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# FLIGHT VA245: ARIANESPACE TO DELIVER BEPICOLOMBO, EUROPE'S FIRST MISSION TO MERCURY, FOR ESA AND JAXA

**For its seventh launch of the year, Arianespace will use an Ariane 5 ECA from the Guiana Space Center (CSG), to send the BepiColombo spacecraft on its way to the solar system's smallest and least-explored terrestrial planet: Mercury.**

**The BepiColombo mission will be carried out jointly by the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA).**

**After launching the successful Rosetta mission in 2004, Arianespace's launch services once again helps unlock mysteries of deep space.**

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## BepiColombo: Europe's first mission to Mercury

Carried out jointly between ESA and JAXA, the BepiColombo spacecraft will conduct an interdisciplinary mission to Mercury, the smallest and least explored planet in our solar system. The purpose of Flight VA245 is to inject BepiColombo into an Earth escape trajectory, allowing its European and Japanese probes to reach Mercury after a seven-year voyage through space.

Missions to Mercury already have been undertaken in the past, including NASA's Mariner 10, which revealed the first images of the planet in 1974-1975; and Messenger, which provided new but also unexpected data and images when it went into orbit around Mercury between 2011 and 2015. However, BepiColombo will be the first-ever European mission to Mercury providing measurements to study and understand the planet's history, composition, geophysics, exosphere and magnetosphere.

As the nearest planet to the Sun, exploring Mercury is key to acquiring knowledge of how terrestrial planets originate and evolve, as well as to understand how conditions supporting life arose in the solar system, and possibly elsewhere.

Named after the Italian mathematician and engineer Giuseppe (Bepi) Colombo, the mission comprises dual science orbiters: the Mercury Planetary Orbiter (MPO), developed by ESA to map the planet by focusing on its surface and interior; and the Mercury Magnetospheric Orbiter (MMO) – developed and built by JAXA to investigate its magnetosphere by exploring the environment.

The Mercury Composite Spacecraft (MCS) consists of the MTM, MPO, MMO, and MOSIF. The Mercury Transfer Module (MTM) will carry the two orbiters (MPO and MMO) to their destination and the MMO Sunshield and Interface Structure (MOSIF) will provide thermal protection.

The expected arrival is scheduled in late 2025, with BepiColombo to be gravity captured after jettisoning the MTM. Its descent into Mercury orbit will be performed by chemical propulsion engine within the MPO.

Once at Mercury, BepiColombo will endure temperatures in excess of 350°C. It will then conduct a one-year nominal mission, with a possible one-year extension.

## European and Japanese collaboration for space exploration

BepiColombo will be the 51st mission to be performed by Arianespace (with the 73rd satellite) for the European Space Agency and the 23rd mission at the service of deep space exploration.

After the successful launch of four Galileo satellites on July 25 and Aeolus on August 22, BepiColombo will be the third mission of the year for ESA, for which Arianespace has four additional missions (for six satellites) in its backlog: James Webb Space Telescope, 2x Galileo (x2) on Ariane 62 and CHEOPS on Soyuz.

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By launching BepiColombo on behalf of ESA, Arianespace thus continues to guarantee Europe's independent and reliable access to space, furthering knowledge of our universe and for a better life on Earth through European initiatives.

In 32 years, Arianespace has built a close relationship with Japan epitomized by the opening an office in Tokyo in 1986, the cooperation with the Japanese launch service provider MHI, and the 32 contracts signed with Japanese operators (31 GEO satellites): for SKY Perfect JSAT (20 satellites launched), B-SAT (11 satellites launched) and National Space Development Agency of Japan (2 auxiliary satellites).

Arianespace's next missions for Japanese operators will be: JCSAT-17 for SKY Perfect JSAT and BSAT-4b for B-SAT.

## Manufacturer

BepiColombo was built under the industrial leadership of Airbus Defence and Space at its Friedrichshafen space installation complex, in Germany. Leading a consortium of 83 companies from 16 countries, Airbus Defence and Space is responsible for designing and building the MPO, the MTM as well as all other European spacecraft hardware.

