

AVIO IN SPACE WITH VEGA LAUNCHER

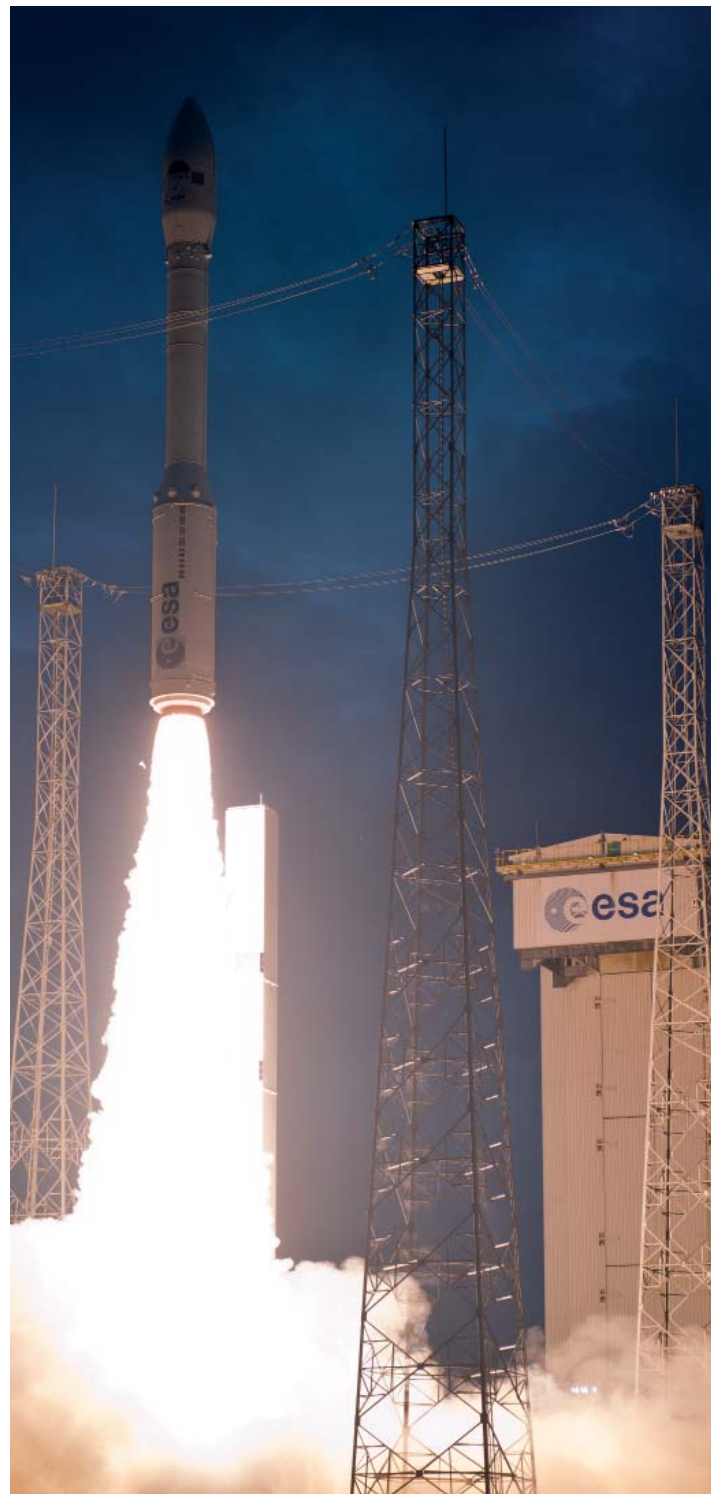
Avio strengthened its presence in the space sector through its ELV subsidiary, a company jointly owned by Avio with a 70% share and the Italian Space Agency with a 30% share. Since its establishment, ELV has continued to grow both in terms of turnover and number of employees.

ELV is the prime contractor for the Vega launcher, which received its go ahead from the European Space Agency (ESA) in December 2000. Twelve years later, on Monday 13 February 2012, at 10am, Vega successfully completed its maiden flight from the European Space Centre in Kourou, French Guiana.

The new launcher successfully placed nine scientific and research satellite into orbit, making Vega a great success for both Avio and the over 40 companies that contributed to the project.

