

European Space Agency

From the beginnings of the 'space age', Europe has been actively involved in spaceflight. Today it launches satellites for Earth observation, navigation, telecommunications and astronomy, sends probes to the far reaches of the Solar System, and cooperates in the human exploration of space.

Space is a key asset for Europe, providing essential information needed by decision-makers to respond to global challenges. Space provides indispensable technologies and services, and increases our understanding of our planet and the Universe. Since 1975, the European Space Agency (ESA) has been shaping the development of this space capability.

By pooling the resources of 20 Member States, ESA undertakes programmes and activities far beyond the scope of any single European country, developing the launchers, spacecraft and ground facilities needed to keep Europe at the forefront of global space activities.

The Member States are: 18 states of the EU (Austria, Belgium, Czech Republic, Denmark Finland, France, Germany, Greece, Ireland, Italy Luxembourg, Netherlands, Poland, Portugal Romania, Spain, Sweden and the United Kingdom) plus Norway and Switzerland

Eight other EU states have Cooperation Agreements with ESA: Estonia, Slovenia, Hungary, Cyprus, Latvia, Lithuania, Malta and the Slovak Republic. Bulgaria is negotiating a Cooperation Agreement. Canada takes part in some programmes under a Cooperation Agreement.





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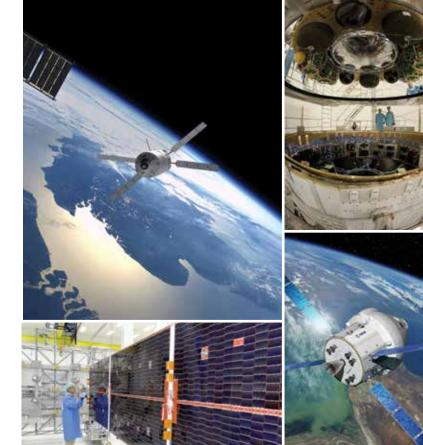


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The Automated Transfer Vehicle (ATV) has the greatest cargo capacity and power of all vehicles that visit the International Space Station. It is the most reliable and complex spacecraft ever built in Europe, combining fully automatic rendezvous capabilities with human safety requirements.

ATV contributes to keep the Station and its permanent crew of six working at full capacity. The spacecraft plays a vital role in Station logistics: it serves as cargo carrier, 'space tug' and storage facility.

Each spacecraft can deliver up to seven tonnes of cargo. ATV provides astronauts with food, water, atmospheric gases and research equipment, but it also helps adjust the Space Station's orbit.

The 20-tonne vehicle is able to navigate on its own and dock automatically with the Station with a precision better than six centimetres.

Once attached, the engines of the European vessel are used to raise the Station to a higher orbit, counteracting atmospheric drag that slowly causes the Station to lose altitude. ATV can even push the Station out of the way of space debris. It also provides attitude control when other spacecraft are approaching the Station.

ATV remains attached as a pressurised module of the Station for up to six months. The spacecraft ends its mission by undocking from the Station filled with a few tonnes of waste. ATV's last journey is a controlled but destructive reentry into Earth's atmosphere.

Servicing the International Space Station

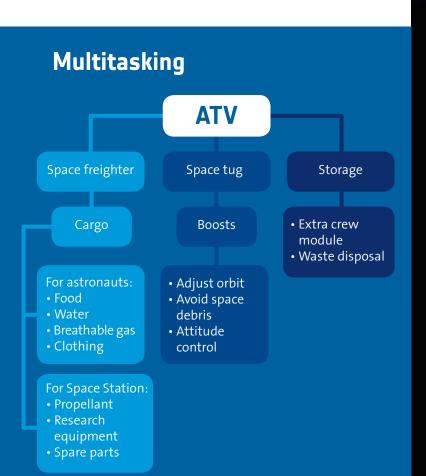
ATV is a service vehicle. With its large capacity it delivers critical supplies to the 450-tonne International Space Station. The spacecraft is Europe's in kind contribution towards its share of the operational costs of the orbital outpost.

The birth of the ATV programme

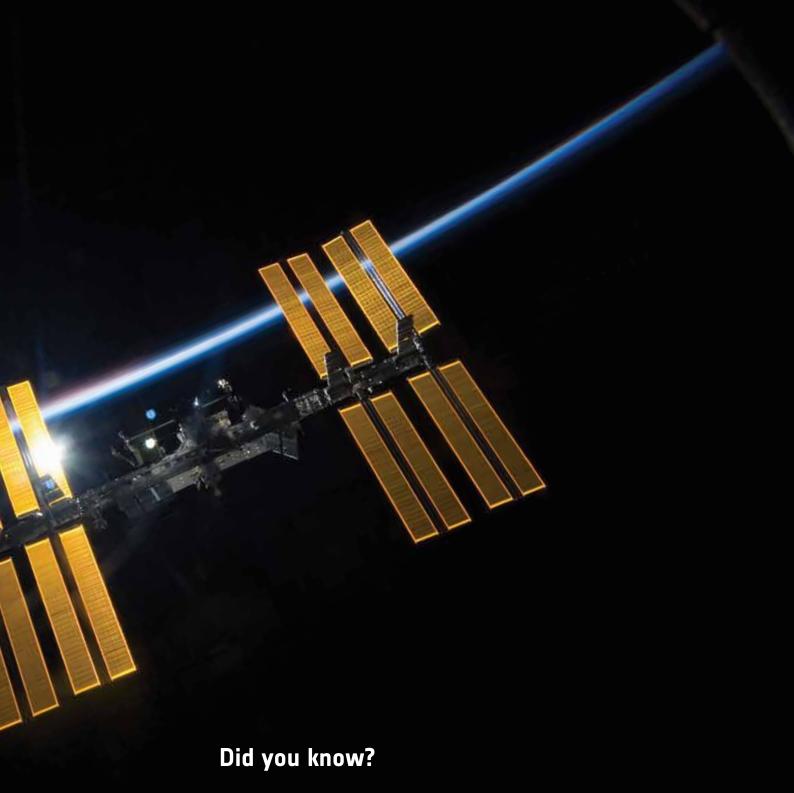
Under ESA's leadership, European industry conducted concept and system studies for an automated supply spacecraft from 1987. In the early 1990s, ESA started joint studies with NASA and the Russians to define ATV missions to the International Space Station.

Europe's formal approval for the ATV development programme came in 1995. At the beginning, only about half a dozen people were part of the production team.