BepiColombo will be the 121st Airbus Defence and Space spacecraft to be lofted by Arianespace, whose backlog currently comprises 22 additional satellites to launch for the global manufacturer.

## Arianespace and scientific missions

After Flight VA245, Arianespace will have conducted 23 major scientific missions since the early days of the company. Among them:

- XMM-Newton (ESA) - Flight VA119, December 10, 1999,
- Rosetta (ESA) - Flight VA158, March 2, 2004,
- Herschel & Planck (ESA) - V188, May 14, 2009,
- Aeolus (ESA) - VV12, August 22, 2018,

Moreover, Arianespace also will put into orbit the most emblematic scientific mission of the next decade: James Webb Space Telescope (JWST), the joint project of NASA, ESA and the Canadian Space Agency is to be launched on Ariane 5, from the Guiana Space Center in 2021. The mission's objectives are detecting the first stars in the Universe and following their evolution over time, witnessing the birth of new ones and their planetary systems, and studying planets in our Solar System and around other stars.

Entrusting Arianespace with the launch of the most expensive and powerful space telescope (approximately 10 billion dollars) proves how confident NASA, ESA and the Canadian Space Agency are in Arianespace's launch services.

# MISSION DESCRIPTION

**Arianespace's fifth Ariane 5 ECA launch of the year will place its satellite passenger into an Earth escape orbit.**

**The launcher will be carrying a total payload of approximately 4,241 kg.**

The launch will be performed from Ariane Launch Complex No. 3 (ELA-3) in Kourou, French Guiana.

## DATE AND TIME

Liftoff is planned on **Friday, October 19, 2018** at exactly:

- **09:45:28 p.m.** Washington, D.C. time
- **10:45:28 p.m.** Kourou, French Guiana time
- **01:45:28** Universal Time (UTC) on Saturday, October 20, 2018
- **03:45:28 a.m.** Paris time on Saturday, October 20, 2018
- **10:45:28 a.m.** Tokyo time on Saturday, October 20, 2018

## MISSION DURATION

The nominal duration of the mission (from liftoff to separation of the spacecraft) is:

**26 minutes, 47 seconds.**

## TARGETED EARTH ESCAPE ORBIT

**Infinite velocity**
3,475 m/s

**Declination**
-3.8 degrees

## THE LAUNCH AT A GLANCE

The launcher's attitude and trajectory are controlled by the two onboard computers located in the Ariane 5 vehicle equipment bay (VEB).

About seven seconds after start of the ignition of the main stage cryogenic engine at T-0, the two solid-propellant boosters are ignited, enabling liftoff. The launcher first climbs vertically for 13 seconds, then rotates towards the East. It maintains an attitude that ensures the axis of the launcher remains parallel to its velocity vector to minimize aerodynamic loads throughout the entire atmospheric phase until the solid boosters are jettisoned.

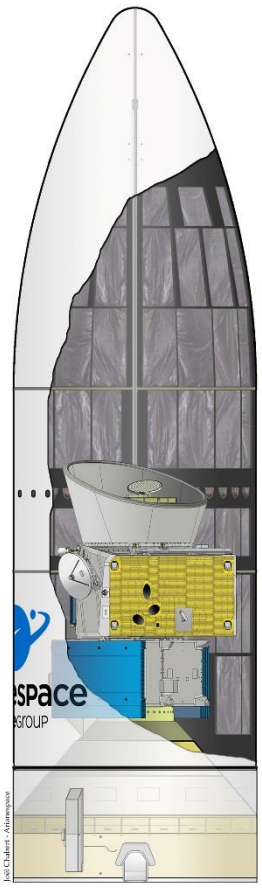
The fairing protecting the payload is jettisoned at T+189 seconds.

Once this first part of the flight is completed, the onboard computers optimize the trajectory in real time, minimizing propellant consumption to bring the launcher first to the intermediate orbit targeted at the end of the main stage propulsion phase, and then the final orbit at the end of the flight of the cryogenic upper stage.

