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LAUNCH KIT

December 2018

VS20

CSO-1

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MINISTÈRE DES ARMÉES

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CENTRE NATIONAL D'ÉTUDES SPATIALES

ARIANESPACE TO ORBIT CSO-1 A MILITARY OBSERVATION SATELLITE FOR CNES AND DGA

For its 11th and final launch of the year — and the third with the Soyuz medium launcher — Arianespace will send the CSO-1 Earth observation satellite, intended for defense and security applications, into Sun-synchronous orbit for the French CNES (*Centre National d'Etudes Spatiales*) space agency and the DGA (*Direction générale de l'armement*) defense procurement agency on behalf of the French Ministry of Defense.

This also will be the 20th mission carried out by Soyuz since it began operating at the Guiana Space Center (CSG) in October 2011.

With this latest launch at the service of France's defense requirements, as well as for the capacity needs of several partner countries, Arianespace once again guarantees French and European autonomous access to space – a strategic priority, and a key element for sovereignty.

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CSO-1 satellite

CSO-1 is the first satellite of the Optical Space Component (CSO – *Composante Spatiale Optique*) program, a constellation of three satellites dedicated to Earth observation for defense and security. They will be placed into polar orbit at different altitudes, and will carry out two different missions: reconnaissance for CSO-1 and CSO-3, and identification for CSO-2.

The French CNES space agency is delegated as the contracting authority for the Optical Space Component (CSO) program and its mission ground segment, as well as being the overall system co-architect. CNES also is responsible for orbital positioning, in-orbit acceptance testing and satellite operation. France's DGA defense procurement agency is contracting authority for the construction and through-life maintenance of the user ground segment, and will serve as the interface between the sensors deployed in space and the operators. The French armed forces headquarters is the operating authority for CSO.

The successor to the Helios 1 and 2 systems, CSO will address France and Europe's operational needs for global intelligence and strategic surveillance, knowledge of the geographic environment and support for operational deployments.

As France's third generation of military satellites, CSO was developed in a national framework and will remain accessible to European partners. Indeed, Germany, Sweden and Belgium already have joined the CSO community, and an agreement with Italy is expected shortly.

The CSO-1 satellite will be placed in a Sun-synchronous orbit at an altitude of 800 km. It will be used to acquire very-high-resolution images in the visible and infrared bandwidths, day or night and in fair weather, and using a variety of imaging modes to meet as many operational requirements as possible.

Airbus Defence and Space France is prime contractor for the satellites, while Thales Alenia Space France supplies the optical imaging instrument. CSO-1 will be the 123rd Airbus Defence and Space satellite to be launched by Arianespace

Arianespace: supporting French institutions…

Since its creation in 1980, Arianespace has orbited a total of 590 satellites, including 67 intended for defense and security (including auxiliary payloads).

CSO-1, the first in a series of three first-generation satellites for the French armed forces ministry, will be the 42nd satellite launched by Arianespace for CNES and DGA.

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Its predecessors include the Syracuse family of military telecommunications satellites, and the Pleiades family of very-high-resolution imaging satellites.

To date, Arianespace's backlog includes six more missions for French institutions (CNES/DGA): Syracuse 4A and 4B, CSO-2 and CSO-3, the CERES system and the Taranis satellite.

… as well as European partners

Among the 67 defense and security satellites launched by Arianespace to date, 25 were for European partners:

- United Kingdom: Skynet communications satellites;
- Germany: SATCOMBw satellites;
- Italy: Sicral and OPSAT-3000 satellites as well as the Athena-Fidus satellite in cooperation with France;
- Spain: XTAR communications system and Spainsat satellites.

Arianespace has 14 more satellites in its order book for European institutions:

- PRISMA for the Italian space agency ASI, using a Vega light launcher;
- 2 COSMO-SkyMed satellites for Thales Alenia Space on behalf of the Italian Ministry of Defense and ASI, one using a Soyuz launcher and the other Vega C;
- H2Sat for OHB on behalf of the German Aerospace Center DLR, using an Ariane 5 heavy launcher;
- 4 Galileo satellites for the European Space Agency (ESA) and the European Commission, using two Ariane 62 launchers;
- CHEOPS for ESA, using Soyuz;
- The MTG I1 and MTG S1 satellites for the operator EUMETSAT, using Ariane 5;
- METOP-SG A1 and METOP-SG B1 for the operator EUMETSAT, using Soyuz;
- James Webb Space Telescope (JWST) for ESA in collaboration with NASA, using Ariane 5.

Arianespace also has a very successful export track record providing launch services for military applications. Japan, Peru, Chile, Brazil, Morocco, Turkey, Thailand, Egypt and the United Arab Emirates have all chosen Arianespace to orbit satellites that safeguard national sovereignty.

Drawing on the reliability and availability of its current launchers, along with the upcoming generation of Ariane 6 and Vega C, Arianespace guarantees independent access to space for all customers, especially European institutions.

MISSION DESCRIPTION

The 20th Soyuz launch from the Guiana Space Center (CSG) will place its satellite passenger into a Sun-synchronous orbit, at an altitude of 800 km.

