

## A launch for the International Space Station

For its first mission of the year, Arianespace will launch the first Automated Transfer Vehicle (ATV), dubbed "Jules Verne", for the European Space Agency (ESA). Right from this first launch, the ATV will play a vital role in bringing supplies to the International Space Station (ISS).

Weighing more than 20 tons, this will be by far the heaviest payload ever launched by Ariane 5. An Ariane 5 ES will inject the Jules Verne ATV into a circular orbit at an altitude of 260 kilometers, inclined 51.6 degrees.

With this launch, Ariane 5 further expands its array of missions, ranging from scientific spacecraft in special orbits to commercial launches into geostationary orbit.

The ATV is designed to bring supplies to the ISS (water, air, food, propellants for the Russian section, spare parts, experimental hardware, etc.), and to reboost the ISS into its nominal orbit. The ISS now weighs more than 240 metric tons, including the recently attached European laboratory, Columbus. After being docked to the ISS for up to six months, the ATV will be loaded with waste items by the astronauts, and sent back down.

After separating from the launch vehicle, the ATV will be autonomous, using its own systems for energy (batteries and four large solar panels) and guidance (GPS, star tracker), in liaison with the control center in Toulouse. During final approach, an optical navigation system will guide the ATV to its rendezvous with the Space Station, where it will automatically dock several days after launch. The ATV will remain docked to the ISS for nearly six months, before separating and making a guided reentry and disintegrating in the atmosphere.

The ATV was built by EADS Astrium at the head of a consortium of European manufacturers. A large cylinder measuring about 10 meters long by 4.5 meters in diameter, the ATV comprises two main parts: a service module with the avionics and propulsion systems, and a pressurized cargo carrier.

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## 1. Mission profile

The 181st Ariane launch will place the European Space Agency's first Automated Transfer Vehicle (ATV) into a low Earth orbit inclined 51.6 degrees.

This will be the 37th Ariane 5 launch.

The launcher will be carrying a total payload of 19,356 kg, including 19,012 kg for the ATV itself.

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

### *Injection orbit*

<i>Circular orbit</i>	<b>260 km</b>
<i>Inclination</i>	<b>51,61° degrees</b>

Lift-off is planned during the night of March 7 to 8, 2008.

### *Launch opportunity*

	<i>Universal time (GMT)</i>	<i>Paris time</i>	<i>Houston time</i>	<i>Kourou time</i>	<i>Moscow time</i>
<i>at</i>	4:23 am	5:23 am	10:23 pm	1:23 am	7:23 am
<i>on</i>	March 8, 2007	March 8, 2008	March 7, 2008	March 8, 2008	March 8, 2008

## Configuration of Ariane payload

The ATV Jules Verne was built by EADS Astrium, leading a large industrial consortium that includes Thales Alenia Space (Italy), Contraves (Switzerland) and Dutch Space (Netherlands).



## 2. Range operations campaign: ARIANE 5 - ATV Jules Verne

### ATV and launch vehicle campaign calendar

<i>Ariane activities</i>	<i>Dates</i>	<i>ATV activities</i>
	July 29, 2007	Arrival in Kourou and beginning of the ATV Jules Verne preparation campaign in building S5C
Campaign start review	December 10, 2007	
EPC Erection	December 10, 2007	
EAP transfer and positioning	December 11, 2007	
Integration EPC/EAP	December 12, 2007	
	January 7, 2008	Transfer of the ATV from the S5C to the S5B
EPS Erection	January 11, 2008	
Integration equipment bay	January 11, 2008	
	Jan 9-20, 2008	Operations of filling of the sub-system russian propellants in S5 B
	Jan 24-Feb 4, 2008	Operations of filling of the sub-system of propulsion of the ATV in S5 B
Roll-out from BIL to BAF	February 8, 2008	

### ATV and launch vehicle campaign final calendar

Wednesday, February 13, 2008		ATV transfer to Final Assembly Building (BAF)
Friday, February 15, 2008		ATV integration on launcher
Friday, February 22, 2008		Preparations EPS and SCA for filling
Monday, February 25, 2008		Fairing integration around ATV
Wednesday, February 27, 2008		Filling of SCA
Thursday, February 28, 2008		EPS filling with MMH
Friday, February 29, 2008		Launch rehearsal. EPS filling with N2O4
Tuesday, March 4, 2008		Arming of launch vehicle
Wednesday, March 5, 2008		Launch readiness review (RAL) and final preparation of launcher
Thursday, March 6, 2008	J-1	Roll-out from BAF to Launch Area (ZL), launch vehicle connections and filling of the EPC liquid Helium sphere
Friday, March 7, 2008	J-0	Launch countdown including EPC filling with liquid oxygen and liquid hydrogen
Saturday, March 8, 2008	H-0	

### 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 boosters, for a liftoff at the targeted time.

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.