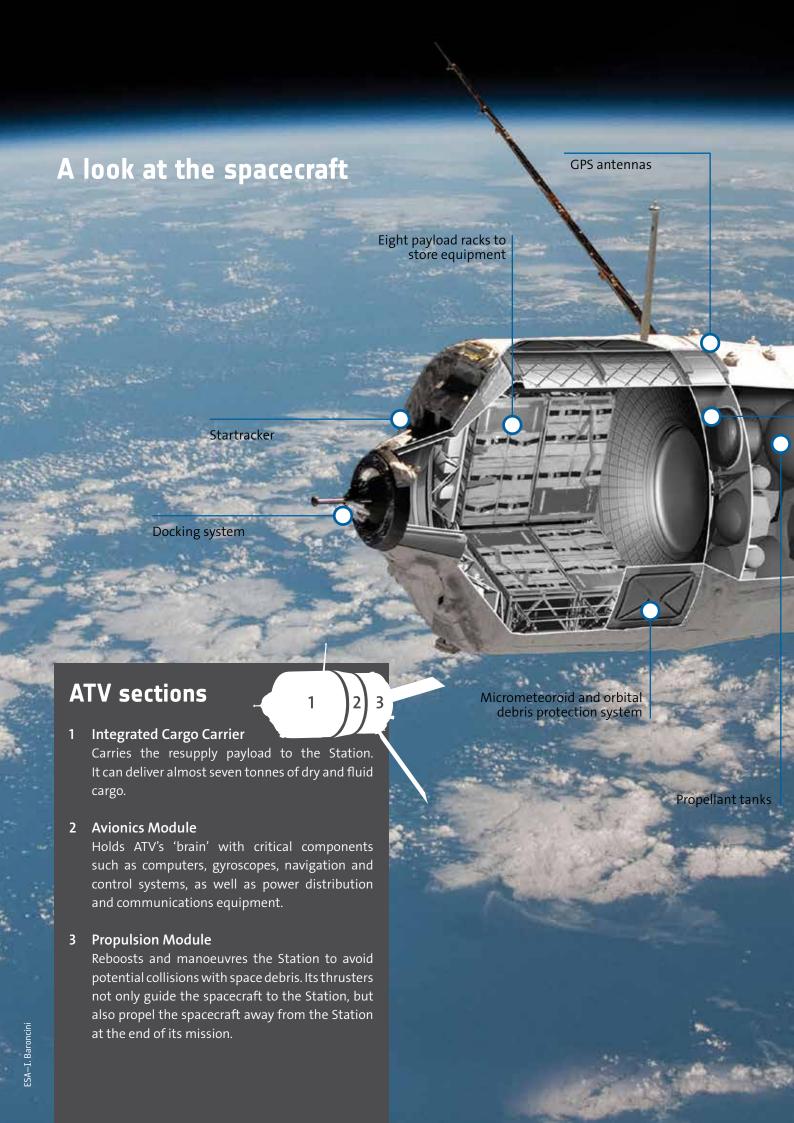
With ATV, ESA gained the right to visit the Space Station with its own space transportation systems. Independent access to the orbital outpost is an important political and operational aspect, as well as a financial asset in contributing to Space Station operation costs.

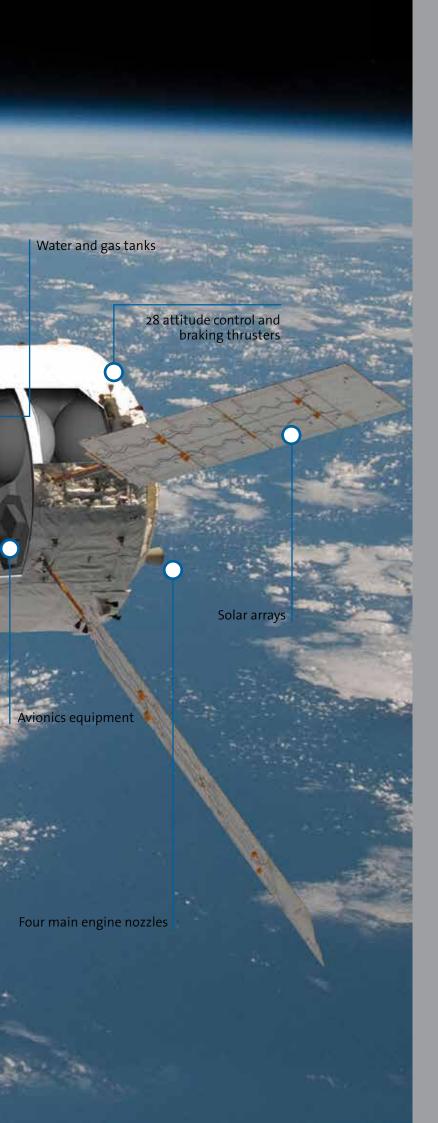






- The Station is larger than a conventional five-bedroom house, with two toilets, fitness facilities and a 360-degree bay window called Cupola.
- In clear skies around sunset or sunrise, the International Space Station can be seen from most places on Earth with the naked eye.
- Unmanned vehicles are used to haul supplies to the Space Station: the European ATV, Russia's Progress vehicles, Japan's HTV Transfer Vehicle and the commercial US spacecraft Dragon and Cygnus.
- The Station's construction in space began in 1998. It has been occupied permanently since 2000. No other space station has been inhabited for longer.
- More than 130 spaceflights and 170 spacewalks have been conducted to build and maintain the Station.





Rocketed into space

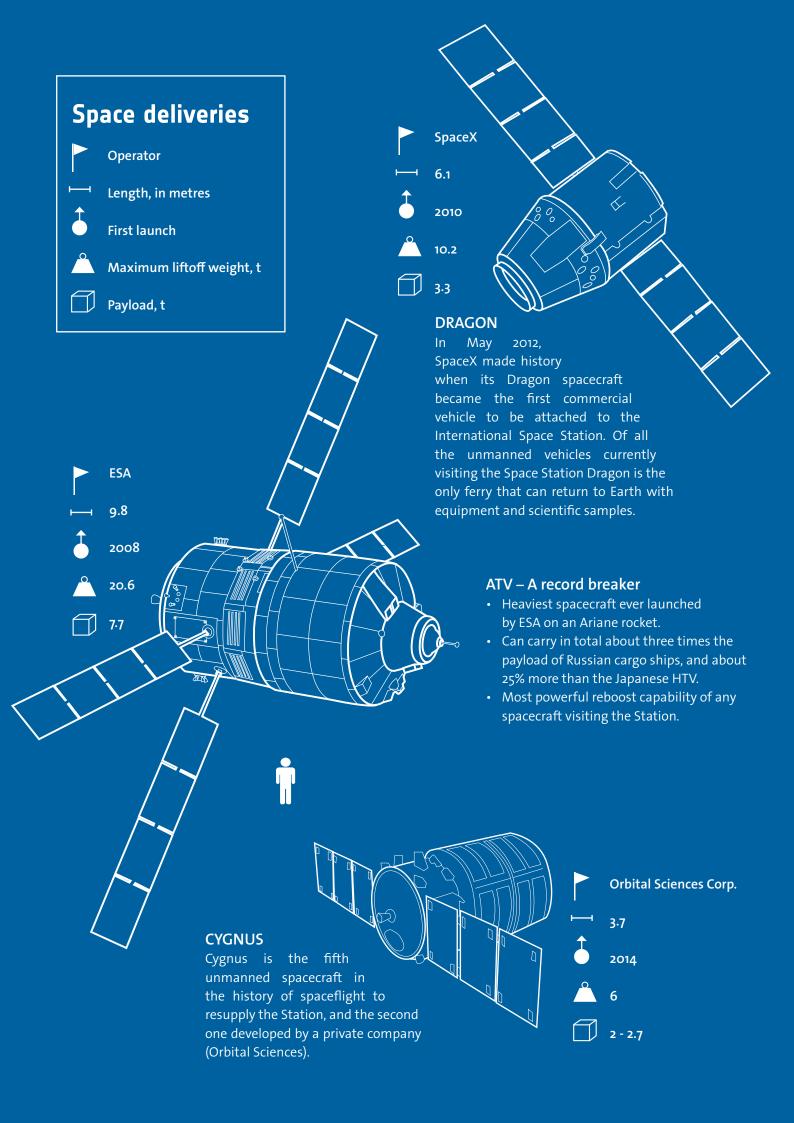
- The Ariane 5 rocket is 52 m tall, equal to a
 15-storey building.
- When Ariane 5 lifts off the launch pad, it weighs over
 760 tonnes, equal to around 500 cars.
- Ariane 5 takes ATV into a 260 km circular orbit,
 20 times higher than a passenger aircraft's cruising altitude.

