arianespace
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LAUNCH KIT

July 2018

VA244

Galileo FOC-M8

SAT 23-24-25-26

esa

GALILEO
23-24-25-26

cnes

ARIANESPACE'S ARIANE 5 LAUNCH FOR THE GALILEO CONSTELLATION AND EUROPE

For its fourth launch of the year, Arianespace will orbit four more satellites (satellites 23 to 26) for the Galileo constellation. This mission is being performed on behalf of the European Commission under a contract with the European Space Agency (ESA).

For the third time, an Ariane 5 ES version will be used to orbit satellites in Europe's own satellite navigation system; with all Galileo spacecraft having been launched to date by Arianespace. Ariane 6 will take over from 2020.

Arianespace is proud to mobilize its entire family of launch vehicles for the benefit of Europe's ambitions and its independent access to space.

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Galileo, an ambitious program serving Europe's and the world's citizens

Galileo is Europe's own global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control. Currently providing Initial Services, Galileo is interoperable with GPS and Glonass, the U.S. and Russian global satellite navigation systems. By offering dual frequencies as standard, Galileo is set to deliver real-time positioning accuracy down to the meter range.

The constellation will count 24 operational satellites plus in-orbit spares, of which 22 already have been put into orbit by Arianespace.

In July 2017, ESA officially transferred the supervision of Galileo in-orbit operations to the European Global Navigation Satellite Systems Agency (GSA), on behalf of the European Union.

After the VA244 launch, the GSA will be responsible for operating the satellites as soon as they are separated from the launcher. These operations of setting up and operating the system will be done in collaboration with ESA.

THE ARIANESPACE FAMILY: SUPPORTING THE DEPLOYMENT OF GALILEO

Arianespace orbited the Galileo IOV 1 and 2 (In-Orbit Validation) satellites on Soyuz Flight VS01 on October 21, 2011, followed by IOV 3 and 4 on Flight VS03 on October 12, 2012. Under European Space Agency-European Union co-financing, this phase allowed validation of the overall concept.

Previously, the ESA GIOVE-A and GIOVE-B experimental satellites were orbited by Soyuz from the Baikonur Cosmodrome in Kazakhstan (via Arianespace's Starsem affiliate) in 2005 and 2008.

The first two Full Operational Capability (FOC) satellites for Galileo (Sats 5 and 6) were launched on August 22, 2014. From 2015 to 2016, the Galileo Sats 7 to 22 were deployed by Arianespace Flights VS11, VS12, VS13, VS15, all via Soyuz; and VA233 and VA240, via launches of Ariane 5 ES versions.

Arianespace will deploy Galileo FOC-M8 satellites 23 to 26 on the third and final dedicated Ariane 5 ES mission in support of the navigation system.

The Ariane 6's A62 version will take over, with two launches used to orbit another four satellites during a timeframe between December 2020 and June 2021.

The Flight VA244 mission will be Arianespace's 49th performed for ESA. Arianespace has seven more ESA missions in its launch manifest: two for the European Commission, carrying four Galileo spacecraft; and five other missions (to orbit EDRS-C, Bepi-Colombo, the James Webb Space Telescope, CHEOPS and ADM-Aeolus).

These launches clearly show that Arianespace is meeting its assigned mission of ensuring independent access to space for Europe.

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MADE IN EUROPE

The Galileo satellites are built by prime contractor OHB System in Bremen, Germany, with the payloads supplied by UK-based Surrey Satellite Technology Ltd (SSTL), which is an Airbus Defense and Space affiliate.

MISSION DESCRIPTION

The third Arianespace Ariane 5 launch of 2018 will place the four Galileo satellites into MEO (Medium Earth Orbit) circular orbit.

The launcher will be carrying a total payload of approximately 3,379 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 **Wednesday, July 25, 2018** at exactly:

> **8:25:01 a.m.,** Kourou time
> **7:25:01 a.m.,** Washington D.C. time
> **11:25:01,** Universal Time (UTC)
> **1:25:01 p.m.,** Paris time

MISSION DURATION

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

3 hours, 56 minutes and 54 seconds.

TARGETED ORBIT

Circular orbit
MEO-plane B.

Altitude
22,922 km.
Semi-major axis: 29,300 km.

Inclination
56.00 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 six seconds, then rotates towards the East. It maintains an attitude that ensures the axis of the launcher remains parallel to its velocity vector, in order to minimize aerodynamic loads throughout the entire atmospheric phase until the solid boosters are jettisoned.