The main stage splashes down off the coast of Africa in the Atlantic Ocean (in the Gulf of Guinea). At orbital injection, the launcher will have attained a velocity of approximately 10,155 meters/second, and will be at an altitude of 1,449 km.

## PAYLOAD CONFIGURATION

- **Payload (CU): BepiColombo**
  Mass at liftoff: 4,081 kg.
- **Long version of the payload fairing**



# BepiColombo SATELLITE

| | |
|---|---|
| **CUSTOMER** | **ESA** |
| **JOURNEY** | Ariane 5 will place the spacecraft into an Earth escape orbit to Mercury. BepiColombo will travel through space for seven years and be captured by Mercurian gravity before conducting a one-year scientific operation. |
| **PRIME CONTRACTOR** | Airbus Defence and Space, leading a consortium of 83 companies from 16 countries |
| **MISSION** | Scientific Mission to Mercury Planet |
| **MASS AT LAUNCH** | 4,081 kg. |
| **MERCURY COMPOSITE SPACECRAFT (MCS)** | The Mercury Transfer Module (MTM); the Mercury Planetary Orbiter (MPO); the Mercury Magnetospheric Orbiter (MMO); the MMO Sunshield and Interface Structure (MOSIF) |
| **REQUIRED ORBIT** | Earth escape orbit |
| **STABILIZATION** | 3 axis |
| **INFINITE VELOCITY** | 3,475 m/s |
| **DECLINATION** | -3.8 deg |
| **BODY DIMENSIONS** | 3.9 m. x 3.6 m. x 6.3 m. |
| **POWER OF SOLAR ARRAYS** | 11.2 KW |
| **DESIGN LIFE** | 8.5 years ( including one year scientific operation ) + one year extension |

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# ARIANE 5 ECA LAUNCH VEHICLE

The launcher is delivered to Arianespace by ArianeGroup as production prime contractor.

54.8 m.

**Fairing**

*(RUAG Space):* 17 m.
Mass: 2.4 t.

**780 metric tons**
(total mass at liftoff)

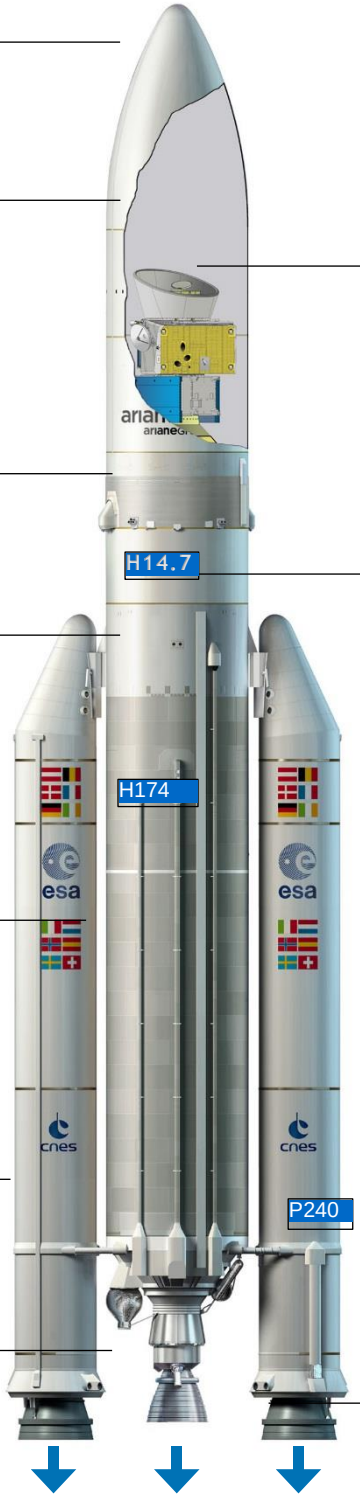
**BepiColombo**
Mass: 4,081 Kg.

**PA - Payload adaptor (1)**

*(RUAG Space or Airbus)*
Mass: approx. 160 kg.

**Vehicle Equipment Bay**

Height: 1.13 m.
Mass: 970 kg.




