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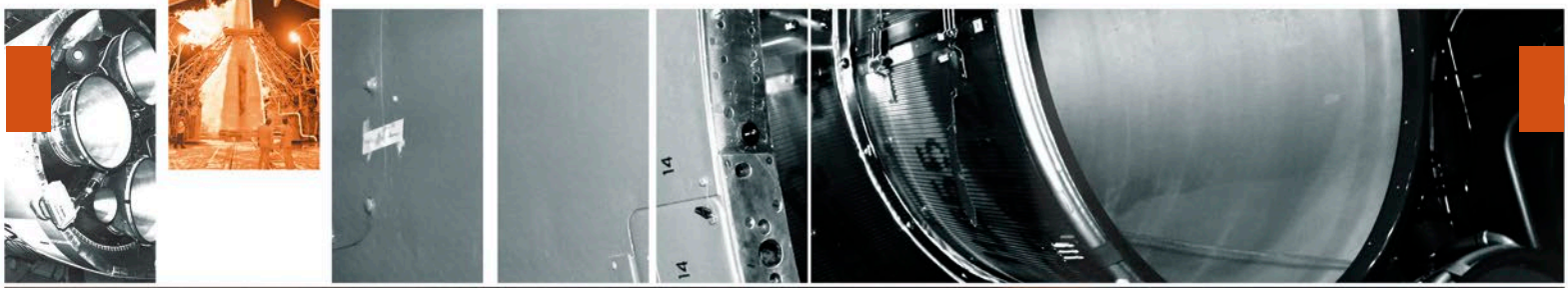
December
2015

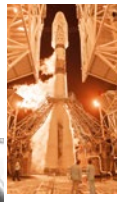


VS 13
Galileo FOC-M4
SAT 11-12

esa

GALILEO
SAT 11-12

cnes



VS 13

GALILEO FOC-M4, SAT 11-12

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12TH AND FINAL FLIGHT OF 2015 FOR GALILEO PROGRAM

For its 12th flight of the year, and the 13th Soyuz launch overall from the Guiana Space Center (CSG), Arianespace will orbit another pair of satellites for the Galileo constellation. This mission, conducted for the European Commission under a contract with the European Space Agency (ESA), will orbit Galileo FOC (Full Operational Capability) satellites 11 and 12.

After this flight, 12 Galileo satellites will have been deployed by Arianespace, which is proud to be serving Europe as launch service provider for this its independent access to space.

Galileo, an iconic project for Europe

Galileo is a European initiative to develop a new global satellite navigation system. Under civilian control, it will offer a guaranteed, high-precision positioning service and will end Europe's dependence on the American GPS system. Galileo is the first joint infrastructure produced and funded by the European Union. It features innovative technologies developed in Europe for the benefit of all citizens.

Stepping up deployment in 2015

Arianespace orbited the Galileo IOV 1 and 2 (In-Orbit Validation) satellites on the first Soyuz flight (VS01) on October 21, 2011, followed by IOV 3 and 4 on VS03 on October 12, 2012, all from the CSG.

Prior to that, the GIOVE-A and GIOVE-B experimental satellites were launched from the Baikonur Cosmodrome by Soyuz (via Starsem) in 2005 and 2008.

The first two Galileo FOC satellites (5 and 6) were launched on August 22, 2014. Despite injection into a non-compliant orbit, the ESA teams were able to validate their operation, then reposition them so that they can contribute to the constellation.

On March 26 and September 10, 2015, Soyuz flights VS11 and VS12 successfully launched Galileo FOC satellites 7, 8, 9 and 10.

After this latest launch, Arianespace will pursue deployment of two more FOC satellites using a Soyuz rocket, followed by 12 using three Ariane 5 rockets from the CSG.

The next mission for the Galileo program is planned for the second half of 2016, using the first Ariane 5 ES, which will carry four satellites.

Made in Europe

The Galileo satellites are built by prime contractor OHB System in Bremen, Germany. The payload for each satellite is supplied by UK-based Surrey Satellite Technology Ltd (SSTL), which is 99% owned by Airbus Defence and Space.

These will be the seventh and eighth OHB satellites launched by Arianespace. The next 14 are under construction at OHB in Bremen.