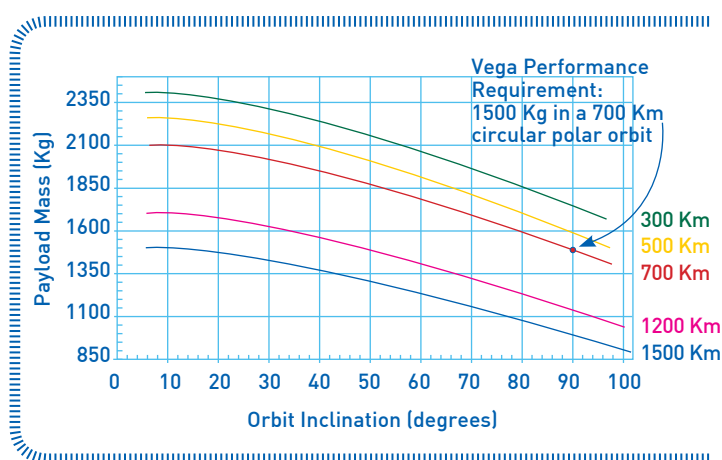
Avio is currently working on the production of the first five launch vehicles as part of the European Space Agency's VERTA programme, signed in September 2010. ELV is the lead designer for the launch vehicle, also acting as systems integrator.

ELV manages Vega's industrial supply chain, which includes companies from seven European countries. 65% of Vega is developed and manufactured in Italy, and the remaining 35% is made in Spain, Belgium, the Netherlands, Switzerland, Sweden and France. ELV draws on Avio's heritage in the technology and manufacturing sectors, achieved through initiatives sponsored by the Italian Space Agency and the Italian Ministry of Defence, such as SCOUT (1990), launched from the San Marco Range in Malindi, Kenya, and the IRIS upper stage, which was successfully launched in the space shuttle.



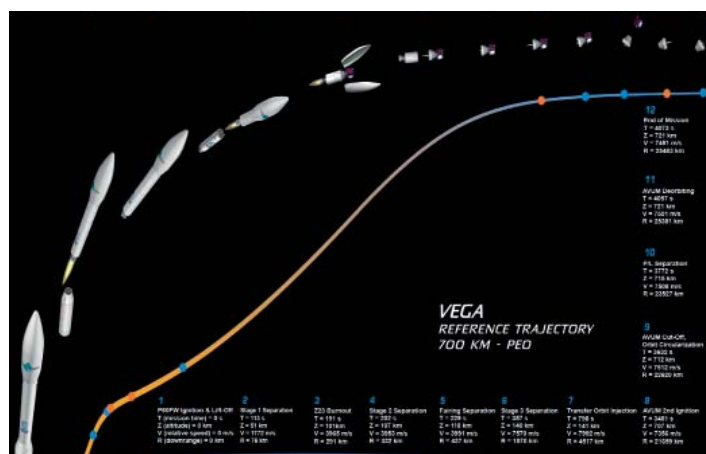
Vega launcher's main characteristics

Vega is the ESA's satellite launch vehicle to send small satellite into Low Earth Orbit. It provides great flexibility of mission for an affordable cost. Vega can carry up to six payloads at a time in any orbit up to 1,500 km (reference performance is 1,500 kg at a circular polar orbit of 700 km). Vega is a four-stage vehicle powered primarily through solid propulsion. It is integrated with the Ariane LV family. It is 30m high and weighs 137 tonnes at liftoff. It hosts a payload dynamic envelope of 2.3 m diameter and 3.5 m height as well as an additional conical volume of 2.8 m in height.



Vega Guidance, Navigation (VGN) and Control

Thanks to the Navigation and Control algorithms in Vega's on-board computer, the launcher can go into the atmosphere autonomously despite disturbances. It can initiate ignition and separation of the successive stages and finally put the satellites into orbit with the required accuracy. The ELV team's skills of range from the development of algorithms to software and hardware tests.



Vega's propulsion

The launcher's first three stages are manufactured using advanced technologies which deliver high performance at a lower cost. The engine cases, made of strong graphite fibre and epoxy resin, provide significant savings compared to conventional metal cases. The first stage motor case is produced using filament-winding manufacturing devised for large diameters (3 m) and lengths (10 m), never before used in Europe. The P80 engine is another example of how this technology can be applied to solid-propellant boosters of Ariane 5 launchers, creating important synergies between Vega and Ariane 5.