The fairing protecting the payload is jettisoned at T+225 seconds.
The flight of the Ariane 5 lower composite, comprising the two solid boosters and the cryogenic main stage, will last about nine minutes. This stage then separates from the upper stage and falls back into the Pacific Ocean, off the coast of Peru.
The storable propellant upper stage will ignite its own engine at this point, to bring the upper composite - comprising the Galileo satellites and their dispenser - into a transfer orbit. Following this initial ignition, the upper composite is spun up for a ballistic phase lasting 3 hours, 8 minutes.
At a predetermined point in this orbit, the upper stage will again ignite its engine for a little more than six minutes, to reach a circular separation orbit. Once stabilized, the dispenser will release the first two satellites, followed by the second pair 20 minutes later.
The upper stage will be passivated at the end of the mission. The Galileo satellites will then perform a maneuver to increase their altitude and reach the operational orbit at 23,222 km.

At orbital injection, the launcher will have attained a velocity of approximately 3,000 meters/second, and will be at an altitude of 22,922 kilometers, which is 300 km. below Galileo's operational orbit.

PAYLOAD CONFIGURATION

> **Payload:** Galileo FOC-M8, SAT 23, 24, 25, 26
Mass at liftoff: 738 kg. each, for a total of 2,952 kg.

> **Medium version of the payload fairing**

> **Dispenser (carrying structure and deployment system) for the four Galileo FOC-M8 payloads, developed and built by ArianeGroup.**

Galileo FOC-M8, SATELLITES 23-24-25-26

CUSTOMER	The European Space Agency (ESA) on behalf of the European Commission
PRIME CONTRACTOR	OHB System AG (spacecraft bus, prime), SSTL (payload)
MISSION	Navigation
MASS	Mass at launch of 738 kg. each, for a total of 2,952 kg.
DIMENSIONS	2.7 m. x 1.2 m. x 1.1 m.
WIDTH (with solar array deployed)	14.67 m.
DESIGN LIFE	More than 12 years
ONBOARD POWER	1,900 W
ORBITAL POSITION	Medium Earth Orbit (MEO)
NAVIGATION SIGNAL	3 bands (E5, E6 and E1)

PRESS CONTACTS

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ARIANE 5 ES LAUNCH VEHICLE

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

47.4 m.

Fairing

(RUAG Space): 14 m.
Mass: 1.9 t.

760 tons
(total mass at liftoff)

4 x Galileo Satellites

(ESA)
Mass: 3,379 kg.

Dispenser FOC A5 - Internal structure

Mass: 427 kg.

Vehicle equipment bay

Height: 1.13 m.
Mass: 1.4 t.

EPS – Storable propellant upper stage

Height: 3.36 m.
Mass: 1.9 t.

Aestus engine

Thrust: 29 kN (in vacuum)
12,300 sec. of propulsion

EPC - Cryogenic main stage

Height: 31 m.
Mass: 188 t.

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

EAP - Solid rocket boosters

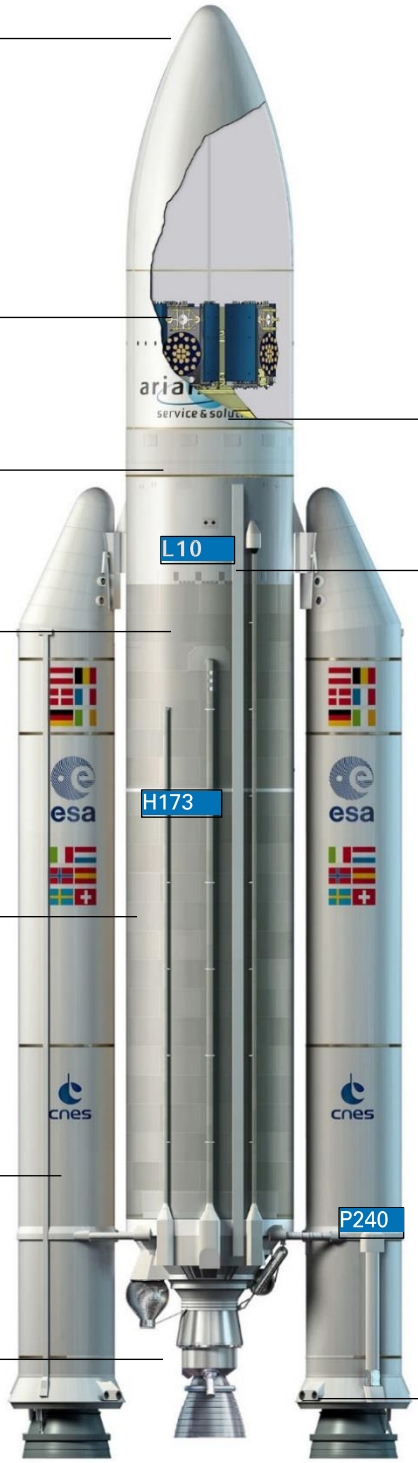
Height: 31.6 m.
Mass: 277 t. approx.

