

Vega on the Move

Heading towards Qualification





Fabrizio Felici, Miguel Lopez, Stefano Bianchi & Renato Lafranconi
 Vega Department, Directorate of Launchers,
 ESRIN, Frascati, Italy

Mauro Cardone
 Unita' Trasporto Spaziale, ASI, Rome, Italy

Philippe Pascal
 Direction des Lanceurs, CNES, Evry, France

Vega, the European small launcher, will expand the range of launch services offered by Arianespace from French Guiana. It is particularly suited to the smaller Earth-observation and scientific satellites from European institutions, and will reinforce Europe's strategy of guaranteeing affordable access to space. The first launch is scheduled for November 2007.

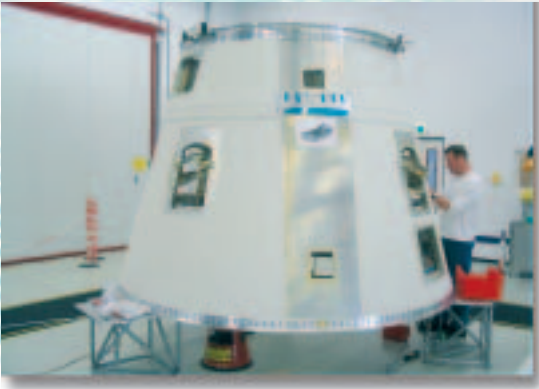
Introduction

Vega is an ESA optional programme financed by Belgium, France, Italy, The Netherlands, Spain, Sweden and Switzerland. It is managed by the Vega Department within the Directorate of Launchers, with an Integrated Project Team from ESA, ASI and CNES at ESRIN (Frascati, I) and the CNES Launcher Directorate (Evry, F). The two Vega programme declarations cover three projects:

- the Launch Vehicle, with ELV SpA (Colleferro, I) as prime contractor;
- the P80 Demonstrator (the Vega first stage solid-propellant motor), with



The Z23 Zefiro stage-2 solid-propellant motor is prepared for shipment to Sardinia for the June 2006 firing test.



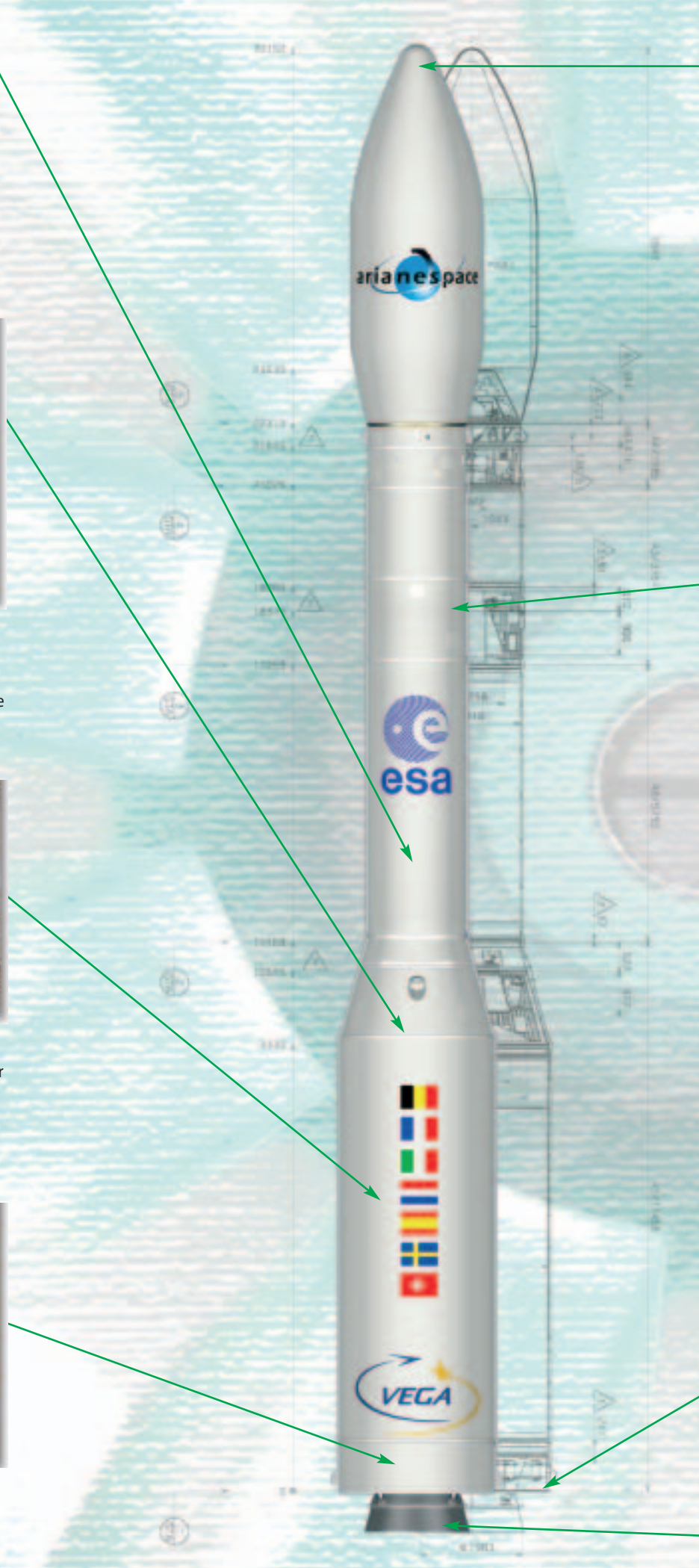
The Structural Model of Interstage-1/2 at Dutch Space in Leiden (NL) during integration. The interstage remains attached to stage-1 and carries six forward-facing solid-propellant retrorockets to ease separation at the end of the 107-second P80 burn. The interstage qualification tests are under way.