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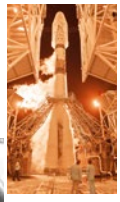

VS 13

GALILEO FOC-M4, SAT 11-12

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MISSION DESCRIPTION

The 13th Soyuz launch from the Guiana Space Center (CSG) will place two new satellites for Europe's Galileo satellite navigation system into circular orbit.

The launcher will be carrying a total payload of 1,603 kg.

The launch will be from the Soyuz Launch Complex (ELS) in Sinnamary, French Guiana.

Targeted orbit: **MEO circular orbit - Orbital Plane C**
Altitude: **23,222 km**
Inclined: **54.946 degrees**

Liftoff is scheduled for **Thursday, December 17, 2015** at exactly:

- 08:51:56 a.m., (Local time in French Guiana)
- 06:51:56 a.m., (in Washington, D.C.)
- 11:51:56 a.m., (UTC)
- 12:51:56 p.m, (in Paris)
- 14:51:56 p.m., (in Moscow)

The launch at a glance

Following liftoff from the Guiana Space Center, the powered phase of the lower three Soyuz stages will last about nine minutes. The third stage of the launcher will then be separated from the upper composite, comprising the Fregat upper stage and the Galileo FOC-M4, SAT 11-12 satellites. The three lower stages and the fairing will fall back into the sea.

After a first burn, the upper composite is spun up during a ballistic phase lasting about 3 hours and 15 minutes. Then, Fregat will ignite its own engine to bring the upper composite to a transfer orbit above the Earth.

At a pre-determined point of this orbit, Fregat will ignite for a second burn lasting 4 minutes to reach the circular orbit of separation. At the end of the mission, the Fregat upper stage will be passivated. The Galileo FOC-M4 SAT 11-12 satellites will then lower their altitude in order to reach their operational orbit.

Soyuz payload configuration

Payload: Galileo FOC-M4, SAT 11-12
Mass at liftoff: 717 and 717.5 kg.