Vulcain 2 Engine

Thrust: 1,390 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 - Galileo FOC-M8 SATELLITES 23-24-25-26

SATELLITES AND LAUNCH VEHICLE CAMPAIGN CALENDAR

DATES	SATELLITE ACTIVITIES	LAUNCH VEHICLE ACTIVITIES
May 4, 2018	Arrival in French Guiana of the two first Galileo satellites; beginning of preparation in the S1A hall	
June 1, 2018	Arrival in French Guiana of the two other Galileo satellites; beginning of preparation in the S1A hall	
June 4 to 7, 2018	Fitcheck of the four Galileo satellites in the S1A hall	
June 11, 2018		Campaign start review; EPC unpacking - EPC erection – EAP 2 transfer
June 12, 2018		EAP 1 transfer - EAP positioning
June 13, 2018		EPC/EAP integration
June 18, 2018		EPS erection - Vehicle Equipment Bay integration
June 21, 2018	Transfer of the two first Galileo satellites to the S3B hall	
June 25, 2018	Transfer of the second two Galileo satellites to the S3B hall	
June 27 to 29, 2018 July 2, 2018	Galileo satellite fueling operations in the S3B hall	
July 5, 2018		Transfer from the BIL (Launcher Integration Building) to BAF (Final Assembly Building)
July 4 to 9, 2018	Integration of the four Galileo satellites on their dispenser	
July 10, 2018	Transfer of the dispenser with the four Galileo satellites to the BAF	

SATELLITES AND LAUNCH VEHICLE CAMPAIGN FINAL CALENDAR

DATES	SATELLITE ACTIVITIES	LAUNCH VEHICLE ACTIVITIES
Wednesday, July 11, 2018	Integration of the four Galileo satellites on the launcher	
Thursday, July 12, 2018	Encapsulation of the four Galileo satellites in the payload fairing	
Monday, July 16, 2018		N2H4 fueling of SCA; SCA pressurization for launch
Tuesday, July 17, 2018		MMH fueling of EPS
Wednesday, July 18, 2018		Launch rehearsal N2H4 fueling of EPS
Thursday, July 19, 2018		Arming of the launch vehicle
Friday, July 20, 2018		Launch readiness review (RAL); final preparation of launcher and BAF for the chronology
Monday, July 23, 2018		Rollout from the BAF to Launch Zone; launch vehicle connections
Tuesday, July 24, 2018		Filling of the EPC liquid helium tank; Heating of EPS tank
Wednesday, July 25, 2018		Final launch countdown; EPC filling with liquid oxygen and liquid hydrogen

COUNTDOWN AND FLIGHT SEQUENCE

The countdown comprises all final preparation steps for the launcher, the satellites/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	38 min		Start of final countdown
- 10 h	53 min		Check of electrical systems
- 04 h	38 min		Start of filling of the EPC with liquid oxygen and hydrogen
- 03 h	18 min		Chilldown of Vulcain main stage engine
- 01 h	10 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
		- 04 s	Onboard systems take over
T-O			Ignition of the cryogenic main stage engine (EPC)
		+ 07 s	Ignition of solid boosters (EAP)
		+ 07 s	Liftoff
		+ 12 s	End of vertical climb, beginning of pitch motion
		+ 17 s	Beginning of roll maneuver
	+ 2 min	19 s	EAP separation
	+ 3 min	44 s	Fairing jettisoned
	+ 8 min	56 s	End of EPC thrust phase
	+ 9 min	01 s	EPC separation
	+ 9 min	19 s	EPS ignition
	+ 19 min	58 s	Shutdown of EPS (first boost) and beginning of the first ballistic phase
+ 3h	+ 27 min	50 s	EPS ignition
+ 3h	+ 34 min	08 s	Shutdown of EPS (second boost) and beginning of the second ballistic phase
+ 3h	+ 36 min	05 s	**Separation of Galileo satellites 23 and 25**
+ 3h	+ 56 min	05 s	**Separation of Galileo satellites 24 and 26**
+ 4h	+ 12min	59 s	Upper stage passivation
+ 4h	+ 40min	52 s	End of the Arianespace mission

ARIANE 5 ES 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).