The P80 motor case (length 10 m, diameter 3 m) at Avio in Colleferro (I). The case is then shipped to French Guiana for propellant casting, integration of components such as the nozzle, thrust vector control and sensors. The qualification firing is scheduled for November 2006 on the site's BEAP test stand. (ESA/S. Corvaja)



The completed interstage-0/1, developed by SABCA (B). The large box is the Control & Power Distribution Unit (SABCA, B), flanked by four Li-ion batteries (SAFT, F). This model will soon complete qualification mechanical tests.



Contraves Space (CH)
Fairing

EADS CASA (E)
Adapter

Thales, Zodiac, Galileo Avionica, CRISA,
SAAB, SAFT
AVUM Avionics

Avio (I)
AVUM (stage integration and test)

EADS CASA (E)
AVUM Structure and AVUM Skirt

Avio (I)
AVUM Propulsion System



Final integration of the fairing qualification model at prime contractor Contraves(CH). Mechanical and separation tests will be performed on this model during the summer.

Avio
Italy, 3rd Stage (production, integration and test)

SABCA (B)
3rd Stage Thrust Vector Control
Oerlikon Contraves Italia (I)
2/3 Interstage

Avio (I)
2nd Stage (production, integration and test)



Interstage-2/3 tests at ELV. The interstage is being developed by Oerlikon Contraves Italiana (I). It has satisfied the qualification vibration level (higher than the expected flight environment), and a separation test was successful in February 2006.

SABCA (B)
2nd Stage Thrust Vector Control

Dutch Space (NL)
1/2 Interstage
Stork Product Engineering (NL)
Stage 1-2 igniters

Avio (I)
1st Stage (stage integration and test)

Europropulsion (F)
P80 Filament Wound Motor



The 'Maquette de Pilotage' facility at ELV (Colleferro, I) was inaugurated in April. It is now being used to characterise the P80 small control loop: moving the nozzle via the electromechanical actuator developed by SABCA (B). Later on, it will be connected to the onboard computer to simulate complete flight sequences and to check the real-time and dynamic performances under realistic conditions. The current tests include rehearsals of the sequence of nozzle movements for the P80 firing test in French Guiana in November. (ESA/S. Corvaja)

SABCA (B)
Interstage Skirt

SABCA (B)
1st Stage Thrust Vector Control

SNECMA Propulsion Solide (F)
Nozzle



Hoisting the P80 nozzle for integration in the control-loop test facility. The nozzle was developed by SNECMA Propulsion Solide (F). The advanced technologies used for the flexible joint and exit cone were covered by the separate P80 demonstrator programme in order to optimise the recurring cost in production. The nozzle for the P80 qualification firing in November was shipped in July to French Guiana for integration with the motor.

Vega's Inertial Reference Navigation System (Thales, F) is an off-the-shelf item from Ariane-5.



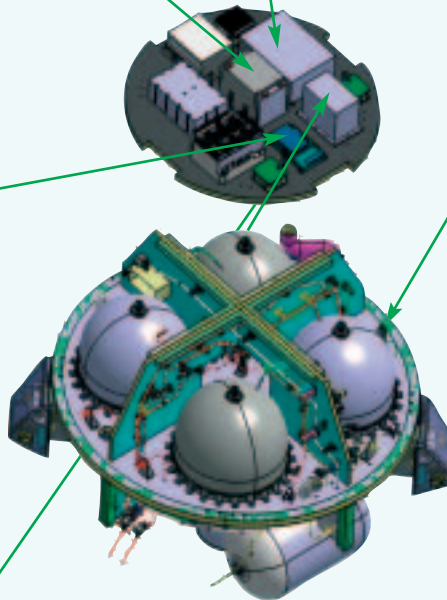
The Multifunctional Unit, developed by EADS-Astrium (E), distributes power to avionics units and relays pyrotechnic commands from the computer.



