

ARIANE 5

Boosting Rosetta on an interplanetary voyage

For its first mission of the year, Arianespace will launch the Rosetta spacecraft. Part of the European Space Agency's solar system exploration program, Rosetta will rendezvous with the comet Churyumov-Gerasimenko after an interplanetary voyage lasting nearly ten years.

An Ariane 5G+ will boost Rosetta into a hyperbolic liberation orbit, in a mission calling on the delayed ignition capability of Ariane 5's EPS upper stage.

This is the first time that an Ariane launcher is being used for this type of trajectory. The launcher will perform a ballistic trajectory lasting 1 hour 45 minutes (about an orbit and a half around the Earth), immediately following separation of the main stage, in order to delay ignition of the upper stage engine and therefore optimize performance.

With missions such as these, Ariane 5 is demonstrating its ability to carry out a wide variety of assignments, ranging from the launch of scientific spacecraft into special orbits, to commercial launches into geostationary orbit.

Built by EADS-Astrium, the Rosetta spacecraft will weigh about 3,000 kg at launch. It is shaped like a cube: its upper part carries the instruments making up the payload, while the bottom part has the platform's subsystems.

Two solar panels, each measuring 32 square meters, will give this interplanetary probe an in-orbit span of over 32 meters.

To build up sufficient energy to reach its orbit, the spacecraft will fly three times around the Earth and once around Mars, using the gravitational fields of these two planets to modify its trajectory. During its ten-year voyage, Rosetta will enter the asteroid belt twice. Because of the time needed for the voyage, the onboard instruments will have to be placed in "hibernation" for long periods.

Maneuvers to rendezvous with the comet Churyumov-Gerasimenko are slated for May 2014. Rosetta's primary mission is to study the core of the comet and its environment; in November 2014, a "lander" carried by the spacecraft will touch down on the comet's surface.

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1. Arianespace Flight 158 mission

The 162nd Ariane launch (Flight 158/Ariane 518) will use an Ariane 5 to place into a liberation orbit the Rosetta spacecraft, part of the European Space Agency's solar system exploration program.

The Ariane 518 launcher will carry a payload of 3,187 kg (7,011.4 lb), including about 3,065 kg (6,743 lb) for the satellite.

The launch will be carried out from the ELA 3 launch complex in Kourou, French Guiana. Because of the special conditions of this mission, the launch slot is relatively limited, lasting just 21 calendar days as from February 26, 2004. If this schedule is not met, the rendezvous will be missed and the mission cannot be carried out.

Injection orbit*

Infinite velocity **3,545 m/s**

Declination **2° degrees**

* This orbit (for a launch the night of February 26 from Kourou) may change in case the launch is delayed.

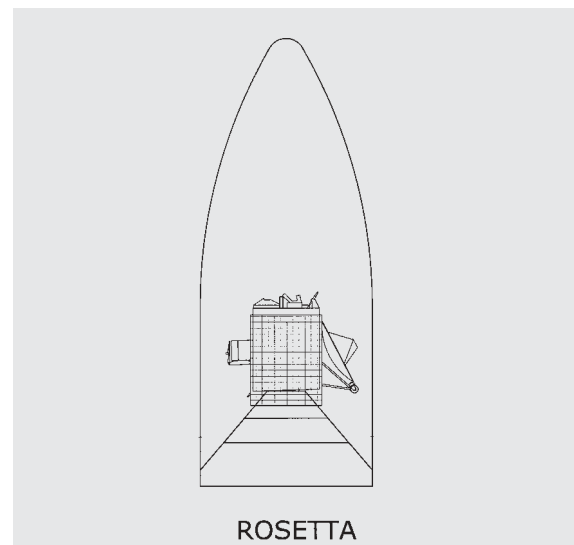
The lift-off is scheduled on the morning of February 26, 2004 at one precise moment:

Launch opportunity

	Universal time (GMT)	Paris time	Washington time	Kourou time
H_0	07:36.49 am	08:36.49 am	02:36.49 am	04:36.49 am
on	February 26, 2004	February 26, 2004	February 26, 2004	February 26, 2004

Ariane 518 payload configuration

The **ROSETTA satellite** was built by EADS-Astrium and integrated by Alenia Spazio for the European Space Agency (ESA).