The Soyuz ST-A launcher will be carrying a total payload of 3,713 kg.

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

DATE AND TIME

Liftoff is scheduled for **Tuesday, December 18, 2018** at exactly:

> **11:37:14 a.m.,** in Washington, D.C.
> **01:37:14 p.m.,** in Kourou, French Guiana
> **16:37:14,** Universal Time (UTC)
> **05:37:14 p.m.,** in Paris
> **07:37:14 p.m.,** in Moscou
> **01:37:14 a.m.,** in Tokyo on December 19, 2018

MISSION DURATION

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

1 hour, 44 seconds.

TARGETED SUN-SYNCHRONOUS ORBIT

Orbit
SSO
(Sun-synchronous orbit)

Altitude at separation
Approx. 800 km.

Inclination
98.6 degrees

THE LAUNCH AT A GLANCE

Following liftoff from the Guiana Space Center, the powered phase of the lower three Soyuz stages will last approximately nine minutes. The launcher's third stage will then be separated from the upper composite, which comprises the Fregat upper stage and the CSO-1 spacecraft. The three lower Soyuz stages and the payload fairing will fall into the sea.

Prior to the separation of the satellite, Fregat will carry out two main powered phases:

- Its 1st burn, lasting about 9 minutes, to be followed by a ballistic phase lasting about 35 minutes.
- Its 2nd burn, lasting approximately 1 minutes and a half, followed by a second ballistic phase, lasting 5 minutes.

The satellite will be then released on the dedicated orbit.

At the end of the mission, one successive firing of the Fregat engine will place Fregat into an orbit safely below that of the CSO-1.

SOYUZ PAYLOAD CONFIGURATION

> **Payload:** CSO-1
> **Mass at liftoff:** 3,565 kg.
> **ST Fairing**

CSO-1 satellite

CUSTOMER	French space agency CNES for French defense procurement agency DGA
MANUFACTURER	Airbus Defence and Space
PLATFORM	Specific
MISSION	Military observation
TOTAL MASS AT LAUNCH	3,565 kg.
DESIGN LIFE	10 years
ORBIT	Sun-synchronous orbit, at 800 km. altitude
COVERAGE	Global

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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 human into space, have performed more than 1,890 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.

Introduced in 1966, Soyuz 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 Soyuz launch vehicle's development program. This modernized version, also used to successfully launch MetOp-A on October 19, 2006 from the Baikonur Cosmodrome, features a digital control system providing additional mission flexibility; it also enables control of the launch vehicle fitted with the 4.1-meter ST payload 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 upgraded Soyuz 2-1b launch vehicle's inaugural flight was successfully performed from Baikonur Cosmodrome 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.

In October 2011, Arianespace successfully launched the first Soyuz rocket from the Guiana Space Center, orbiting the initial 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, Soyuz is being produced at an average rate of 15 to 20 launchers per year. The manufacturer also can 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 interplanetary trajectories to Mars or Venus. Offering an unrivaled heritage, Soyuz already has 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 composed of: 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 - Fairing
2 - Fregat upper stage
3 - Third stage
4 - Central core (2nd stage)
5 - 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, which are 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 Soyuz ST-A (2-1a) version, or a RD-0124 engine in the ST-B (2-1b) 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 Soyuz launcher's capability, now covering a full range of orbits (LEO, SSO, MEO, GTO, GEO and Earth escape). To ensure high reliability for the Fregat stage 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, as 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 three-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 with an external diameter of 4.1 meters and a length of 11.4 meters.

ROSCOSMOS AND THE RUSSIAN LAUNCHER INDUSTRY

The Roscosmos State Corporation for space activities is responsible for license allocations and intergovernmental relations. It is the launch authority in charge of range operations. RKTs-Progress (the Samara Space Center) is responsible for the design, development, and manufacture of launch vehicles, including the Soyuz launch vehicle's first, second, 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.

LAUNCH CAMPAIGN:

CAMPAIGN CALENDAR FOR THE SATELLITE AND LAUNCH VEHICLE

DATE	ACTIVITIES WITH THE SATELLITE	LAUNCH VEHICLE ACTIVITIES
September 13, to October 4, 2018		Campaign start review - Integration and control of the three Soyuz stages at the Soyuz launcher preparation building (MIK)
September 13 to October 24, 2018		Fregat upper stage preparation at the Soyuz MIK
October 25, 2018		Transfer of the Fregat upper stage to the FCube building for fueling operations
November 5, 2018	Arrival in Kourou of the CSO-1 satellite Preparation in the S1A building	
November 12, to 15, 2018		Pneumatic and propulsion system tests on the lower three Soyuz stages in the MIK
November 16 to 22, 2018		Electrical tests on the lower three Soyuz stages in the MIK
November 22 to December 5, 2018		Fregat N204 and UDMH fueling operations in the FCube building
November 28, 2018	CSO-1 satellite transfer from the S1A building to the S3B building	
December 1 to 3, 2018	CSO-1 satellite fueling operations	
December 6, 2018		Fregat upper stage N2H4 fueling operations in the FCube building
December 10, 2018		Fregat upper stage transfer to the S3B building
December 11, 2018	CSO-1 satellite integration on the Fregat upper stage	