**ESC-A - Cryogenic upper stage**

Height: 4.71 m.
Mass: 19 t.

**HM-7B engine**

Thrust: 67 kN (in vacuum)
945 sec. of propulsion

**EPC - Cryogenic main stage**

Height: 31 m.
Mass: 188 t.

**Propellants (in metric tons) at T-O**
H: Cryogenic
P: Solid

**EAP - Solid rocket boosters**

Height: 31.6 m.
Mass: 277 t. approx.

**Vulcain 2 engine**

Thrust: 1,410 kN (in vacuum)
540 sec. of propulsion

**MPS - Solid Rocket Motor (SRM)**

Average thrust: 5,060 kN
Maximum thrust: 7,080 kN (in vacuum)
130 sec. of propulsion

**13,000 kN at liftoff**
(at T+7.3 sec.)

# LAUNCH CAMPAIGN - ARIANE 5
# BepiColombo

## SATELLITE AND LAUNCH VEHICLE CAMPAIGN CALENDAR

| DATE | SATELLITE ACTIVITIES | LAUNCH VEHICLE ACTIVITIES |
|---|---|---|
| **April 24 to May 9, 2018** | Arrival in French Guiana of BepiColombo on Antonov no. 1 to 4 and transfer by road to the Spaceport's S5 payload preparation facility | |
| **August 20 to 21, 2018** | MMO integration on MPO | |
| **September 5 to 12, 2018** | BepiColombo fueling operations | |
| **September 6, 2018** | | Campaign start review<br>EPC unpacking |
| **September 7, 2018** | | EPC erection - EAP 2 transfer |
| **September 10, 2018** | | EAP1 transfer - EPC/EAP integration |
| **September 14, 2018** | | Erection of ESC-A and vehicle equipment bay installation |
| **September 19 to 20, 2018** | BepiColombo final assembly: MPO/MMO integration on MTM | |
| **October 3, 2018** | | Transfer from BIL-BAF |

## SATELLITE AND LAUNCH VEHICLE CAMPAIGN FINAL CALENDAR

| DATE | SATELLITE ACTIVITIES | LAUNCH VEHICLE ACTIVITIES |
|---|---|---|
| **Thursday, October 4, 2018** | BepiColombo integration on payload adaptor | |
| **Monday, October 8, 2018** | BepiColombo transfer to the Final Assembly Building (BAF) | |
| **Tuesday, October 09, 2018** | BepiColombo integration on launch vehicle | |
| **Wednesday, October 10, 2018** | BepiColombo final preparation before fairing encapsulation | HM7B engine final inspection |
| **Thursday, October 11, 2018** | Completion of composite integration on launcher and payload checks | Fairing integration on launch vehicle |
| **Friday, October 12, 2018** | | Finalization of the composite/launcher integration, and payload checks |
| **Monday, October 15, 2018** | BepiColombo participation to launch rehearsal | Launch rehearsal |
| **Tuesday, October 16, 2018** | | Arming of launch vehicle |
| **Wednesday, October 17, 2018** | Beginning of BepiColombo countdown | Launch readiness review (LRR), final preparation of launcher and BAF for the chronology |
| **Thursday, October 18, 2018** | | Roll-out from BAF to Launch Zone, launch vehicle connections and filling of the EPC liquid helium tank |
| **Friday, October 19, 2018** | BepiColombo final countdown on launch pad | Start of launch countdown, EPC and ESC-A filling with liquid oxygen and liquid hydrogen |