<b>Time</b>	<b>Events</b>
- 11 h 30 mn	Start of final countdown
- 7 h 30 mn	Check of electrical systems
- 4 h 50 mn	Start of filling of main cryogenic stage with liquid oxygen and hydrogen
- 3 h 20 mn	Chilldown of Vulcain main stage engine
- 1 h 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

<b>HO</b>	<b>Ignition of the cryogenic main stage engine (EPC)</b>
+ 7,0 s	Ignition of solid boosters
+ 7,3 s	Liftoff
+ 12,5 s	End of vertical rise, beginning of pitch motion
+ 17 s	Beginning of roll manoeuvre
+ 2 mn 19 s	EAP separation
+ 3 mn 29 s	Fairing jettisoning
+ 8 mn 55 s	End of EPC thrust phase
+ 9 mn 01 s	EPC separation
+ 9 mn 08 s	Beginning of EPS first thrust phase
+ 17 mn 13 s	End of EPS first thrust phase
+ 17 mn 16 s	Beginning of ballistic phase
+ 56 mn 28 s	End of ballistic phase
+1h + 2 mn 10 s	Beginning of EPS second thrust phase
+1h + 2 mn 40 s	End of EPS second thrust phase
+1h + 2 mn 42 s	ATV orientation phase
+1h + 6 mn 39 s	<b>ATV separation</b>
+1h + 6 mn 49 s	Avoidance and distancing manoeuvres
+2h + 28 mn 00 s	EPS third boost for deorbitation
+2h + 48 mn 27 s	End of launch vehicle mission

## 4. Ariane 5-ATV trajectory

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

After the main stage cryogenic engine is ignited and its operation checked, the two solid rocket boosters are ignited to provide liftoff. The launcher rises vertically for about five seconds, then tilts towards the northeast. It will maintain its attitude to keep the launcher's axis parallel to its airspeed vector in order to minimize aerodynamic loads throughout the atmospheric phase of the launch, until the solid boosters are jettisoned. The fairing protecting the ATV is jettisoned shortly after the boosters, at about T + 209 seconds.

Once the first part of the flight is completed, the onboard computers optimize the trajectory in real time to minimize fuel burn. The launcher reaches the targeted position for the extinction of the main stage engine, then the intermediate orbit targeted at the end of the first firing of the upper stage.

On this mission, the main stage will fall back into the Atlantic Ocean off the coast of Portugal.

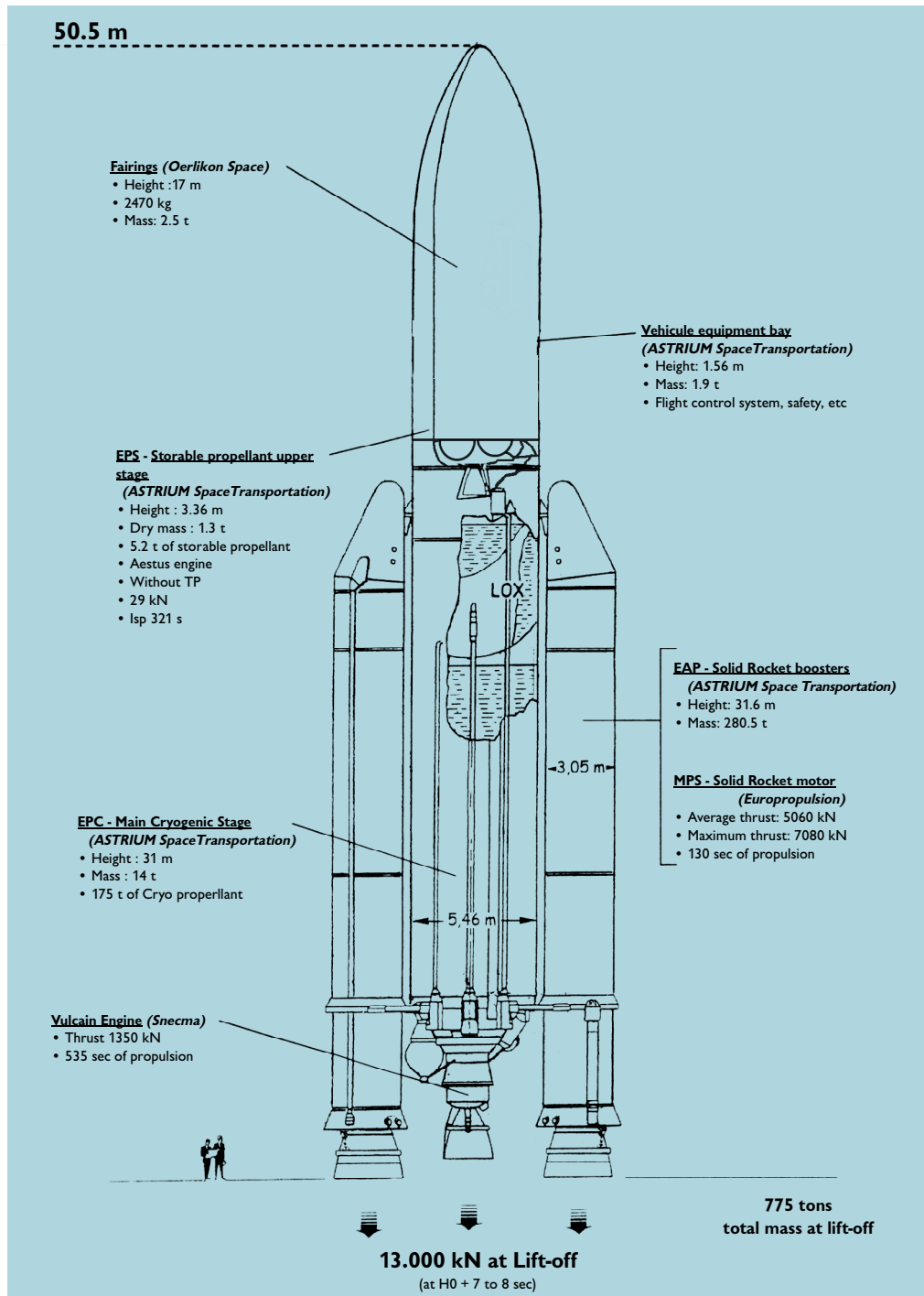
Following a ballistic ("coasting") phase lasting 45 minutes, the upper stage is then reignited to circularize the orbit, directing the ATV, once separated, into its targeted final orbit at an altitude of 260 kilometers and a speed of about 7,600 meters/second.