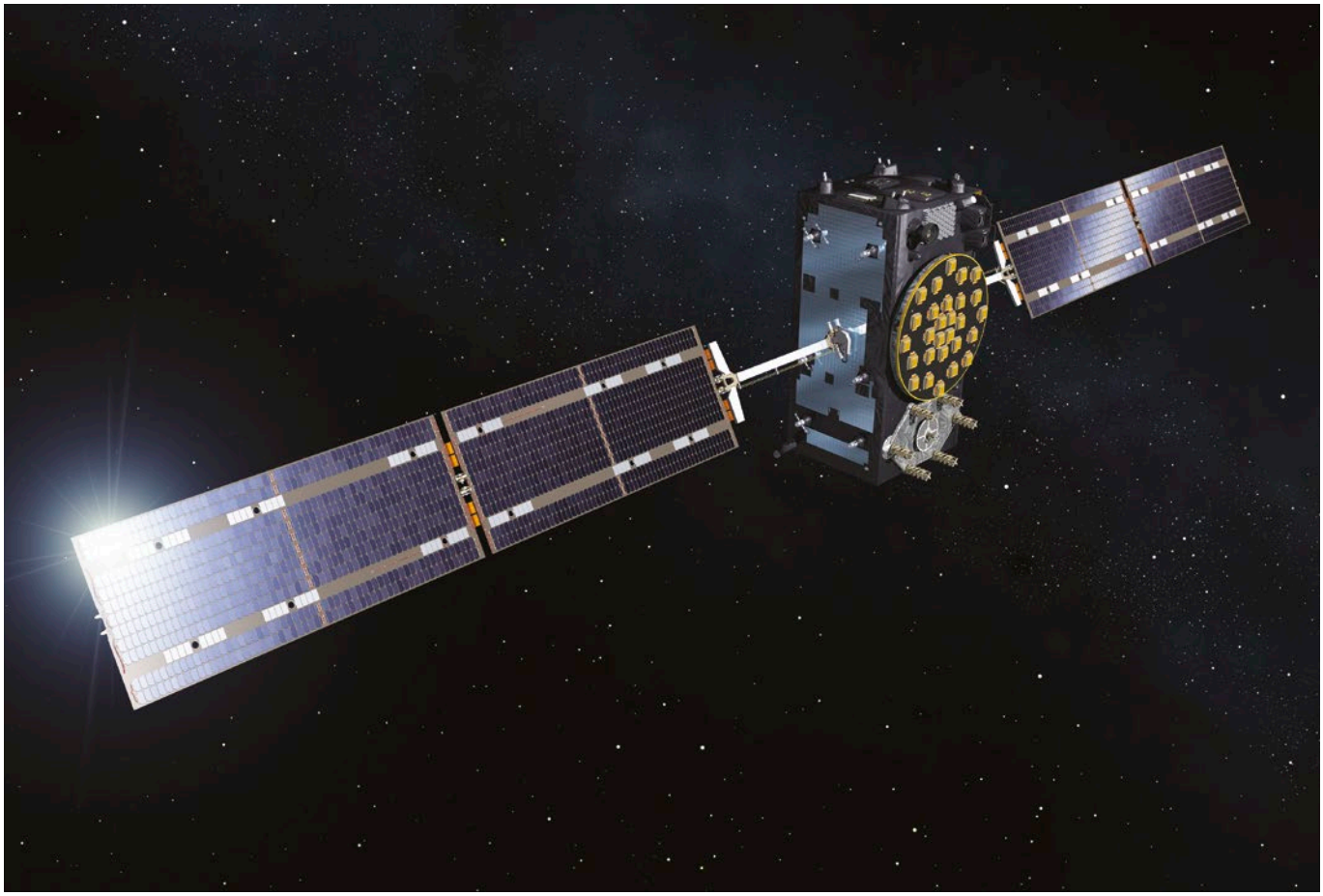
ST Fairing

Dispenser (carrying structure) for the two Galileo FOC-M4 payloads, developed and built by RUAG Space

Mission duration

The nominal duration of the mission (from liftoff to separation of the satellites) is **3 hours 47 minutes, 57 seconds.**

GALILEO FOC-M4, SAT 11-12 SATELLITES



Customer	**The European Space Agency (ESA)**
Manufacturer	**OHB-System (bus, prime), SSTL (payload)**
Liftoff mass	**Mass at liftoff 717 and 717.5 kg**
Dimensions	**2.7 x 1.2 x 1.1 m**
Span in orbit	**14.67 m**
Lifetime	**More than 12 years**
On-board power	**1,900 W**
Orbit	**MEO (Medium Earth Orbit) circular orbit**
Navigation signal	**3 bands (E5, E6 et E1)**
Additional mission	**Search and rescue transponder (COSPAS SARSAT)**

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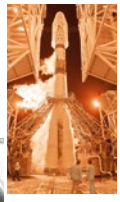


SOYUZ LAUNCH VEHICLE

The Soyuz launch vehicle family has provided reliable and efficient launch services since the start of space exploration. Soyuz rockets, which launched both the first artificial satellite and the first man into space, have been credited with more than 1,845 launches to date. Today, Soyuz is used for manned and unmanned flights to the International Space Station, as well as Russian government launches, and commercial launches with Arianespace as launch operator.

The Soyuz configuration introduced in 1966 has been the workhorse of the Soviet/Russian space program. As the only manned launch vehicle in Russia and the former Soviet Union, Soyuz meets very high standards of reliability and robustness.

The first launch of the Soyuz 2-1a version on November 8, 2004 from the Plesetsk Cosmodrome represented a major step in the launch vehicle development program. This modernized version of Soyuz, also used to successfully launch MetOp-A on October 19, 2006, features a digital control system providing additional mission flexibility; it also enables control of the launch vehicle fitted with the 4.1-meter ST fairing. This was a necessary step towards the next-generation Soyuz 2-1b launcher, the culmination of a joint European/Russian upgrade program. It adds a more powerful third-stage engine, significantly increasing the launcher's overall performance.

The inaugural flight of the upgraded Soyuz 2-1b launch vehicle was successfully performed on December 27, 2006, orbiting the Corot scientific spacecraft for the French CNES space agency.