# COUNTDOWN AND FLIGHT SEQUENCE

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

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

**If an interruption in the countdown results in the T-0 moving outside the launch time, then the launch will be delayed by one, two or more days, depending on the problem involved, and the solution developed.**

| TIME | EVENT |
|---|---|
| - 11 h 23 min | Start of final countdown |
| - 10 h 33 min | Check of electrical systems |
| - 04 h 38 min | Start of filling of EPC with liquid oxygen and liquid hydrogen |
| - 03 h 28 min | Start of filling of ESC-A with liquid oxygen and liquid hydrogen |
| - 03 h 18 min | Chilldown of Vulcain main stage engine |
| - 01 h 15 min | Check of connections between launcher and the telemetry, tracking and command systems |
| - 7 min | "All systems go" report, allowing start of synchronized sequence |
| - 4 min | Tanks pressurized for flight |
| -1 min | Switch to onboard power mode |
| - 05 s | Opening command for the cryogenic arms |
| - 04 s | Onboard systems take over |

| T-0 | Reference time |
|---|---|
| + 01 s | Ignition of the cryogenic main stage (EPC) |
| + 07.05 s | Ignition of solid boosters (EAP) |
| + 07.3 s | Liftoff |
| + 12.3 s | End of vertical climb, beginning of pitch motion |
| + 17.1 s | Beginning of roll maneuver |
| + 32.1 s | End of roll maneuver |
| + 2 min 21 s | EAP separation |
| + 3 min 09 s | Fairing jettisoned |
| + 6 min 26 s | Acquisition by Natal tracking station |
| + 8 min 37 s | End of EPC thrust phase |
| + 8 min 43 s | EPC separation |
| + 8 min 47 s | Ignition of ESC-A stage |
| + 13 min 22 s | Acquisition by Ascension tracking station |
| + 17 min 46 s | Acquisition by Libreville tracking station |
| + 21 min 59 s | Acquisition by Malindi tracking station |
| + 24 min 38 s | Injection |
| + 26 min 47 s | **BepiColombo satellite separation** |

# ARIANE 5 ECA MISSION PROFILE

The launcher's attitude and trajectory are entirely controlled by the two onboard computers in the Ariane 5 Vehicle Equipment Bay (VEB).

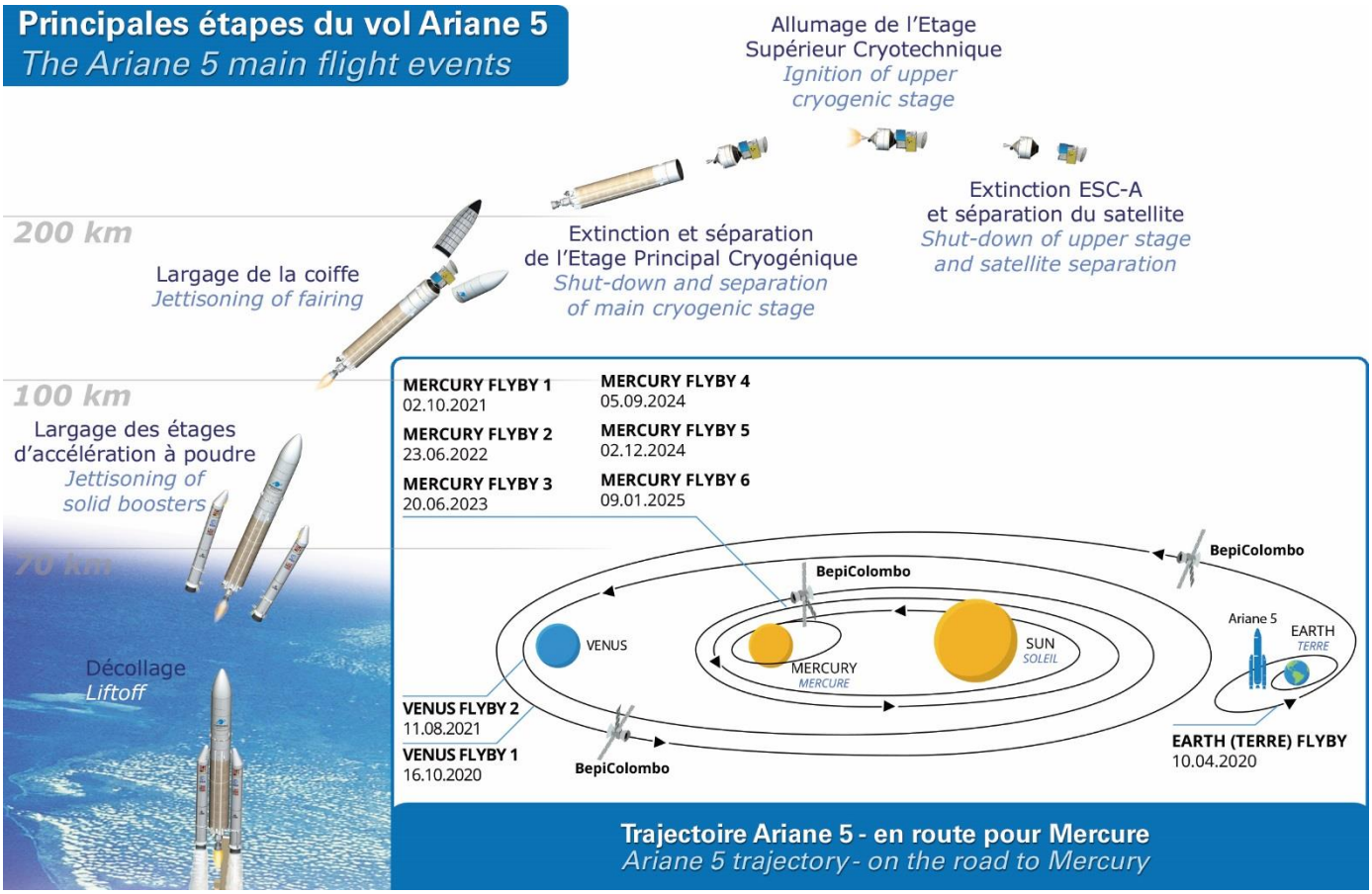
The synchronized sequence starts seven minutes before ignition (T-0). It is primarily designed to perform the final operations on the launcher prior to launch, along with the ultimate checks needed following switchover to flight configuration. As its name indicates, the sequence is fully automatic, and 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, they handle the final ground system configurations, namely:

- Startup of water injection in the flame trenches and exhaust guide (T-30 sec).
- Hydrogen aspiration for chilldown of the Vulcain engine in the exhaust guide (T-18 sec).
- Burn-off 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).
- Checks engine operation (from T+4.5 to T+6.9 sec).
- Commands ignition for the solid boosters at T+7.05 sec for liftoff at T+7.3 seconds.

**Any shutdown of the synchronized sequence after T-7 minutes automatically places the launcher back in its T-7-minute configuration.**



# 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 is a subsidiary of ArianeGroup, which holds 74% of its share capital; the balance is held by 17 other shareholders from the European launcher industry.

Since the outset, Arianespace has signed over 530 launch contracts and launched 570-plus satellites. More than half of the commercial satellites now in service around the globe were launched by Arianespace. The company posted sales of approximately 1.3 billion euros in 2017.

The company's activities are worldwide, with the headquarters in Evry, France (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-lift launcher, operated from the Guiana Space Center in French Guiana.
- The Soyuz medium-lift launcher, currently in operation at the Guiana Space Center and the Baikonur Cosmodrome in Kazakhstan.
- The Vega light-lift 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 700 satellites to be launched.

## THE GUIANA SPACE CENTER: EUROPE'S SPACEPORT

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

- The 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 ArianeGroup – all participate in the production of Ariane 5 components. A total of 40 European manufacturers and local companies are involved in the launcher 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 Arianespace as the operator. 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 France's space program, the Guiana Space Center has evolved into 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 the 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.

Arianespace supervises the integration and checks of the Ariane launcher – which is built under ArianeGroup responsibility as the production prime contractor; coordinates the satellite preparations that are performed in parallel inside the Payload Preparation Complex (EPCU) [which is operated by the Guiana Space Center - CNES/CSG], followed by the payload's integration on the launcher in the Final Assembly Building (BAF); and also works with ArianeGroup teams in charge of the launcher to conduct the final countdown and launch from Launch Control Center no. 3 (CDL3).

Arianespace deploys a top-flight team and technical facilities to ensure the launchers and their satellite payloads are 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.