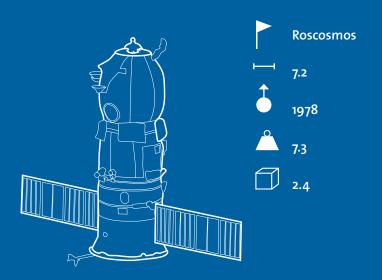
Cosmic automation

- A startracker combined with a GPS receiver is the modern equivalent of centuries-old navigation techniques based on timekeeping and observing the stars.
- ATV docks with the Space Station by hitting a target
 60 cm wide with a precision of 6 cm while
 circling Earth at a speed of 28 000 km/h
 at an altitude of around 400 km.
- ATV operates with 4800 W generated by its four solar wings, more than the electricity used by household water-heaters.
- Its software has 450 000 lines of code,
 the most complex software ever developed by ESA

Lift the Station

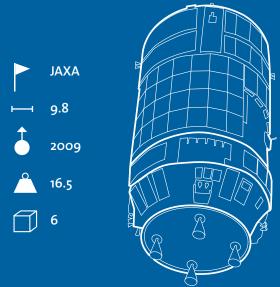
- The International Space Station loses altitude by
 50–100 m each day.
- The second ATV of the series, Johannes Kepler, holds
 the record for the largest space boost
 since the Apollo missions to the Moon: it raised the
 Space Station's orbit by 40 km in one go.
- Propulsion combo: ATV has 32 thrusters
 consisting of four main engines with 28 attitude
 control and braking thrusters.
- The propulsion system also comprises
 68 electric valves, 84 pressure sensors
 and nearly 200 temperature sensors and heaters.





PROGRESS

Progress is the longest-serving unmanned cargo spacecraft — it has been carrying fuel and other supplies to all space stations since 1978. The Progress-M version is currently flying three to four times yearly to the Space Station carrying over two tonnes of supplies each. It is about the same size and shape as a Soyuz and uses the same docking ports.



HTV

The Japanese cargo ship Kounotori, also known as HTV, carries around five tonnes of supplies, science gear and spare parts to the International Space Station. Unlike Russia's unmanned Progress supply ship and Europe's ATV, the spacecraft can carry both pressurised and unpressurised cargo.

What makes ATV different?

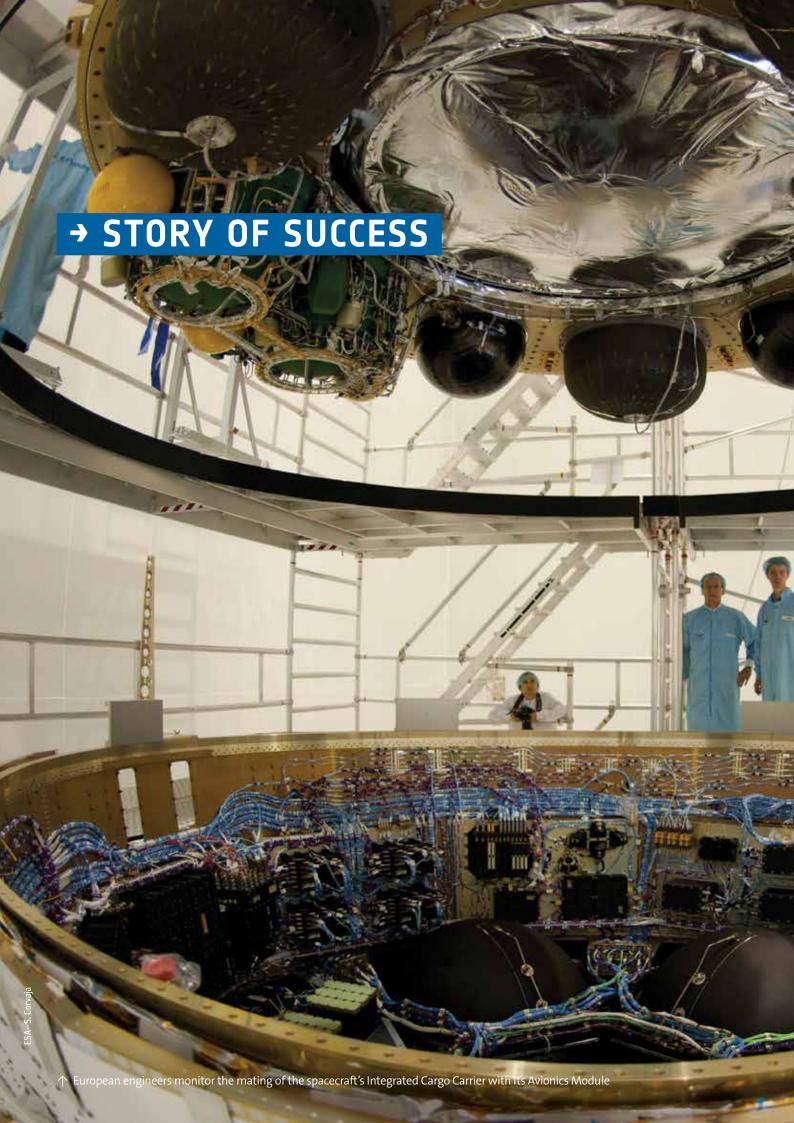
There are at least two things that make this multipurpose spacecraft unique: its flexibility and precision.

The Station's needs change constantly, and there are always last-minute requests from mission control, astronauts and scientists. The versatile ATV allows a diverse mix of payloads, making it possible to adapt the amount of dry cargo, water, gas and propellant for each mission.

In addition, the space ferry has room for last-minute items. A special lift with a rotating platform is used to load each corner of ATV's pressurised module with all sorts of cargo – from heavy bags to crew care packages – during the last weeks before launch. This allows for greater flexibility when ATV is already on top of its Ariane 5 rocket.

ATV's accuracy makes it excel in orbit. Highprecision navigation systems guide the spacecraft on a rendezvous trajectory to the International Space Station. The docking of the fourth ATV was so precise that the spacecraft was only 11 mm off centre when it hit the Station's Russian service module, reaching its target without even touching the surrounding docking cone used to guide less precise spacecraft.