2. Range operations campaign : ARIANE 5 – ROSETTA

The launch of Rosetta was postponed as a precautionary measure following the Flight 157 failure. The preparation campaign for Rosetta and for its Ariane 5 launcher initially was conducted from September 2002 to January 2003, and then from October 2003 to February 2004.

Satellites and launch vehicle campaign calendar

<i>Ariane activities</i>	<i>Dates</i>	<i>Satellites activities</i>
	September 12, 2002	Arrival in Kourou and beginning of ROSETTA preparation campaign in S1A building
Campaign start review	November 18, 2002	
EPC Erection	November 18, 2002	
EAP transfer and positioning	November 20, 2002	
Integration EPC/EAP	November 21, 2002	
EPS Erection	November 22, 2002	
Integration equipment bay	November 22, 2002	
	November 25, 2002	Transfer of ROSETTA into the SSB building
	Nov. 27 and 29, 2002	ROSETTA filling operations in SSB building
	December 2002	Transfer of Rosetta into the S3B building for off-loading
	March-April 2003	Off-loading of the MMH propellant
	April-October 2003	Launch campaign put on hold to readapt Rosetta for its new mission
	October 22, 2003	Restart of launch campaign
Restart of launcher campaign	January 19, 2004	
	January 27, 2004	Filling of ROSETTA with MMH
Roll-out from BIL to BAF	February 10, 2004	
	February 13, 2004	Transfer of ROSETTA in the BAF

Satellite and launch vehicle campaign final calendar

J-7	Monday, February 16	ROSETTA integration on launcher
J-6	Tuesday, February 17	ROSETTA integration on launcher
J-5	Wednesday, February 18	Fairing integration on launcher
J-4	Thursday, February 19	Filling of SCA and EPS
J-3	Friday, February 20	Launch rehearsal
J-2	Monday, February 23	Launch rediness review (RAL) and arming of launch vehicle
J-1	Tuesday, February 24	Roll-out from BAF to Launch Area (ZL), launch vehicle connections and filling of the EPC Helium sphere
J-0	Wednesday, February 25	Launch countdown including EPC filling with liquid oxygen and liquid hydrogen
H-0	Thursday, February 26	Synchronized sequence – Lift-off

3 - Launch countdown and flight events

The countdown comprises all final preparation steps for the launcher, the satellites and the launch site. If it proceeds as planned, the countdown leads to the ignition of the main stage engine, then the two solid boosters, for a liftoff at the targeted time, as early as possible in the satellites launch window.