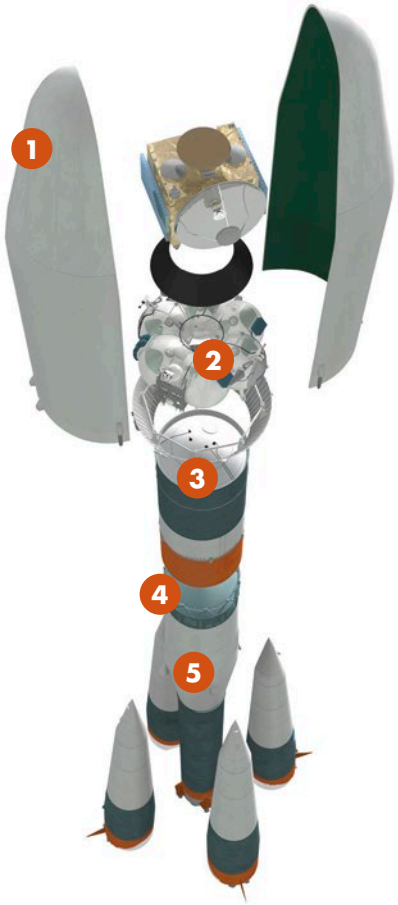
The decision of the European Space Agency to introduce Soyuz launch capability at the Guiana Space Center (CSG) in French Guiana marked a major step forward in expanding the range of missions. With the introduction of Soyuz at CSG, this famed medium-lift Russian launch vehicle is now an integral part of the European launcher fleet, together with the heavy-lift Ariane 5 and the lightweight Vega. Offered exclusively by Arianespace to the commercial market for launches from CSG, Soyuz becomes Europe's standard medium launcher for both government and commercial missions.

On October 21, 2011 Arianespace successfully launched the first Soyuz rocket from the Guiana Space Center, orbiting the first two satellites in the Galileo constellation.

The Samara Space Center in Russia continues to produce Soyuz launchers. Because of sustained demand from the Russian government, International Space Station requirements and Arianespace's commercial orders, the Soyuz is being produced at an average rate of 15 to 20 launchers per year. The manufacturer can also rapidly scale up to accommodate market demand. In fact, annual Soyuz production peaked in the early 1980s at 60 vehicles per year.

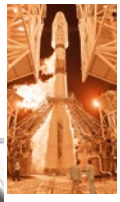
Soyuz is a reliable, efficient, and cost-effective solution for a full range of missions, from LEO (Low Earth Orbit) to Mars or Venus. Offering an unrivaled heritage, Soyuz has already performed almost every type of mission, from launching telecommunications, Earth observation, weather and scientific satellites to manned spacecraft. It is a very scalable and flexible launch vehicle.

The Soyuz version currently offered by Arianespace is a four-stage launch vehicle: four boosters (first stage), a central core (second stage), a third stage, and the restartable Fregat upper stage (fourth stage). It also includes a payload adapter/dispenser and fairing.



SOYUZ

1 - The fairing
2 - The Fregat upper stage
3 - The third stage
4 - The central core (2nd stage)
5 - The boosters (1st stage)



Boosters (first stage)

The four cylindrical-conical boosters are assembled around the central core. The booster's RD-107A engines are powered by liquid oxygen and kerosene, the same propellants used on each of the lower three stages. The kerosene tanks are located in the cylindrical part and the liquid oxygen tanks in the conical section. Each engine has four combustion chambers and four nozzles. Three-axis flight control is provided by aerofins (one per booster) and steerable vernier thrusters (two per booster). Following liftoff, the boosters burn for approximately 118 seconds and are then jettisoned. Thrust is transferred to the vehicle through a ball joint located at the top of the conical structure of the booster, which is attached to the central core by two rear struts.

Central core (second stage)

The central core is similar in construction to the four boosters, with a special shape to accommodate the boosters. A stiffening ring is located at the interface between the boosters and the core. This stage is fitted with an RD-108A engine, also comprising four combustion chambers and four nozzles. It also has four vernier thrusters, used for three-axis flight control once the boosters have separated. The core stage has a nominal burn time of 286 seconds. The core and boosters are ignited simultaneously on the launch pad, 20 seconds before liftoff. Thrust is first adjusted to an intermediate level to check engine readings. The engines are then gradually throttled up, until the launcher develops sufficient thrust for liftoff.

Third stage

The third stage is linked to the central core by a latticework structure. Ignition of the third stage's engine occurs approximately two seconds before shutdown of the central core engine. The third stage engine's thrust enables the stage to separate directly from the central core. Between the oxidizer and fuel tanks is a dry section where the launcher's avionics systems are located. The third stage uses either a RD-0110 engine in the ST-A version, or a RD-0124 engine in the ST-B version.