Europe's most complex spacecraft has a high level of autonomy to navigate on its own and control its automatic rendezvous capability. Besides Russian and Chinese spacecraft, ATV is the only vehicle that has mastered automatic docking. All other vehicles are berthed to the Space Station with the help of robotic arms.





Since its first voyage in April 2008, the Automated Transfer Vehicle has been a vital supply ship for the Space Station. After five missions in a row, Europe's space freighter has grown to become a pillar of Station logistics.

The ATV series confirms European reliability in space transportation. One of the keys to success is its flexibility – ATV is upgraded after every mission and adapts its cargo to the Station's needs.

ESA and European industry worked together to ensure ATVs were ready for the space endeavour. The programme has built important engineering capabilities for orbital spacecraft, from extremely accurate autonomous docking to free-flight operations. New procedures and specific training for contingency situations strengthened ATV operations.

The most innovative spaceship ever developed in Europe is also the only Space Station vehicle to operate trilaterally. Europe, Russia and the United States cooperate closely to make ATV missions a success.

ATV overview

ATV Jules Verne

- **▲** 9/03/2008
- **★** 29/09/2008
- **(**) 205
- First automated docking of an European vehicle
- Δ 6
- 震 1

ATV Johannes Kepler

- **16/02/2011**
- **1** 21/06/2011
- **(**) 126
- Largest boost since the Apollo missions to the Moon First time a European astronaut welcomed ATV
- Two ESA astronauts in ATV: Paolo Nespoli and Roberto Vittori
- Å GeoFlow II
- **∂** 5



Total Cargo: 4575 kg



Total Cargo: 7100 kg

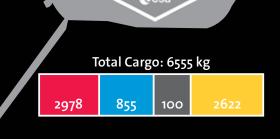
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LEGEND ♣ Launch ♣ Debris avoidance manoeuvre ♣ Deorbit Propellant O Days in Space Records Water Gas

Dry cargo

Late load cargo

- © Cargo anecdote
- 🖔 Science payload
- **∂** Reboosts



ATV Edoardo Amaldi

- **23/03/2012**
- **V** 04/10/2012
- **(**) 196
- Longest attached phase to Space Station: 184 days Launched just one year after its predecessor
- Pump to recycle urine into drinkable water
- Tiles for Altea-Shield
 Biolab Life Support Module 3
 Energy collection kits
- و 🖨

ATV Albert Einstein

- **♦** 05/06/2013
- **v** 02/11/2013
- **(**) 151
- Docked to the Space Station with maximum accuracy
- © Reentry seen from space 3D-printed toolbox
- Å FASES sample container
 New microscope for Biolab
 Sample Cartridge Assembly
 Energy collection kits
- 6



Total Cargo: 6595 kg

4206

285

100

2200



Total Cargo: 6590 kg

			1109
3440	570	100	2489

ATV Georges Lemaître

- **1** 25/07/2014
- Reaviest spacecraft ever launched by Ariane 5: 20 275 kg
- Includes piece of meteorite 'Field of the Sky'
 Pump to recycle urine into drinkable water
- A Shallow reentry experiments (REBR-W , I-Ball, BUC) Electromagnetic levitator Rendezvous demonstrator



↑ Launch. A launch is one the most challenging moments in a mission. ATVs are launched into orbit from Europe's Spaceport in Kourou, French Guiana. ATV *Georges Lemaître* is the heaviest spacecraft to be orbited by any Ariane rocket so far, with a mass of 20 275 kg.



↑ Docking. During the last 250 m until contact with the Space Station, ATV's state-of-the-art automatic rendezvous system employs a videometer's eye-like sensors that analyse laser beams. Despite its mass of about 20 tonnes, the ferry can manoeuvre itself to within a few centimetres.

Getting better all the time

The maiden flight of ATV *Jules Verne* marked the first rendezvous and docking by a European spacecraft in a resupply mission to the International Space Station. Since then, continuous improvements have been made.

After the first mission, post-flight analysis came up with 130 technical recommendations and about 30 of them were incorporated into the design of following ATVs. ATV teams repeat this exercise for every mission and agree on corrections and work-around solutions. Reviews with industry and partners are part of the business.

The challenge is to upgrade the spacecraft in every mission and yet deal with an ever-changing cargo manifest. Time adds extra pressure, pushing European production and integration chains to work at full capacity.

ATV Johannes Kepler was the first production unit. From a one-of-a-kind spacecraft, the Automated Transfer Vehicle became a frequent flyer with a target launch rate of one a year. Typically, there is half a year from the end of a mission to the launch of the next ATV, and that leaves very little time to implement upgrades to the next spacecraft.



↑ Rendezvous. After launch, a high-precision navigation system guides ATV on a rendezvous trajectory towards the Space Station. ATV *Jules Verne* was the first European vehicle to perform an automated rendezvous. In this image, ATV *Edoardo Amaldi* is free-flying against the dark background of space with its thrusters firing.



↑ Reentry. Each ATV mission ends with the spacecraft burning up harmlessly in the atmosphere over an uninhabited area of the Pacific Ocean. The fifth and last Automated Transfer Vehicle carries several instruments to gain valuable data on spacecraft reentries.

A major advantage of this tight rhythm is that communication and efficiency within ATV teams increased exponentially. Engineers working on the hardware did not have to wait long to see it being launched into space. The nature of the ATV programme allowed them to check end-results and look for possible solutions as they happened.

From electrical failures and a stuck communication antenna boom, to detached thermal blankets and fans that refused to work, all Automated Transfer Vehicles have had a number of small flaws that did not jeopardise the missions.

The Automated Transfer Vehicles are very reliable by design. The key word is safety — and this governs all operations. When docking, there are at least three safety barriers to protect the International Space Station and its crew.

ATVs became much more accommodating to last-minute cargo requests. One of the most welcomed upgrades on ground was the Late Cargo Access Means. This special lift with a rotating platform allows each corner inside the pressurised module to be reached even after an ATV has been placed on its launcher. The lift, that includes a telescoped handling arm, is used to load larger and heavier bags according to the Station's needs.

Team spirit

There is nothing like constant challenges to build a strong team-culture. People working on the European spacecraft are extremely committed to it, and most of them won't hesitate to declare it as the best part of their careers.

A great sense of cooperation emanates from all the teams involved in the ATV project. Even with short turnarounds, team spirit opened the door to success for ATV missions.

ATV navigates, flies and docks with the Station automatically, but it does require some ground support.



