AVIO IN A NUTSHELL

UNOOSA Webinar: Access to Space for All
July, 29, 2020

€369M
Revenues
2019

1000
Employees

€407M
Mkt Cap
65% free float

VEGA
Prime
Contractor

ariane 6
Partner
Supplier

Avio on Earth



Colleferro, Rome
(GMT +1) N41.727 E13.003

The company's headquarters and production plants of solid and liquid propellant motors for launch vehicles. In Colleferro, Avio also carries out the development of the new launchers, Vega C and other evolutions.




Paris
(GMT +2) N48.856 E2.351

Headquarters of Europropulsion (50% Avio and 50% AG), main contractor of the solid-propellant motors for Ariane 5 and Ariane 6.

Turin
(GMT +1) N45.067 E7.682

Avio designs and produces the liquid oxygen turbopump for the Vulcain and Vinci engines for Ariane 5 and Ariane 6.

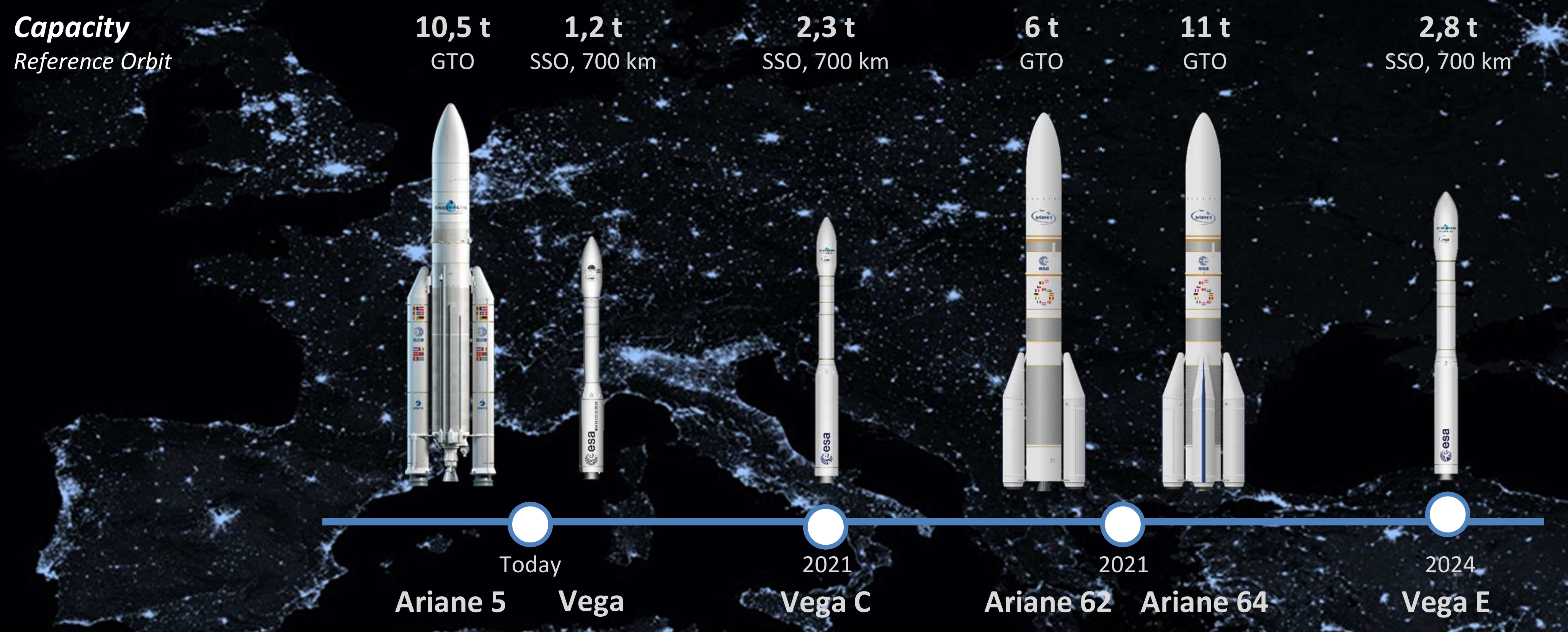
French Guiana
(GMT -3) N4.003 E52.999

Avio runs three facilities at the European Spaceport located in Kourou, French Guiana : (i) REGULUS for Ariane 5 segments, Vega P80 and P120C propellant manufacturing and cast, (ii) EUROPROPULSION for Ariane 5 boosters final integration and (iii) the Vega Launch Zone, where the Vega stages' integration takes place before launch.