Fregat upper stage (fourth stage)

Flight qualified in 2000, the Fregat upper stage is an autonomous and flexible stage that is designed to operate as an orbital vehicle. It extends the capability of the Soyuz launcher, now covering a full range of orbits (LEO, SSO, MEO, GTO, GEO and escape). To ensure high reliability for the Fregat stage right from the outset, various flight-proven subsystems and components from previous spacecraft and rockets are used. The upper stage consists of six spherical tanks (four for propellants, two for avionics) arranged in a circle and welded together. A set of eight struts through the tanks provide an attachment point for the payload, and also transfer thrust loads to the launcher. The upper stage is independent from the lower three stages, since Fregat has its own guidance, navigation, attitude control, tracking, and telemetry systems. The stage's engine uses storable propellants – UDMH (unsymmetrical dimethyl hydrazine) and NTO (nitrogen tetroxide) – and can be restarted up to 20 times in flight, thus enabling it to carry out complex missions. It can provide the customer with 3-axis or spin stabilization of their spacecraft.

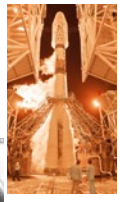
The Fregat upper stage is encapsulated in a fairing with the payload and a payload adapter/dispenser

The fairing

Soyuz launchers operated by Arianespace at the Guiana Space Center use the ST fairing in a standard configuration, with an external diameter of 4.1 meters and a length of 11.4 meters.

Roscosmos and the Russian launcher industry

Roscosmos, the Russian space agency, is responsible for license allocations and intergovernmental relations. It is the launch authority in charge of range operations. RKTs-Progress (Samara Space Center) is responsible for the design, development, and manufacture of launch vehicles, including the Soyuz launch vehicle's first, second and third stages and fairing. It also integrates vehicle stages and handles flight operations. NPO Lavochkin manufactures and integrates the Fregat upper stage, and is responsible for its launch operations. TsENKI is in charge of launch planning and the provision of associated services, including systems engineering, the design, and technical and operational management of the launch pad and associated facilities dedicated to the Soyuz launcher.



COUNTDOWN AND FLIGHT SEQUENCE

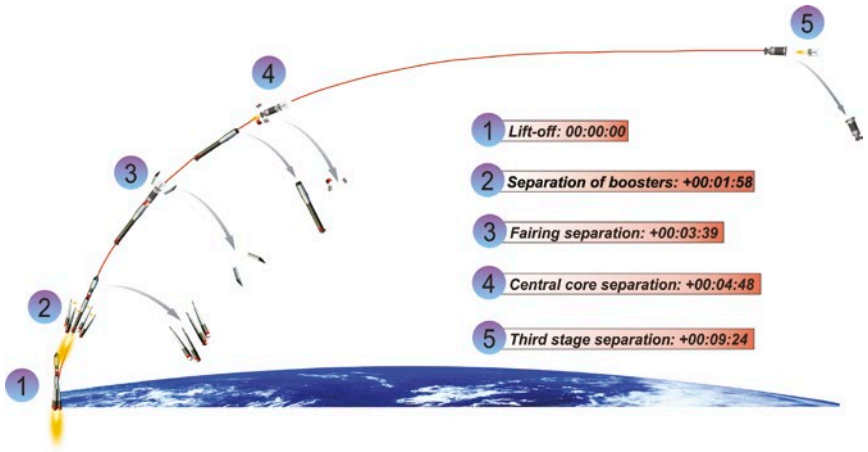
The countdown comprises all final preparation steps for the launcher, the satellite and the launch site. If it proceeds as planned, the countdown leads to the ignition of the core stage engine and the four boosters.

EVENT	Time (h:min:s)
Beginning of the meeting for launcher fueling authorization (BTR)	-05:00:00
Launch vehicle fueling begins	-04:30:00
End of fueling operation	-01:35:00
Mobile gantry withdrawal	-01:10:00
Key on start	-00:05:10
Fregat transfer to onboard power supply	-00:05:00
Upper composite umbilical drop off command	-00:02:25
Ground-board power transfer	-00:00:40
Lower stage umbilical mast retraction	-00:00:28
Ignition	-00:00:17
Preliminary thrust level	-00:00:15
Full thrust level	-00:00:03