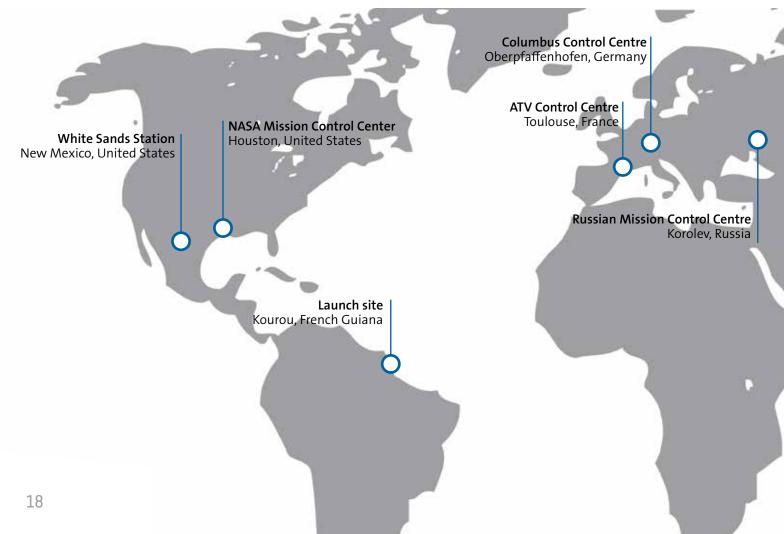
Throughout its mission, the spacecraft is monitored and commanded from the ATV Control Centre (ATV-CC), which works day and night in close coordination with the other control centres in Russia and the US. ATV-CC is responsible for directing in-flight operations and coordinating ground resources. Every command is run in agreement with the Space Station partners.

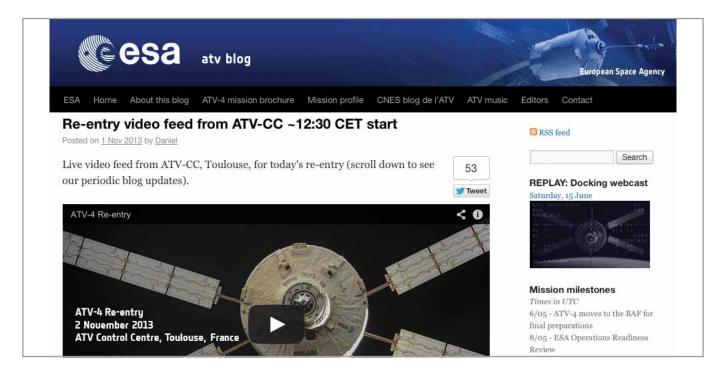
Three space agencies, three different engineering cultures. The trilateral nature of this complex space vehicle kept the teams open-minded. The ATV project allowed common approaches to design, construction and control to be developed.

Made in Europe

It is no coincidence that Automated Transfer Vehicles are named after great European scientists and visionaries. The vessels carry their names to highlight Europe's deep roots in science, technology and culture.

The ATV project involves dozens of companies and thousands of technicians and engineers across Europe. Each spacecraft is the happy conclusion to a complex industrial cooperation that goes beyond agencies, companies and borders.





A highly-skilled workforce of ESA employees and European industry makes the development of advanced space systems and technology for ATV possible. Airbus DS is the industrial prime contractor for production. It manages more than 30 subcontractors and about 2000 people, integrating all subsystems that come from around 10 European countries.

Arianespace, the world's first commercial space transportation company, developed the Ariane 5 ES launcher specially for ATV with a reignitable upper stage. Throughout its missions, ATVs are monitored and commanded by the ATV Control Centre in France, working day and night in close coordination with other control centres in Russia and the US.

ATV is not only a European endeavour. The project includes the cooperation of Russian companies, that built the docking mechanism, the refuelling system and the electronics. A number of US companies are also involved with the video targets, lights and propulsion components.



A blogging phenomenon

ESA's ATV blog has become a major communication success. It is an extremely popular source of information and is now permanently linked and regularly cited by numerous top-level media and space enthusiast sites, as well as social media.

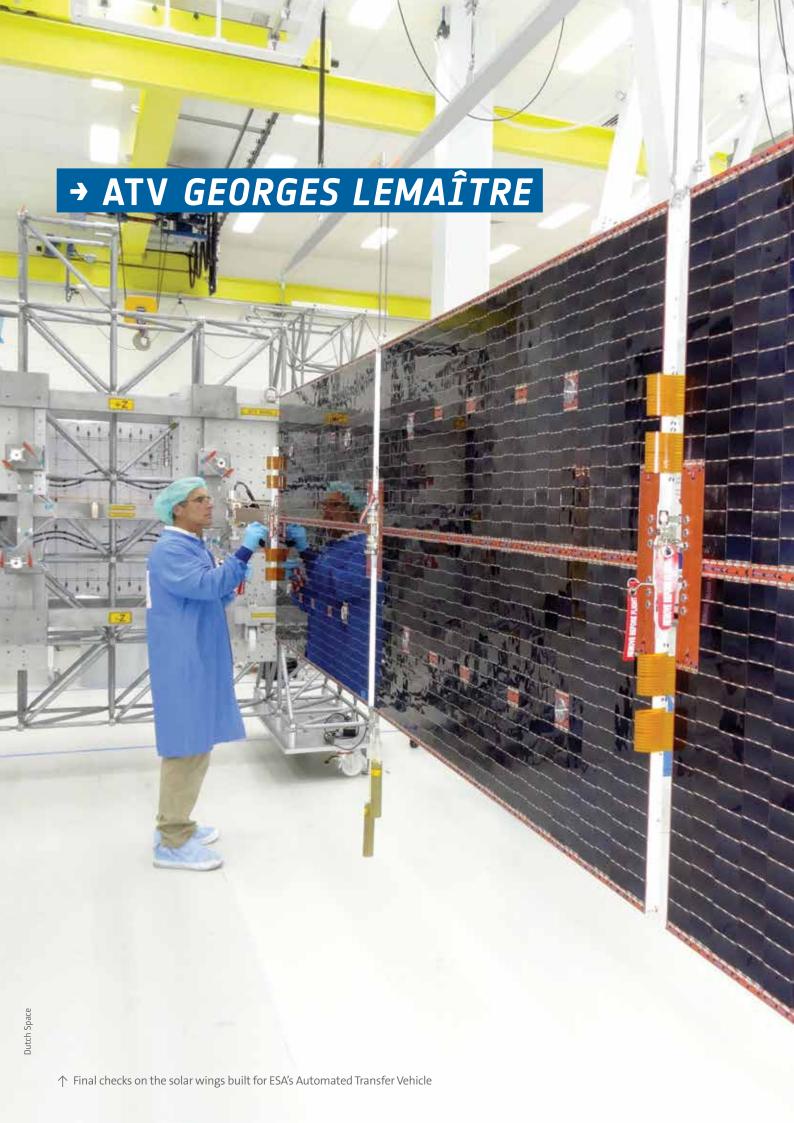
Since 2010, almost 621 000 page views plus millions of content impressions linked via ESA's Facebook page confirm the success of its formula: an editorial 'human touch' with quotes, interviews, video and comments published in a friendly and informal style.

The blog has won a reputation for being the authoritative source for mission updates as they happen. Even the ATV mission directors answer directly to blog visitors.

Since 2013, ATV social media coverage has expanded to include the popular @esaoperations Twitter channel. This has generated an additional 35 million views of news and real-time updates from Kourou, the ATV Control Centre and the International Space Station.

