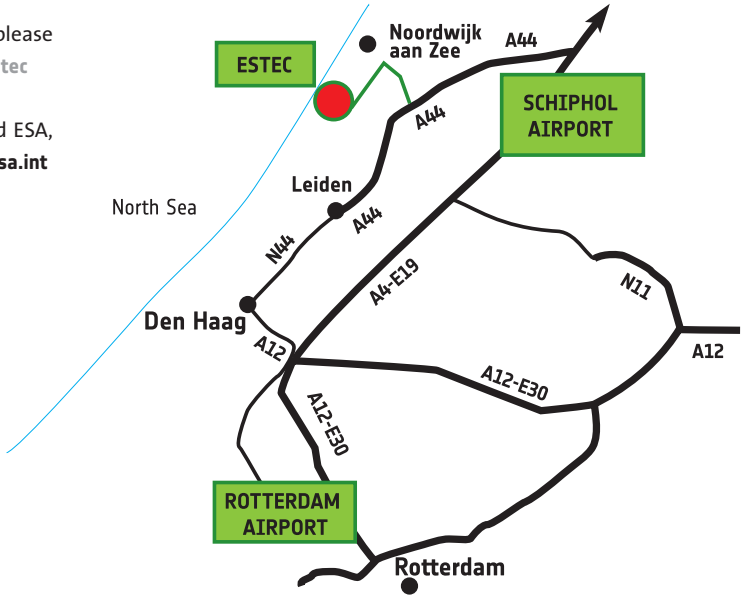

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