Once the ATV has separated, the launcher starts a second long ballistic phase (making nearly a complete revolution around the Earth). The upper stage is then reignited once more to deorbit the upper segment of the launcher, sending it towards a deserted area of the South Pacific.

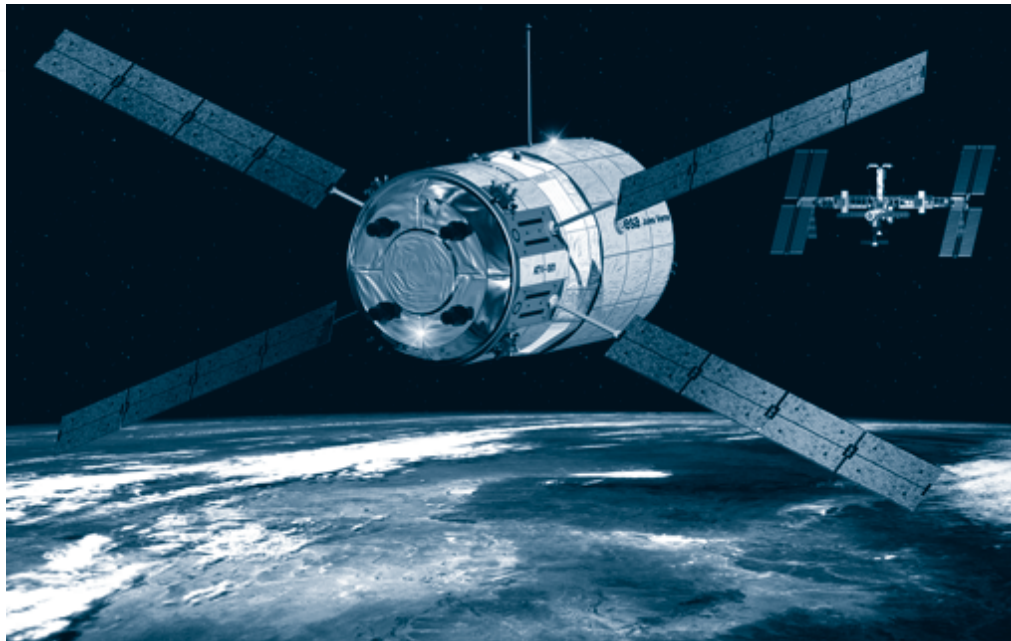
### *Ariane 5ES - ATV trajectory*



## 5. The Ariane 5ES (Industrial prime contractor: ASTRIUM Space Transportation)



## 6. The Automated Transfer Vehicle (ATV) Jules Verne



<b>Customer</b>	The European Space Agency (ESA)	
<b>Prime contractor</b>	EADS Astrium	
<b>Mission</b>	to provide cargo to ISS, re-boost ISS to higher altitude.	
<b>Mass</b>	Total mass at lift-off	19 012kg
	Dry mass	10 470 kg
<b>Stabilization</b>	3 axis	
<b>Dimensions</b>	9,79 m Length	
	4,48 m Diameter (max.)	
<b>Span in orbit</b>	22,3 m with deployed solar arrays	
<b>On-board power</b>	4 600 W (end of life)	