Any and all aspects of the ATV mission are covered, from the launch campaign, astronaut training, lift-off and docking through to the attached and reentry phases. The blog provides quick, real-time updates during critical mission phases. It is especially trafficked during peak times, and was visited by over 23 000 readers during the ATV *Edoardo Amaldi* docking in just 10 hours.

blogs.esa.int/atv/





The European spacecraft starts its fifth – and last – voyage to the International Space Station loaded with more water and dry cargo in its hold than any other ATV mission to date. Named *Georges Lemaître*, after the Belgian astronomer and cosmologist, the spacecraft is scheduled to lift off in the summer from Kourou, French Guiana, on top of the Ariane 5 heavy-lift launcher.

Following the path of its predecessors, ATV *Georges Lemaître* is ready to fulfil its duty of resupplying the crew with food, water, oxygen and research equipment. It will also adjust the Space Station's orbit during its six months attached to the orbital outpost.

The last ATV in the series is carrying nearly 6.6 tonnes of supplies to the Station. While ATV *Georges Lemaître* will carry a record amount of around 2620 kg of dry cargo, this time there is less propellant for reboosting the Station. For the first time, the space freighter's three water tanks are fully loaded, totalling 850 litres.

The European spacecraft is delivering critical equipment for science research. Included in its cargo are several units for the Electromagnetic Levitator, a facility that allows melting and solidifying metals as they float freely thanks to weightlessness in space.

Experience with ATV Georges Lemaître could help develop tools for a rendezvous with a non-cooperative object such as space debris or an asteroid. The spacecraft will serve as a test-bed for a suite of optical-sensor prototypes to home in on targets, based on a long-range infrared camera and a short-range 3D imaging sensor.

No ATV mission is the same as its predecessor, and relaxation is not an option for the teams. Experience and confidence gained from previous missions allows them to master the complex vehicle's operations while staying focused.

Key data

Launch site Kourou, French Guiana

Launch date25 July 2014LauncherAriane 5 ESDocking12 August 2014UndockingDecember 2014 /

January 2015

ATV-5

Diameter4.5 mLength9.8 mTotal vehicle mass12 039 kgSolar array span22.3 m

Ariane 5 ES launcher

Height50.5 mDiameter5.4 mLiftoff mass760 tonnesPayload mass after launch19.8 tonnes

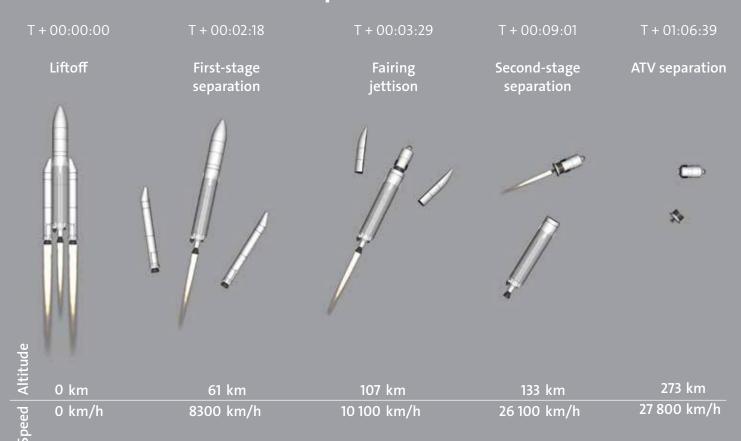
Exact launch and docking date may change.

ESA astronaut Alexander Gerst will be the prime operator monitoring *Georges Lemaître* as it approaches the Station, a role that should not give him too much work: the 20-tonne vehicle will navigate on its own and dock automatically. Once attached, ATV is used as an extra living module by the astronauts on board.

At the end of its mission, the vehicle will undock from the orbital outpost filled with a few tonnes of waste water, materials and equipment. By then, it should be ESA astronaut Samantha Cristoforetti who monitors the undocking, during her mission on the International Space Station later in 2014.

A set of cameras and sensors will record an extensive amount of reentry data as ATV *Georges Lemaître* falls through Earth's atmosphere, following a new, shallower, trajectory. This information will help ease the decommissioning of the Space Station when its time comes.

Destination: International Space Station

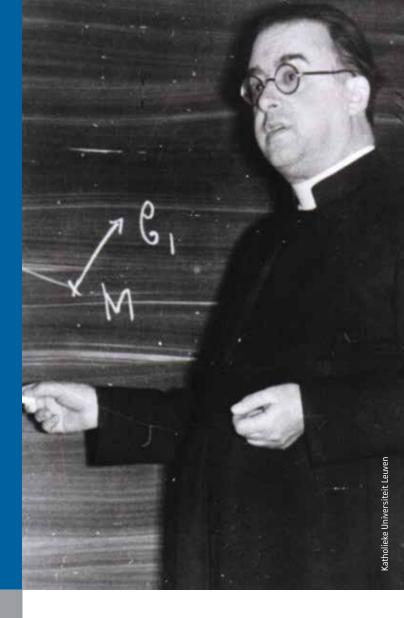


Georges Lemaître: a Belgian genius and the beginning of time

When Georges Lemaître was born in 1894 most scientists thought that the Universe was infinite in age and constant in its general appearance. The astronomer, professor of physics and Catholic priest suggested that the world had a definite beginning in which all matter and energy were concentrated in one point. The theory of the Big Bang was born.

He discovered a family of solutions to Einstein's relativity equations describing an expanding Universe rather than a static one and provided a first observational estimation of the Hubble constant.

Lemaître continued to advance science throughout his life. He studied cosmic rays and worked on the three-body problem concerning the motion of three mutually attracted bodies in space. He died in Louvain, Belgium, in 1966, at the age of 71.



Rendezvous and docking Attached phase Up to two weeks Six months

Debris is coming

Micro-meteorites and space debris are no joke: travelling at speeds of up to 72 km per second, even the impact of a fleck of dried paint can have serious effects. ATV has a metal shield that acts like a bumper and stops anything from penetrating critical hardware.

Should telescopes and radars on Earth detect any threats, ATV's propulsion system can adjust the Station's orbit and perform a debris avoidance manoeuvre. These manoeuvres are crucial in ensuring Station and crew safety, and usually require hours of planning.

Impacts from space debris are a rare occurrence. The debris avoidance protocol is only activated when the probability of collision is greater than 1 in 100 000. ATV *Jules Verne* carried out one of these manoeuvres in 2008 to avoid debris from an old satellite.

Critical mission phases

During an ATV flight – from launch to docking, and from undocking to reentry – a dedicated 60-person team works together to control all procedures. Over 5000 commands can be sent to ATV which, in turn, can transmit up to 35 000 telemetry parameters.

Such a flow of information requires multiple telecommunications systems and constant communication between ATV Control Centre, the mission control centres in Houston and Moscow, and the International Space Station itself.

Launch

The 760-tonne Ariane 5 launcher takes off from Kourou, French Guiana.

Separation from launcher

About one hour after launch, ATV separates from the upper stage of the rocket. A high-precision navigation system guides the spacecraft on a rendezvous with the Space Station.