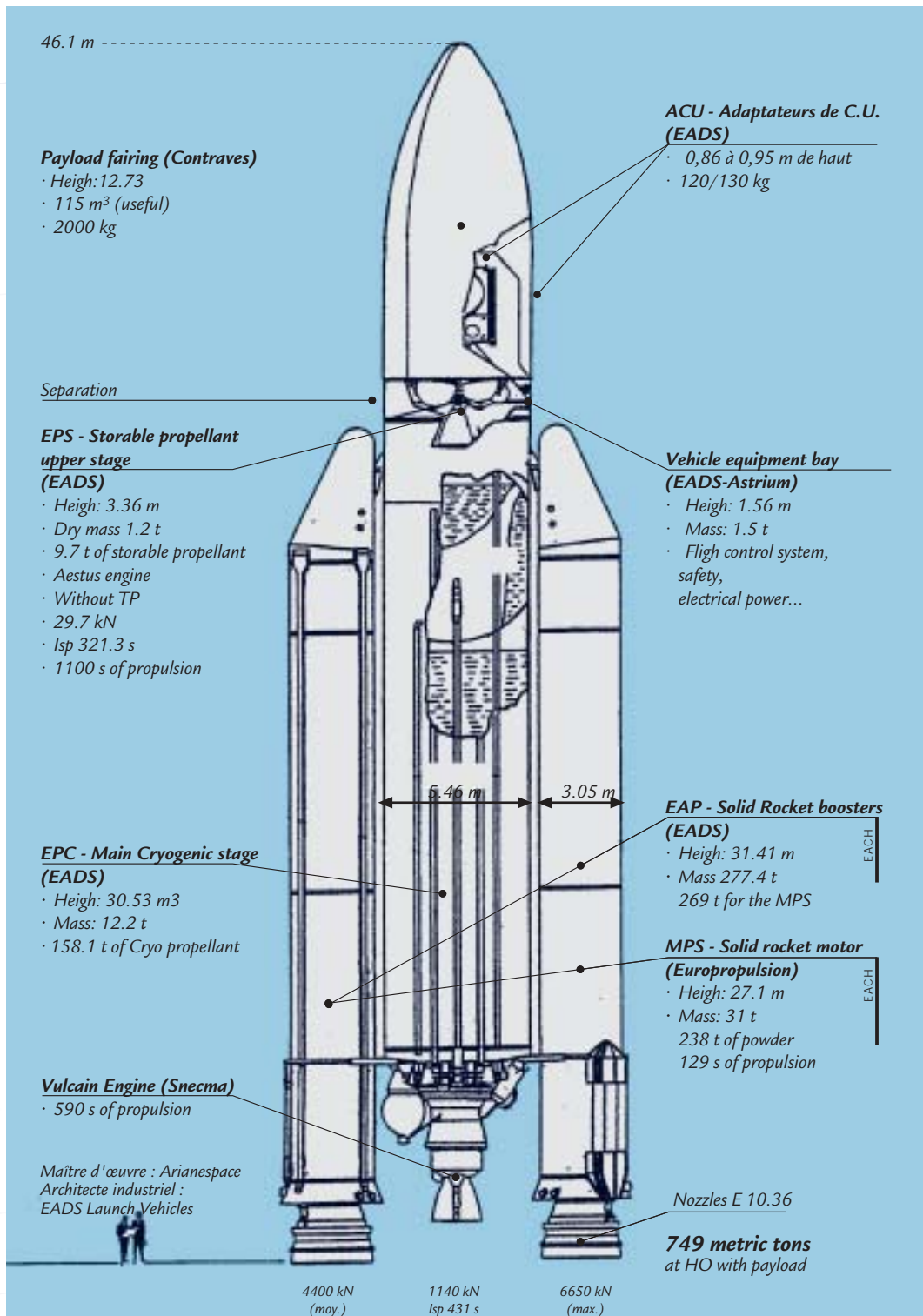
The countdown culminates in a synchronized sequence (see appendix 3), which is managed by the control station and onboard computers starting at T-7 minutes.

If an interruption in the countdown means that T-0 falls outside the launch window, then the launch will be delayed by one, two or more days, depending on the problem involved, and the solution developed.