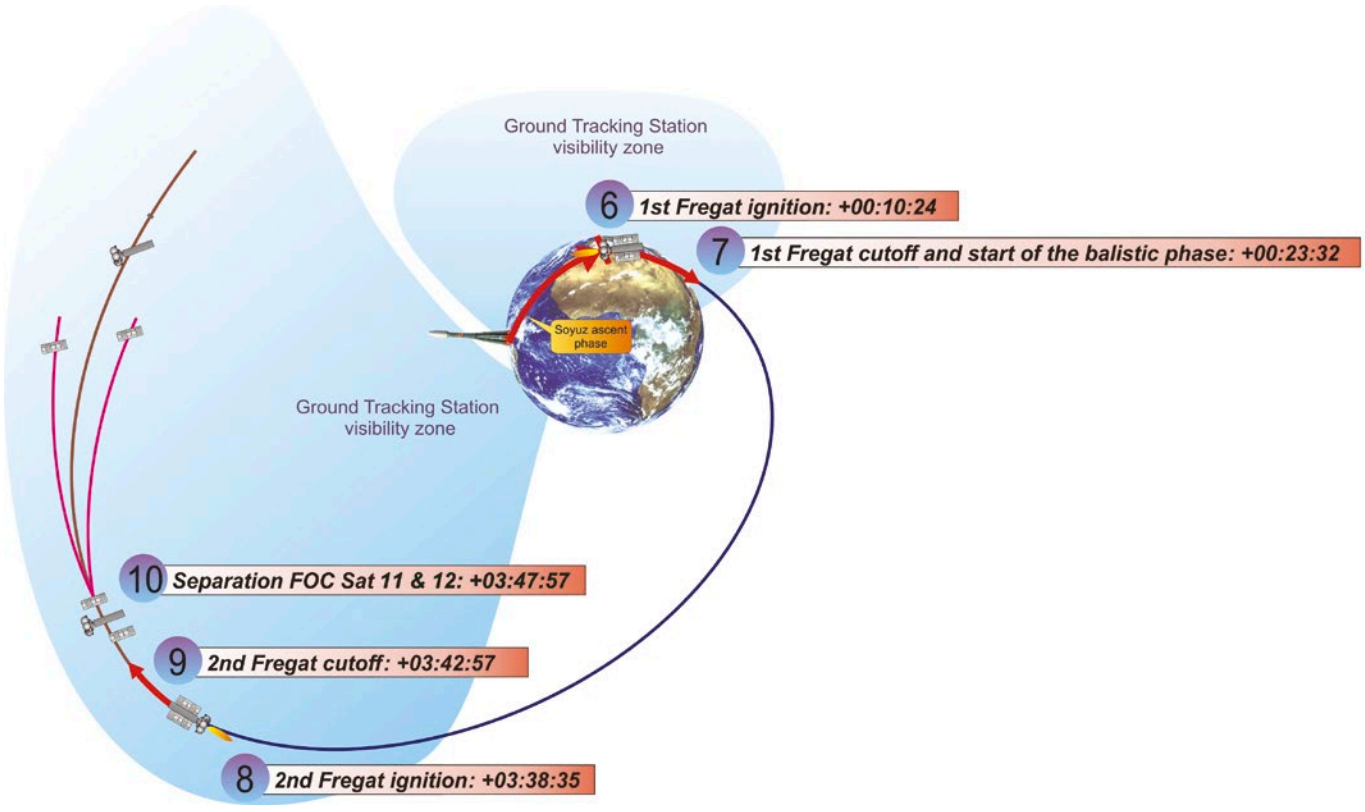
Liftoff	00:00:00
Jettisoning of boosters	+00:01:58
Jettisoning of fairing	+00:03:29
Separation of central core (second stage)	+00:04:48
Separation of 3rd stage	+00:09:24
Fregat 1st burn	+00:10:24
Fregat shut-down and beginning of ballistic phase	+00:23:32
Fregat 2nd burn	+03:38:35
Fregat shut-down	+03:42:57
Galileo FOC-M4, SAT 11-12 separation (in Orbital Plane C)	**+03:47:57**

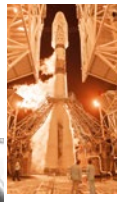
VS 13 MISSION PROFILE

MISSION PROFILE FOR THE THREE SOYUZ STAGES



THE FREGAT MISSION PROFILE





ARIANESPACE AND THE GUIANA SPACE CENTER

Arianespace, the world's first launch services company

Arianespace was founded in 1980 as the world's first launch Services & Solutions company. Arianespace now has 20 shareholders from 10 European countries (including Airbus Safran Launchers, CNES and all European companies participating in the production of Ariane launchers). Since the outset, Arianespace has signed over 450 launch contracts and launched 500-plus satellites. More than two-thirds of the commercial satellites now in service worldwide were launched by Arianespace. The company posted sales of 1,399 million euros in 2014.