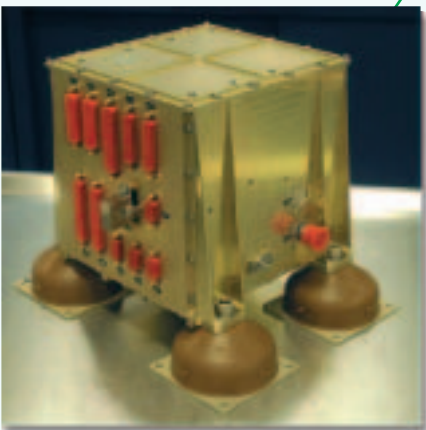
Integration of the AVUM structural models and fluid subsystem components at ELV (Colleferro) for the upper composite mechanical tests. (ESA/S. Corvaja)



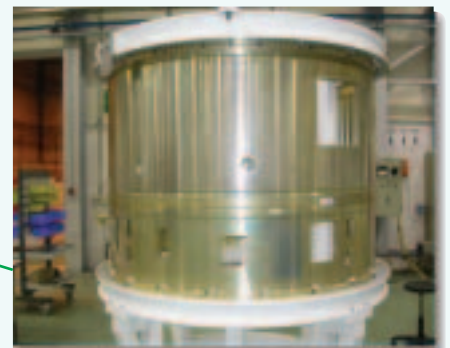
The On-Board Computer, developed by SES (S).



The Safety Main Unit, developed by Galileo Avionica (I). Qualification is planned for summer 2006. Part of the 'Safeguard' system, its job is to issue destruct commands to the lower stages in the event of flight problems.



Manufacture of the interstage-3/AVUM structure at EADS-CASA (E). This will be integrated with the other upper composite elements (AVUM fluids subsystem and avionics, adapter, fairing) for the overall mechanical and acoustic qualification tests at ESTEC later in 2006.





The former ELA-1 Ariane-1 launch pad in French Guiana is being reworked for Vega

Avio SpA (Colleferro, I) as prime and Europropulsion (Suresnes, F) as main contractor;
 – the Ground Segment, with Vitrociset SpA (Rome, I) as prime contractor.

Vega has three solid-propellant stages topped by a liquid-propellant upper module. It is about 30 m high, 3.0 m in diameter and has a launch mass of 137 t (excluding payload). The three main sections are the Lower Composite (principally the three solid motors and their interstages), the Restartable Upper Module and the Payload Composite. The thrust at lift-off is about 2700 kN and reaches a maximum of 3040 kN during the P80 first-stage burn.

Vega is sized to deliver 300–2000 kg payloads (and eventually as multiple payloads) directly into Sun-synchronous orbits, polar circular orbits or circular orbits of different inclinations with

altitudes ranging from 300 km to 1500 km. In addition, the reignition capability of the Attitude & Vernier Upper Module (AVUM) offers great flexibility for servicing a variety of elliptical orbits.

Status


Where is the Vega programme today? Many subsystems have passed their Critical Design Reviews and some have begun the qualification process. Since last year, testing has progressively replaced the specification, design and trade-off analyses and simulation work; this trend will become even more obvious in 2006. In October 2005, a firing test of the AVUM engine was successful at contractor Yuzhnoye in Ukraine. This was followed in December by the first firing of Vega's Zefiro-9 third-stage motor, at Salto di Quirra in south-eastern Sardinia.



The first Zefiro test, in Sardinia during December 2005, was followed by a Z23 stage-2 motor firing on 26 June. Further tests are planned for end-2006 and in 2007 as part of the qualification process



The casing of the P80 motor is created by winding filaments of carbon fibre. (ESA/S. Corvaja)



This year is even more challenging for Vega, because many of the subsystems are now undergoing significant testing and beginning their qualification process. Three solid-motor firing tests are planned – two in Sardinia and one at Europe's Spaceport in French Guiana. At the same time, the Upper Composite mechanical tests and hardware-in-the-loop tests at system level have started and will be completed before the System Critical Design Review at the end of 2006. This is a major step towards the combined tests of mid-2007, integrating the launch vehicle and the ground segment components to check the interfaces and the operational concept to be used for the qualification campaign.

At the Spaceport, work continues on adapting the former Ariane-1 launch pad for Vega. The Mobile Gantry, where Vega's integration and preparation will be performed, will be completed in the last quarter of 2006. This then allows the installation of subsystems such as air conditioning, fluids and power to go

ahead. Vega's control centre will be located in the Centre de Lancement CDL-3, the same building used for conducting Ariane-5 operations.

The qualification flight at the end of 2007 will give the green light for the exploitation phase by Arianespace. The VERTA Vega Research & Technology Accompaniment programme, approved by the Ministerial Conference in Berlin in December 2005, includes five demonstration flights, mainly of ESA missions, to demonstrate the vehicle's flexibility in various configurations and orbits.

Acknowledgements

The authors would like to acknowledge the excellent work by industry colleagues in Vega, P80 and ground segment development and operations. They would also like to thank all their colleagues in the Integrated Project Team in Frascati and Evry, as well as those supporting the Project in Evry, Estec, ESOC and HQ.