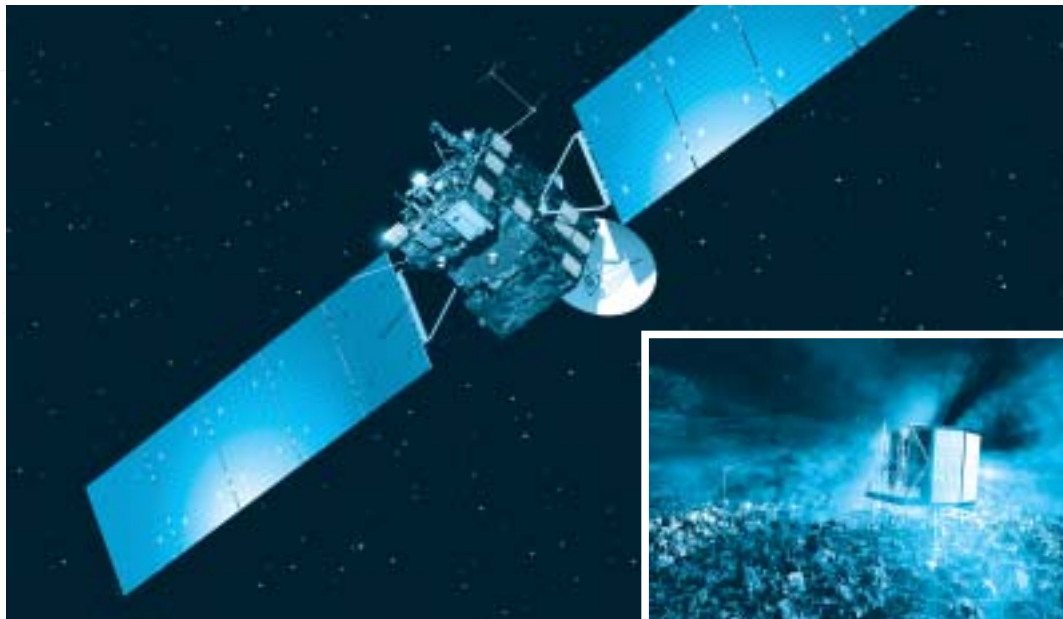
Time	Events
- 11h 30 mn	Start of final countdown
- 7h 30 mn	Check of electrical systems
- 4h 50 mn	Start of filling of main cryogenic stage and with liquid oxygen and hydrogen
- 3h 20 mn	Chilldown of Vulcain main stage engine
- 1h 10 mn	Check of connections between launcher and telemetry, tracking and command systems
- 7 mn 00 s	"All systems go" report, allowing start of synchronized sequence
- 4 mn 00 s	Tanks pressurized for flight
- 1 mn 00 s	Switch to onboard power mode
- 04 s	Onboard systems take over
- 03 s	Unlocking of guidance systems to flight mode

HO	Ignition of the cryogenic main stage engine (EPC)	ALT (km)	V. rel. (m/s)
+ 7.0 s	Ignition of solid boosters	0	0
+ 7.3 s	Liftoff	0	0
+ 13 s	End of vertical climb and beginning of pitch rotation (10 seconds duration)	0.08	33.6
+ 17 s	Beginning of roll maneuver	0.29	66.1
+ 2 mn 19 s	Jettisoning of solid boosters	66.2	2086.0
+ 3 mn 11 s	Jettisoning of fairing	105.8	2315.0
+ 8 mn 19 s	Acquisition by Natal tracking station		
+ 9 mn 50 s	Extinction of main cryogenic stage	169.3	8098.3
+ 9 mn 56 s	Separation of main cryogenic stage	173.4	8117.2
+ 9 mn 57 s	Beginning of ballistic phase		
+ 12 mn 10 s	Acquisition by Ascension tracking station		
+ 21 mn 50 s	Acquisition by Malindi tracking station (Kenya)		
+ 48 mn 10 s	Acquisition by Dongara tracking station (Australia)		
+ 1 h 46 mn 13 s	Acquisition by South Point tracking station (Hawaii)		
+ 1 h 54 mn 47 s	Ignition of EPS	652.6	7591.3
+ 2 h 11 mn 04 s	Acquisition by Kourou tracking station		
+ 2 h 11 mn 48 s	Injection of EPS	1091.8	10410.1
+ 2 h 11 mn 48 s	Beginning of ROSETTA orientation	1091.8	10410.1
+ 2 h 13 mn 30 s	Separation of ROSETTA satellite	1364.3	10228.9
+ 2 h 50 mn 00 s	End of ARIANESPACE Flight 158 mission	6370.0	8050.0

5 - The Ariane 5 Launcher (Industrial architect: EADS Launch Vehicles)