> Burnoff of hydrogen used for chilldown (T-5.5 sec).

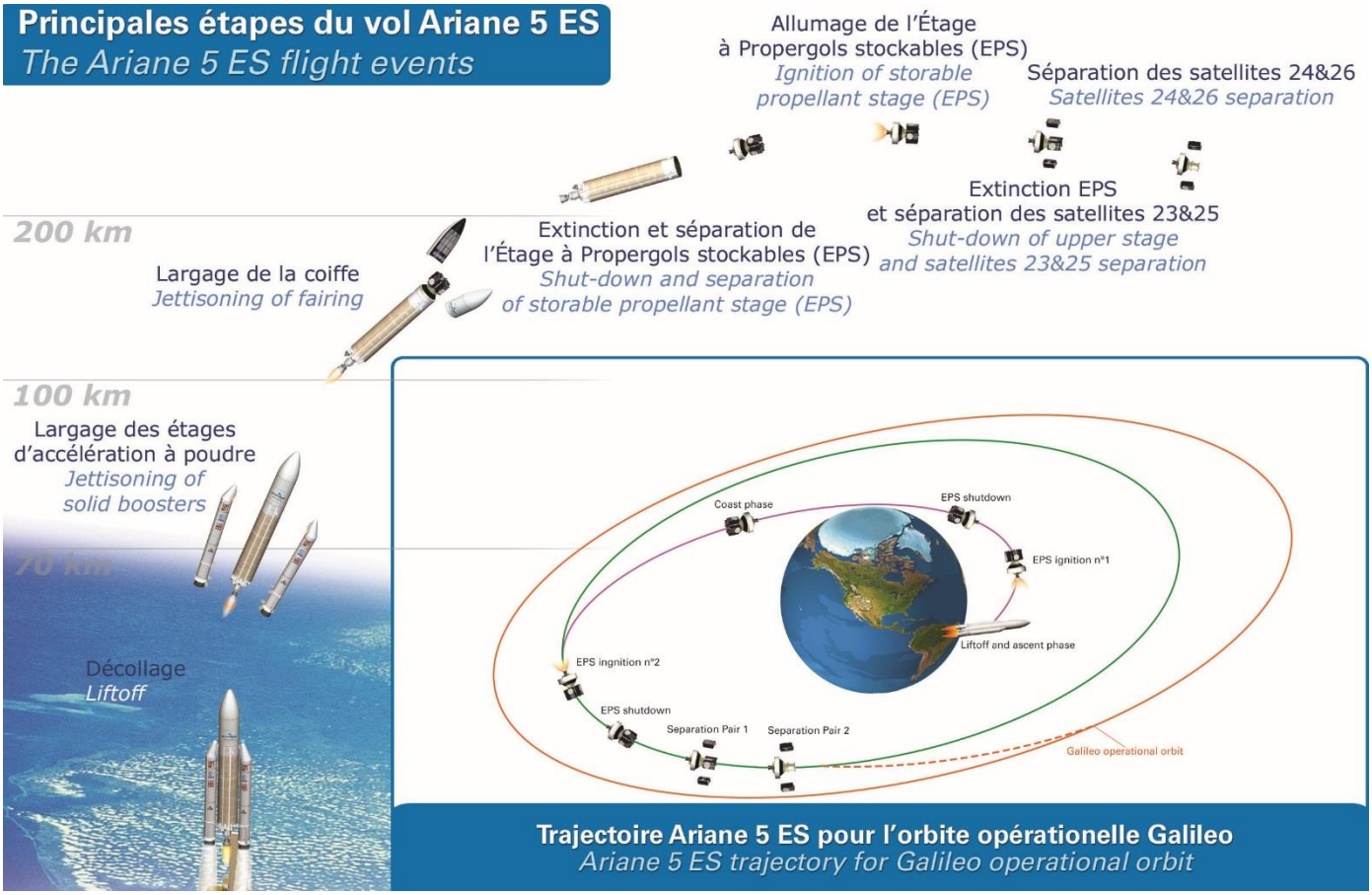
At T-4 seconds, the onboard computer takes over control of final engine startup and liftoff operations. It:

> Starts the ignition sequence for the Vulcain main stage engine (T-0).

> 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 70 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 participating 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 mission. Building on this unrivalled expertise and outstanding local facilities, Arianespace is now the undisputed benchmark in the global launch services market.