As of March 1, 2015, Arianespace had 322 employees, working at the company's headquarters in Evry (near Paris); the Guiana Space Center in French Guiana, where the Ariane, Soyuz and Vega launch pads are located; and offices in Washington, D.C., Tokyo and Singapore. Arianespace offers launch services to satellite operators from around the world, including private companies and government agencies. These services call on three launch vehicles:

- The Ariane 5 heavy launcher, operated from the Guiana Space Center in French Guiana.
- The Soyuz medium launcher, currently in operation at the Guiana Space Center and the Baikonur Cosmodrome in Kazakhstan.
- The Vega light launcher, also operated from the Guiana Space Center.

Building on its complete family of launchers, Arianespace has won over half of the commercial launch contracts up for bid worldwide in the past two years. Arianespace now has a backlog of more than 70 satellites to be launched.

The Guiana Space Center: Europe's Spaceport

For 40 years, the Guiana Space Center (CSG), Europe's Spaceport in French Guiana, has offered a complete array of facilities for rocket launches. It mainly comprises the following:

- CNES/CSG technical center, including various resources and facilities that are critical to launch base operations, such as radars, telecom network, weather station, receiving sites for launcher telemetry, etc.
- Payload processing facilities (ECPU), in particular the S5 facility.
- Ariane, Soyuz and Vega launch complexes, comprising the launch zones and launcher integration buildings.
- Various industrial facilities, including those operated by Regulus, Europropulsion, Air Liquide Spatial Guyane and Airbus Safran Launchers - all involved in the production of Ariane 5 components. A total of 40 European manufacturers and local companies are involved in operations.

Europe's commitment to independent access to space is based on actions by three key players: the European Space Agency (ESA), the French CNES space agency and Arianespace. ESA is responsible for the Ariane, Soyuz and Vega development programs. Once these launch systems are qualified, ESA transfers responsibility to the operator Arianespace. ESA has helped change the role of the Guiana Space Center, in particular by funding the construction of the launch complexes, payload processing buildings and associated facilities. Initially used for the French space program, the Guiana Space Center has gradually become Europe's own Spaceport, according to the terms of an agreement between ESA and the French government. To ensure that the Spaceport is available for its programs, ESA takes charge of the lion's share of CNES/CSG fixed expenses, and also helps finance the fixed costs for the ELA launch complexes.

The French CNES space agency has several main responsibilities at the Guiana Space Center. It designs all infrastructure and, on behalf of the French government, is responsible for safety and security. It provides the resources needed to prepare the satellites and launchers for missions. Whether during tests or actual launches, CNES is also responsible for overall coordination of operations and it collects and processes all data transmitted from the launcher via a network of receiving stations to track Ariane, Soyuz and Vega rockets throughout their trajectories.

Arianespace in French Guiana

In French Guiana, Arianespace is the contracting authority in charge of operating the family of three launchers: Ariane, Soyuz and Vega.

For Soyuz, Arianespace supervises the integration and functional checks of the launcher in the MIK facility, carried out by RKTs-Progress for the three lower stages, and by NPO-Lavochkin for the Fregat upper stage. It also coordinates Fregat propellant loading operations in the Fregat Fueling Facility (FCube), and satellite preparations in the EPCU payload preparation facility operated by CNES/CSG. Arianespace then integrates the satellite(s) on the Fregat stage in the S3B building, transfers the launcher and upper composite to the Soyuz Launch Zone and, along with the Russian entities in charge of the launcher, conducts the final countdown and liftoff operations from the Soyuz Launch Center (CDLS). Arianespace deploys a top-flight team and technical facilities to prepare launchers and satellites for theirs missions.

Building on this unrivalled expertise and outstanding local facilities, Arianespace is now the undisputed benchmark in the global launch services market.