FINAL CAMPAIGN CALENDAR FOR THE SATELLITE AND LAUNCH VEHICLE

DATE	ACTIVITIES WITH THE SATELLITE	LAUNCH VEHICLE ACTIVITIES
Monday, December 10, 2018	Final preparations of CSO-1 satellite	Final preparations of the lower three Soyuz stages in the MIK
Wednesday, November 12, and Thursday, December 13, 2018		Fregat upper stage final preparation; Encapsulation in the payload fairing
Friday, December 14, 2018	Roll-out of the payload upper composite from S3B to the launch zone; integration on the launcher	Rollout from MIK to the launch zone;
Saturday, December 15, 2018	Payload checks	Final launcher checks
Sunday, December 16, 2018	Launch rehearsal	
Monday, December 17, 2018		Final launcher checks; Launch rehearsal at the Spaceport facilities; Preparation for fueling operations; Launch readiness review (RAL)
Tuesday, December 18, 2018		Launcher final preparations; Launch countdown; Launch vehicle fueling operations

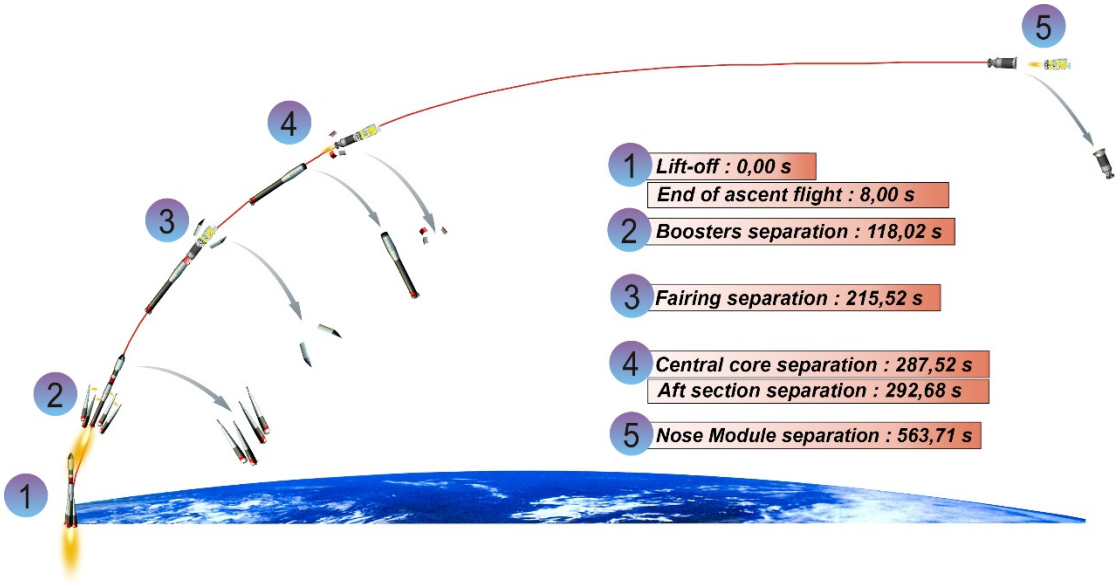
COUNTDOWN AND FLIGHT SEQUENCE

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.

TIME	EVENTS
- 5 hrs.	Meeting for launcher fueling authorization (BTR)
- 4 hrs. 30 min.	Launch vehicle fueling begins
- 1 hr. 35 min.	End of fueling operations
- 1 hr. 10 min.	Mobile gantry removal
- 5 min. 09 s	Key on start
- 5 min.	Fregat transfer to onboard power supply
-2 min. 25 s	Upper composite umbilical drop-off command
- 40 s	Ground-onboard power transfer
- 28 s	Lower stage umbilical mast retraction
- 16 s	Ignition
- 14 s	Preliminary thrust level
- 01 s	Full thrust level
HO 00 s	**Liftoff**
+ 1 min. 58 s	Jettisoning of boosters
+ 4 min. 15 s	Jettisoning of fairing
+ 4 min. 47 s	Separation of central core (second stage)
+ 8 min. 49 s	Separation of 3rd stage
+ 9 min. 49 s	First Fregat burn
+ 18 min. 41 s	First Fregat burn cut-off
+ 54 min. 15 s	Second Fregat burn
+ 55 min. 44 s	Second Fregat burn cut-off
+ 1 h 00 min. 44 s	**Separation of CSO-1**
+ 1 h 51 min. 40 s	Third Fregat burn (for deorbiting)
+ 1 h 52 min. 35 s	Third Fregat burn cut-off
+ 1 h 53 min. 05 s	End of the Arianespace mission

VS20 MISSION PROFILE

MISSION PROFILE FOR THE THREE SOYUZ STAGES



THE FREGAT MISSION PROFILE

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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 15 other shareholders from the European launcher industry.

Since the outset, Arianespace has signed over 530 launch contracts and launched 590-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, Soyuz and Vega 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 5, Soyuz and Vega.

For Soyuz, Arianespace supervises the launcher's integration and functional checks 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 their missions.

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