Free-flying phase

ATV Georges Lemaître will take its time to get to the Station. While a startracker calculates the vessel's orientation by identifying constellations in the sky, a GPS receiver allows it to calculate its position. ATVs can stay free-flying in space for up to two weeks, but ATV-5 mission plan estimates around a week of total flight time, including a fly-around of the Space Station for testing optical-sensor prototypes.

Pre-homing

A precise sequence of engine burns takes ATV to a hold point some 30 km from the Space Station, from where the spacecraft aligns itself and then continues to the Station.

Closing

During the last 250 m, ATV's state-of-the-art automatic rendezvous system employs its videometer's eye-like sensors to calculate distance, speed and angle relative to the docking port on the Russian Zvezda module.

Rendezvous and docking

The 20-tonne ferry manoeuvres itself and docks with the International Space Station in roughly three and a half hours with a precision of better than 6 cm.



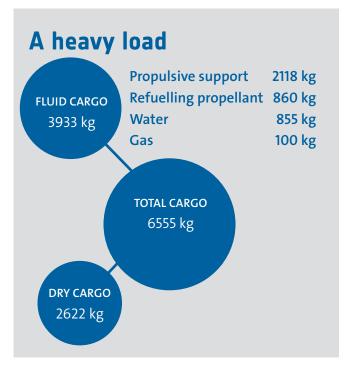






Loaded for the last round

Europe's ATV heavy-hauler is carrying a varied mix of cargo on its last trip. Permanently crewed since 2000, the International Space Station and its astronauts depend on regular deliveries to keep functioning.







Water

There are two types of drinking water on the International Space Station. Russians and Americans add different agents to it to prevent bacterial growth in the drinking water: silver ion or iodine. ATV supplies the Russian tanks with water from a source rich in natural minerals that is close to Turin, Italy. The spacecraft is also delivering the Fluids Control Pump Assembly, a critical piece of the system that recycles urine into drinkable water that could affect the Station's life support systems.

Gas

ATV Georges Lemaître can carry different types of gas: oxygen, air and nitrogen. Oxygen is used to increase pressure in the Station but air, of which 21% is oxygen, is usually used after a spacewalk to pressurise quickly.

Propellant

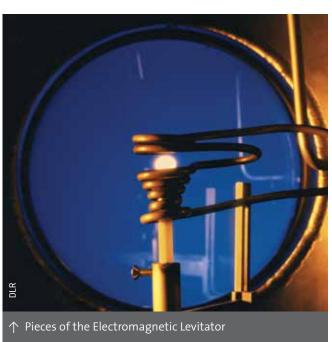
Of all the vessels that deliver cargo to the Station, ATV brings the largest quantity of fuel. *Georges Lemaître* is focused on delivering propellant: its main payload is nearly three tonnes of fuel, most of it used to reboost the Station. Nearly one third of it will be used to replenish Russian fuel tanks on the orbital outpost, allowing the Station to perform its own attitude control and boosts when no docked vehicle is available.



Lab supplies

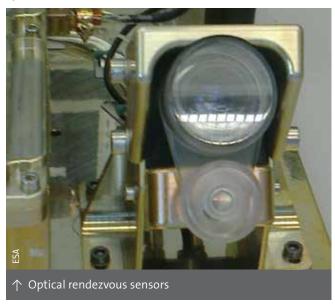
Levitating science

The Electromagnetic Levitator provides unique experiment opportunities for melting and solidifying metallic samples without containers. ATV carries several units to allow this facility to process materials up to a temperature of about 2000 °C.



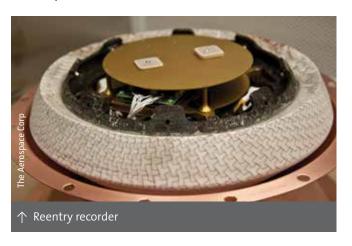
Eyes on Station

New navigation technologies will observe the Station from different angles and ranges to help design better sensors for future rendezvous with a space station or an asteroid. ATV *Georges Lemaître* will perform a fly-around a few days before docking to gather as much footage as possible with special cameras and a short-range 3D-imaging sensor installed on the spacecraft's front cone.



Time for destruction

The last spacecraft in ESA's family of Automated Transfer Vehicles will contribute to the Space Station's final moments. Due to the size of the orbital outpost, there is a risk of fragments bouncing back into space off Earth's atmosphere, much like a flat stone skimming across a pond. Until now, ATVs reentered at a steep angle to reduce the area of collision with Earth's atmosphere. ATV *Georges Lemaître* will perform a shallow reentry. Three different experiments (designated REBR-W, IBall and BUC) will generate precious information about the break-up for future reentries.





Swan song

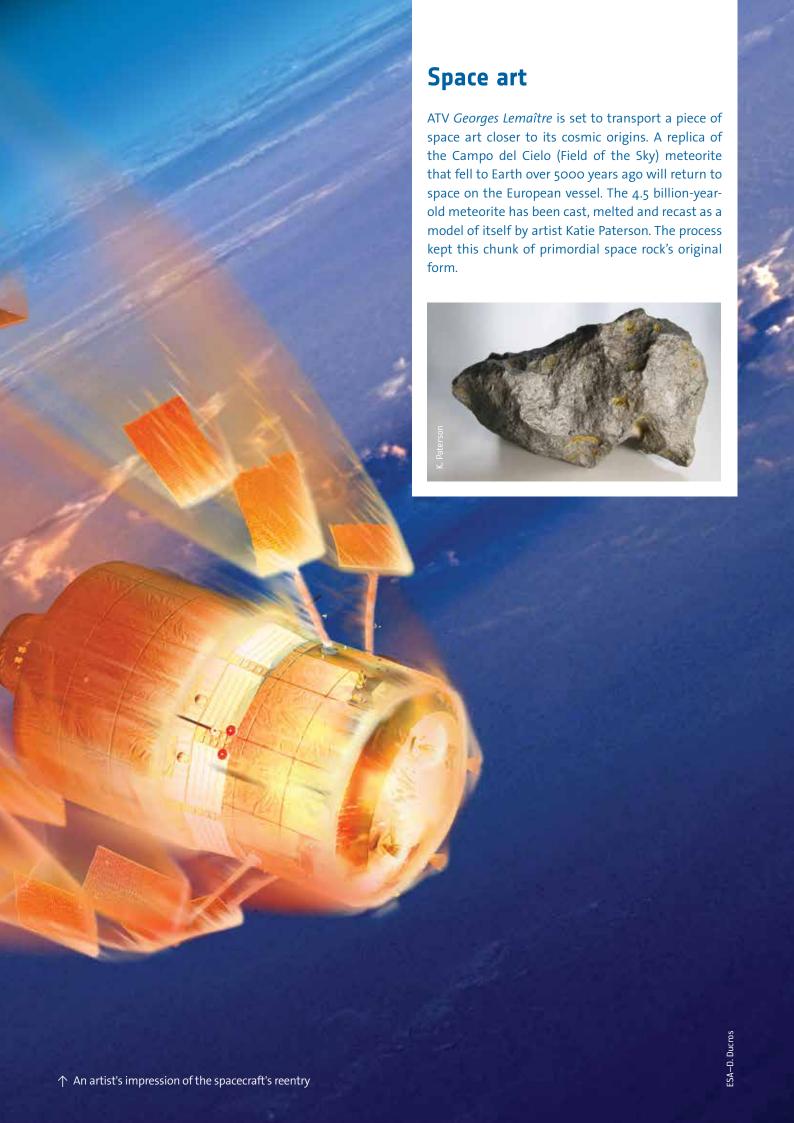
ATV Georges Lemaître remains a pressurised part of the International Space Station for up to six months. Once its resupply mission is complete, the European vehicle leaves with up to six tonnes of Station waste. ATV's last journey will be a controlled and destructive reentry into Earth's atmosphere, the shallowest ever in the series.