6 - The ROSETTA satellite



Customer	ESA	
Prime contractor	EADS-Astrium	
Mission	Rendez-vous with Comet 67P/Churyumov-Gerasimenko	
Mass	Total mass at lift-off	3,065 kg including
	Propellants:	1,670 kg
	Scientific payload:	165 kg
	Lander	100 kg
Stabilization	3 axis stabilized	
Dimensions	2.8 x 2.1 x 2.0 m	
	Span in orbit	32 m
On-board power	850 W at 3.4 AU and 395 W at 5.25 AU	
Life time	12 years	

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Annex 1 - Arianespace Flight 158 key personnel

In charge of the launch campaign

Mission Director	(CM)	Dan MURE	ARIANESPACE
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In charge of the launch service contracts

ARIANE Payload Manager	(RCUA)	Alexandre MADEMBA-SY	ARIANESPACE
ARIANE Deputy Mission Manager	(RCUA/A)	Patrick LOIRE	ARIANESPACE

In charge of ROSETTA satellite

Satellite Mission Director	(DMS)	John ELLWOOD	ESA
Satellite Project Director	(CPS)	Claude BERNER	ESA
Satellite Preparation Manager	(RPS)	Claude BERNER / Flemming PEDERSEN	ESA

In charge of the launch vehicle

Launch Site Operations Manager	(COEL)	André SICARD	ARIANESPACE
ARIANE Production Project Manager	(CPAP)	Franck VASSEUR	ARIANESPACE

In charge of the Guiana Space Center (CSG)

Range Operations Manager	(DDO)	Thierry VALLEE	CNES/CSG
Flight Safety Officer	(RSV)	Hervé POUSSIN	CNES/CSG

Annex 2 - Launch environment conditions

Acceptable wind speed limits at liftoff range from between 7.5 m/s. to 9.5 m/s. according to the wind direction. The most critical is a northerly wind. For safety reasons, the wind's speed on the ground (Kourou) and at a high-altitude (between 10.000 and 2.000 m) is also into account.

Annex 3 - The synchronized sequence

The synchronized launch sequence starts 7 mn before ignition (T-0). It is primarily designed to perform the final operations on the launcher prior to launch, along with the ultimate checks needed following switchover to flight configuration. As its name indicates, it is fully automatic, and is performed concurrently by the onboard computer and by two redundant computers at the ELA 3 launch complex until T-4 seconds.

The computers command the final electrical operations (startup of the flight program, servocontrols, switching from ground power supply to onboard batteries, etc.) and associated checks. They also place the propellant and fluid systems in flight configuration and perform associated checks. In addition, it handles the final ground system configurations, namely :

- startup of water injection in the flame trenches and jet guide (T-30 sec);
- hydrogen aspiration for chilldown of Vulcain engine in the jet guide (T-18 sec);
- burnoff of hydrogen used for chilldown (T-5.5 sec);

At T-4 seconds, the onboard computer takes over control of final engine startup and liftoff operations :

- It starts the ignition sequence for the Vulcain main stage engine (T-0);
- It checks engine operation (from T+4.5 to T+7.3 sec);
- It commands ignition of the solid boosters for immediate liftoff at T+7.3 seconds.

Any shutdown of the synchronized sequence after T - 7 mn automatically places the launcher back in its T-7 min configuration.

Appendix 4 - ARIANESPACE, its relations with ESA and CNES

FROM A PRODUCTION BASE IN EUROPE, ARIANESPACE, A PRIVATE COMPANY, SERVES CUSTOMERS ALL OVER THE WORLD.

Arianespace is the world's first commercial space transportation company, created in 1980 by 36 leading European aerospace and electronics corporations, 13 major banks and the French space agency CNES (Centre National d'Etudes Spatiales).

The shareholder partners in Arianespace represent the scientific, technical, financial and political capabilities of 12 countries : Belgium, Denmark, Germany, France, Great Britain, Ireland, Italy, Netherlands, Norway, Spain, Switzerland and Sweden.

In order to meet the market needs, Arianespace is present throughout the world : in Europe, with its head office located near Paris, France at Evry, in North America with its subsidiary in Washington D.C. and in the Pacific Region, with its representative offices in Tokyo, Japan, and in Singapore.