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## Appendix 1. Arianespace - ATV Jules Verne launch key personnel

### *In charge of the launch campaign*

Mission Director	(CM)	Philippe ROLLAND	ARIANESPACE
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### *In charge of the launch service contract*

Ariane Payload Manager	(RCUA)	Jean-Michel DESOBEAU	ARIANESPACE
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Ariane Deputy Mission Manager	(RCUA/A)	Patrick LOIRE	ARIANESPACE
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### *In charge of ATV Jules Verne*

ATV Mission Director 1	(DMS)	John ELLWOOD	ESA
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ATV Mission Director 2	(DMS)	Partrice AMADIEU	ESA
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ATV Program Manager 1	(CPS)	Nicolas CHAMUSSY	ASTRIUM
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ATV Program Manager 2	(CPS)	Marc CHEVALIER	ASTRIUM
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ATV Preparation Manager ESA	(RPE)	Dominique SIRUGUET	ESA
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ATV Preparation Manager	(RPS)	Laurent DENEUVILLE	ASTRIUM
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### *In charge of the launch vehicle*

Launch Site Operations Manager	(COEL)	André SICARD	ARIANESPACE
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Ariane Production Project Manager	(CPAP)	Didier AUBIN	ARIANESPACE
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### *In charge of the Guiana Space Center (CSG)*

Range Operations Manager	(DDO)	Thierry VALLÉE	CNES/CSG
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Range Operations Deputy	(DDO/A)	Emmanuel SANCHEZ	CNES/CSG
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## Appendix 2. Launch environment conditions

Acceptable wind speed limits at lift-off 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 20,000 m) is also taken into account.

## Appendix 3. The synchronized sequence

The synchronized 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 the 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 lift-off 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 lift-off 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.



## Service & Solutions

### Appendix 4. Arianespace and the Guiana Space Center

Arianespace was founded in 1980 as the world's first launch Service & Solutions company. Today, Arianespace has 23 shareholders from ten European countries (including French space agency CNES with 34%, EADS with 30%, and all European companies participating in the construction of Ariane launchers).

Since the outset, Arianespace has signed more than 290 launch contracts and launched 254 satellites. More than two-thirds of the commercial satellites now in service worldwide were launched by Arianespace.

The company posted sales of more than 900 million euros in 2007, and stayed in the black for the fifth year in a row.

At January 1, 2008, Arianespace had 292 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 Service & Solutions to satellite operators from around the world, including private companies and government agencies. These Service & Solutions call on three launch vehicles:

- The Ariane 5 heavy launcher, operated from the Guiana Space Center in Kourou, French Guiana.
- The Soyuz medium launcher. Currently in operation at the Baikonur Cosmodrome in Kazakhstan under the responsibility of Starsem, a Euro-Russian subsidiary of Arianespace, it will be launched from the Guiana Space Center starting in 2009.
- The Vega light launcher, to be launched from the Guiana Space Center starting in 2009.

Arianespace has also signed a mutual backup agreement with Boeing Launch Services and Mitsubishi Heavy Industries, through an entity called the Launch Services Alliance. This arrangement guarantees that customers' payloads will be launched in case the chosen launcher is unavailable for technical reasons.

With its family of launchers and this backup agreement, Arianespace won over half of the commercial launch contracts up for bid worldwide in the last two years. Arianespace now has a backlog of about 50 satellites to be launched, as well as three more launches to be handled by Starsem.

#### 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 bas operation, such as radars, telecom network, weather station, receiving sites for launcher telemetry, etc.
- Payload processing facilities (EPCU), in particular the 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 Spacial 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.

The Guiana Space Center is preparing to welcome two new launch vehicles, Soyuz and Vega. The Soyuz launch complex (ELS) and the Vega launch complex (SLV) are now under construction.

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 the contracting authority in charge of operating the family of three launchers, Ariane, Soyuz and Vega.

Arianespace supervises the integration and functional checks of the Ariane launcher, built by EADS Astrium as production prime contractor, in the Launcher Integration Building (BL). It then carries out acceptance tests of the launcher at the same time as satellite preparations in the Payload Preparation Complex (EPCU), operated by the Guiana Space Center (CSG). Arianespace next oversees final assembly of the launcher and integration of satellites in the Final Assembly Building (BAF), followed by transfer of the launcher to Launch Zone No. 3 (ZL3), and then final countdown and liftoff from Launch Complex No. 3 (CDL3).

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.