While attached to the Station, astronauts gradually remove cargo from ATV and fill it with liquid and dry waste to clear space in the Station. Once all the cargo is transferred and the reboosts are completed, *Georges Lemaître* is ready to leave.

The return flight starts with a thruster burn that pushes ATV back and away from the Station. About 24 hours later it will break apart and burn up harmlessly over an uninhabited area of the southern Pacific Ocean.

ATV Georges Lemaître will depart with a final gesture before its mission ends. Its 'big dive' will differ from past ATV missions as its engines will deorbit the spacecraft on a shallower flight-path. This reentry angle will help plan the Space Station's end of life. While the date is still unknown, engineers are already looking into a reentry strategy for the Station.

ATV's swan song will be in the spotlight on a moonless night. A camera from the Station flying just above ATV's reentry path together with the three experiments on ATV and ground-based telescopes will make the reentry the most-recorded mission end for a European spacecraft.







A versatile showcase of European space capability, ATV will have a second life after completing its resupply role for the International Space Station. The spacecraft's distinctive X-wing shape will not disappear from space history.

ESA is studying ways of developing its successor, an ATV-derived service module to support NASA's Orion spacecraft. This vehicle will carry astronauts farther into space than ever before.

ATV heritage

The duration, assigned resources and technical complexity of the ATV programme have no equal in the history of European spaceflight. Lessons learned from building and operating the spacecraft have delivered enormous know-how. ESA is already pursuing the exploitation of this expertise and technology for future spaceflight applications.

ATV's success is backed by nearly two decades of international partnership. The priceless experience of close cooperation between different engineering cultures and teams is paving the way for joint projects on human space exploration in coming decades.

The European space vessel was designed to be flexible, so that it can be the basis for developing a wide variety of new space vehicles. ATV technologies could be used for automated missions such as controlling space debris or servicing other spacecraft in-orbit. ATV could evolve into an unmanned free-flying laboratory or even a space tug carrying tonnes of supplies to lunar and Martian orbits.

With the ATV series coming to an end, ESA had to decide between building a sixth spacecraft or developing something new. The choice was a future-oriented evolution. ESA began discussing options about building a new spacecraft together with NASA. The vehicle will build on the heritage of ATV-derived technology that has proven itself after its flawless missions.

US companies have already benefited from ATV heritage. The Cygnus spacecraft, a commercial spacecraft built by Orbital Sciences, uses ATV systems for its missions to the Space Station. European industry benefit from the extra business from Cygnus.

Leaving Earth orbit

ESA is ready to face the new challenges of space transportation – a European module will power NASA's Orion spacecraft to the Moon and beyond.

This will be the first collaboration between ESA and NASA on a crew transportation vehicle beyond low Earth orbit. Providing the service module for Orion will be ESA's remaining in-kind contribution to the Space Station partnership. The plan allows European industry to capitalise on ATV technology while significantly cutting research and production costs for NASA.



The project will create highly skilled jobs for Europeans in an innovative sector ensuring future space endeavours. Sending European astronauts on Orion is, of course, on the European space community's wishlist.

Orion

Orion's official name is 'Multi-Purpose Crew Vehicle' as the spacecraft can be used to complete different missions.

If everything goes according to plan, the spacecraft will transport up to four astronauts to space and bring the crew safely back to Earth.

The first Orion flight will be Exploration Flight Test-1, in which Orion will fly to an altitude of around 5700 km above Earth's surface, farther than a manned spacecraft has gone in 40 years. The objective of its

maiden flight is to test the crew module at high reentry speeds. No astronauts will be on board this time and an adaptor will be put in place to simulate the structure of the service module.

The European Service Module will fly on Exploration Mission-1, the first flight of the completed Orion spacecraft. The Service Module will feature ATV-derived technologies to provide propulsion and power to the spacecraft as well as much-needed oxygen, nitrogen and water for future astronaut crews.

The Exploration Mission-1 will be an uncrewed lunar flyby, returning to Earth's atmosphere at 11 km/s — the fastest reentry ever. The flight is set to take place at the end of this decade.



European Service Module

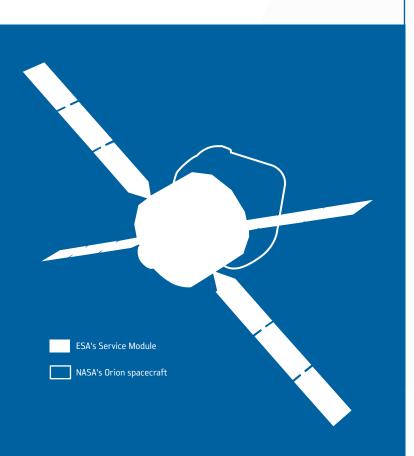
Orion is a delicate spacecraft with demanding functional requirements. The European Service Module will be located directly under its crew module. Extending from the main body of the spacecraft are ATV's characteristic X-shaped solar arrays.

This is the first time ESA will cooperate in such a critical part of a NASA spacecraft. The entire development will take place in Europe after which US engineers will take care of integrating the European Service Module with Orion.

The main design and the expertise gained throughout a decade of ATV development will be reused for the Orion spacecraft. ESA is implementing new techniques to redefine and qualify the Service Module, and will provide support during the missions in case of anomalies.

The Service Module will be heavily based on ATV technology. It will provide four major system functions to the capsule: propulsion, power, thermal control and vital resources for the astronauts, such as water and a breathable atmosphere. All those basic functions and several other components are the same as used on ATV.

The European Service Module also houses Orion's main engine, thrusters and fuel needed for orbital transfers, attitude control and high-attitude ascent aborts.





Spot the differences

Thermal control system

Based on an active fluid thermal loop as used on the Space Station rather than the heat pipes used on ATV and many other satellites. Thermal radiators surround the propulsion tanks.

Main engine

Identical to the engines used by the Space Shuttle for its orbital manoeuvres.

Solar panels

ATV's wings will get a significant upgrade. Slightly shorter but wider, Orion's solar panels will use gallium arsenide technology and supply more electricity, up to 11 kW, or enough to power the energy needs of a typical household. These newer European solar panels offer 30% efficiency converting solar energy, ATV's solar panels manage around 17%.

2.7 m long and 4.5 m in diameter, similar to an ATV but half as long. The Service Module may provide additional volume and other resources for missions, for example by accommodating scientific experiments, engineering demonstrations or deploying lunar equipment.

Extras

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