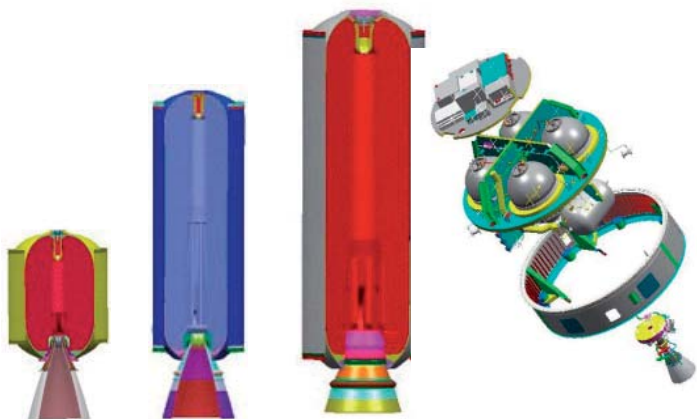
Vega holds two technological world records: the first stage engine, the P80, is the largest single launcher engine ever built made of carbon fibre (3 m diameter, 10 m length), while the third stage engine, Zefiro 9, is the most efficient solid propulsion launcher engine in terms of performance.

The fourth stage is a liquid-propulsion system: a bipropellant system using storable fuel, unsymmetrical di-methyl hydrazine (UDMH) and nitrogen tetroxide (NTO). The LPS uses the YUZHNO-YE RD869 engine as its main engine (ME), which is capable of at least five ignitions during a nominal flight with a single payload (three ignitions were demonstrated during Vega's maiden flight). The new industrial plant dedicated to Vega's propulsion systems, with a surface area of 7,000 m², and a height 22 m, is an important investment for Avio. The plant is dedicated to manufacturing the engine casing and thermal protection for the three solid propulsion engines, the P80, Zefiro 23 and Zefiro 9. State-of-the-art machinery specifically designed for the P80 motor case applies filament-winding technology.

Engine testing

The three solid rocket engines have been successfully tested. The third stage Zefiro 9 and second stage Zefiro 23 were tested respectively in December 2005 and June 2006 in Sardinia's Military Testing Range, PISQ, at Salto di Quirra. The first stage P80 engine test was completed in November 2006 at the Kourou Space Centre French Guiana.

Qualification phase began with a second engine test for the Zefiro 9 in March 2007. The second P80 test was successfully completed in December 2007, while the second Z23 test was carried out in March 2008 and the second Zefiro 9 test was completed in October 2008. The AVUM propulsion module was also tested during the propulsion system test campaign, at Astrium's facilities in Lampoldahusen, Germany, in November 2008. It was concluded successfully in April 2009.



Main characteristics of Vega's propulsion system



	1st stage P80FW	2nd stage Zefiro23	3rd stage Zefiro9	4th stage AVUM
Motor length (m)	11.7	7.5	3.5	1.7
Diameter (m)	3	1.9	1.9	2.31
Propellant mass (tons)	88	24	10.5	0.55
Motor dry mass (kg)	7,330	1,950	915	131
Motor case mass (kg)	3,260	900	400	16
Average thrust (kN)	2,200	871	260	2.42
Specific impulse (s)	280	287.5	296	315.5
Combustion time (s)	110	77	120	6,672
Design leader	Avio	Avio	Avio	ELV





NEW PROGRAMMES: WORK IN PROGRESS

Lyra programme

The Lyra programme, financed by the Italian Space Agency, researches the potential evolution of the Vega launcher in order to achieve a 30% increase in satellite loads of up to 2,000 kg in LEO of 700 km. Avio will pursue performance increases through the substitution of the third and AVUM stage with an innovative LOX/LHC liquid propulsion system. This new engine, called Mira, will have a thrust of approximately 10 tonnes and will use an expanded cycle. During the Lyra programme, a full scale demonstrator of this new cryogenic propulsion system was produced and tested. Innovative GNC algorithms were developed and tested as part of Lyra.

Evolution of Vega

ELV aims to develop Vega and its technologies to consolidate its position as a system integrator for the development and operation of launch vehicles for small satellites and to be able to find adequate solutions for market challenges ahead. Through its evolution, Vega will be able to increase its financial competitiveness and launch performance through the implementation of cost reduction activities, systems architecture, design and supply chain rationalisation.

With regards design, Vega's evolved launcher will be even more flexible and versatile, extending Vega's market from 50% of accessible LEO satellites to up to 90% with a consistent part covered by dual P/L launch. During the strategic planning for Vega, evolution-enabling technologies were identified focusing on performance improvement through to cost reduction, payload comfort and the consolidation of ELV system integration capabilities within the Europe's industry.

Future Launcher Preparatory Programme (FLPP)

ELV participates in the FLPP, an ESA programme which began in February 2004 aimed at developing a next-generation launcher (NGL). The programme's goal is to be operational by around 2020. Within the programme, ELV has the responsibility to research Medium Class Launchers in the two to six tonne range, able to carry P/Ls into GTO orbit in a cost-effective way. ELV will also be involved in the specifications of innovative technologies to be applied on NGLs, looking at the reliability and competitiveness of European launchers.