Arianespace employs a staff of 300. Share capital totals 317,362,320 €.

Arianespace is in charge of these main areas :

- markets launch services to customers throughout the world ;
- finances and supervises the construction of Ariane expendable launch vehicles ;
- conducts launches from Europe's Spaceport of Kourou in French Guiana ;
- insures customers for launch risks.

Personalized reliable service forms an integral part of Arianespace launch package. It includes the assignment of a permanent team of experts to each mission for the full launch campaign.

The world's commercial satellite operators have contracted to launch with Arianespace. This record is the result of our company's realistic cost-effective approach to getting satellites into orbit.

RELATIONS BETWEEN ESA, CNES AND ARIANESPACE

Development of the Ariane launcher was undertaken by the European Space Agency in 1973. ESA assumed overall direction of the ARIANE 1 development program, delegating the technical direction and financial management to CNES. The ARIANE 1 launcher was declared qualified and operational in January 1982. At the end of the development phase which included four launchers, ESA started the production of five further ARIANE 1 launchers. This program, known as the "promotion series", was carried out with a management arrangement similar to that for the ARIANE 1 development program.

In January 1980 ESA decided to entrust the commercialization, production and launching of operational launchers to a private-law industrial structure, in the form of ARIANESPACE company, placing at its disposal the facilities, equipment and tooling needed of producing and launching the ARIANE launchers.

Ariane follow-on development programs have been undertaken by ESA since 1980. They include a program for developing uprated versions of the launcher : Ariane 2 and Ariane 3 (qualified in August 1984) ; the program for building a second ARIANE launch site (ELA 2) (validated in August 1985) ; the Ariane 4 launcher development program (qualified on June 15th, 1988) ; and the preparatory and development program of the Ariane 5 launcher and its new launch facilities : ELA 3 (qualified on November, 1997). All these programs are run under the overall direction of ESA, which has appointed CNES as prime contractor. In general, as soon as an uprated version of the launcher has been qualified 5 Oct, 1998, ESA makes the results of the development program together with the corresponding production and launch facilities available to ARIANESPACE.

ESA is responsible (as design authority) for development work on the Ariane launchers. The Agency owns all the assets produced under these development programs. It entrusts technical direction and financial management of the development work to CNES, which writes the program specifications and places the industrial contracts on its behalf. The Agency retains the role of monitoring the work and reporting to the participating States.

Since Flight 9 Arianespace has been responsible for building and launching the operational Ariane launchers (as production authority), and for industrial production management, for placing the launcher manufacturing contracts, initiating procurements, marketing and providing Ariane launch services, and directing launch operations.

THE GUIANA SPACE CENTER: EUROPE'S SPACEPORT

For over 30 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 operation, such as radars, telecom network, weather station, receiving sites for launcher telemetry, etc.
- Payload processing facilities (EPCU), in particular the new S5 facility.
- Ariane launch complexes (ELA), comprising the launch zone and launcher integration buildings.
- Various industrial facilities, including those operated by Regulus, Europropulsion, Air Liquide Spatial Guyane and EADS, which contribute to the production of Ariane 5 elements. 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), French space agency CNES and 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.

French space agency CNES plays several roles at the Space Center:

- It designs all infrastructures and, on behalf of the French government, is responsible for safety and security.
- It provides the resources needed to prepare the satellites and launcher for missions.

Whether during tests or actual launches, CNES is also responsible for overall coordination of operations. It collects and processes all data transmitted from the launcher via a network of receiving stations, to track Ariane rockets throughout their trajectory.

In French Guiana, Arianespace is in charge of launcher integration in the Launcher Integration Building (BIL), coordinates satellite preparation in the payload processing facility (EPCU), and integrates them on the launcher in the Final Assembly Building (BAF). It is also responsible for launch operations, from the CDL 3 Launch Center.

Arianespace has created a top-flight team and array of technical resources to get launchers and satellites ready for their missions. Building on this unrivalled expertise and outstanding local facilities, Arianespace is now the undisputed benchmark in the global launch services market.