Airola
(GMT +1) N41.061 E14.558

Carbon fiber impregnation facility.

The European fleet



VEGA C DESCRIPTION

UNOOSA Webinar: Access to Space for All
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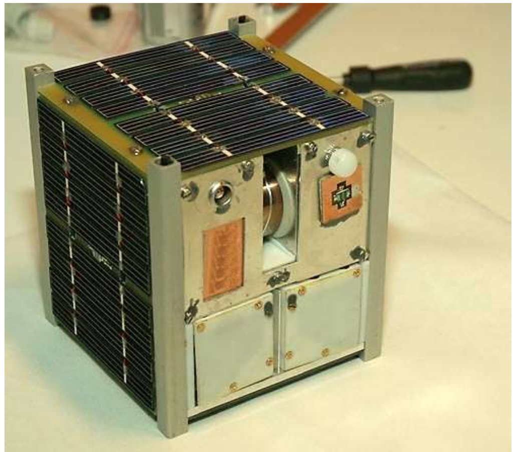
CUBESAT – AN OPPORTUNITY FOR A LOW COST ACCESS TO SPACE

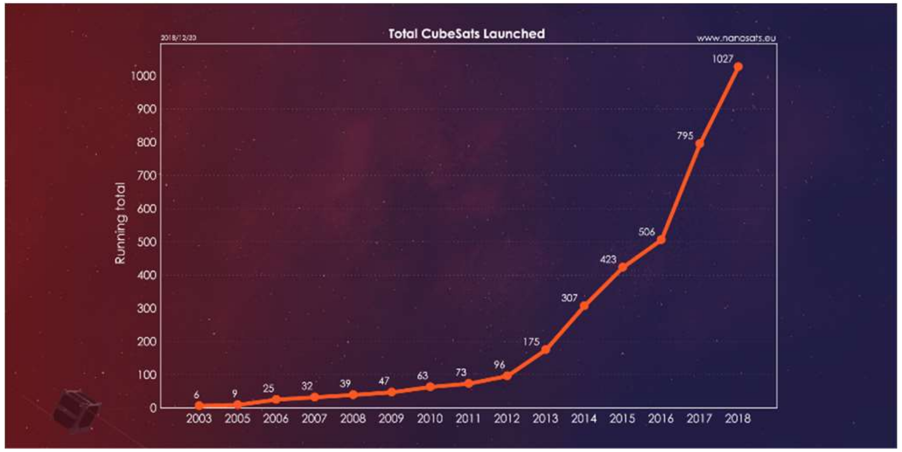
A CubeSat is a type of miniaturized satellite for space research that is made up of multiples of 10 cm × 10 cm × 10 cm cubic units. CubeSats have a mass of no more than 1.33 kilograms (2.9 lb) per unit, and often use commercial off-the-shelf (COTS) components for their electronics and structure.

More than 1200 CubeSats have been launched as of January 2020.

In 1999, California Polytechnic State University (Cal Poly) and Stanford University developed the CubeSat specifications to promote and develop the skills necessary for the design, manufacture, and testing of small satellites intended for low Earth orbit (LEO) that perform a number of scientific research functions and explore new space technologies.

CubeSat specification:
https://static1.squarespace.com/static/5418c831e4b0fa4ecac1bacd/t/56e9b62337013b6c063a655a/1458157095454/cds_rev13_final2.pdf





EXAMPLE OF CUBESAT USE – THOSE LAUNCHED BY VEGA

VEGA missions have already launched several CubeSats allowing low cost access to space to academic entities, universities and countries with no space historical background

VEGA Maiden Flight

- **E-st@r** made by Politecnico di Torino: experimental satellite with EPS, attitude control system (PIC processor) and TLM system.
- **Goliat** made by Romanian Space Agency: scientific mission for micrometeorite flow, cosmic radiation measurement and Earth Observation (3 megapixel camera).
- **MaSat-1** developed and built by students at the Technical University of Budapest: telemetric data as well as VGA resolution color images. (1st Hungarian satellite)
- **PW-Sat** constructed by the Faculty of Power and Aeronautical Engineering of Warsaw University of Technology in cooperation with the Space Research Centre of the Polish Academy of Sciences: to test experimental elastic solar cells, as well as an orbital decay technology consisting of a "tail" designed to speed re-entry.
- **ROBUSTA** developed by the University of Montpellier students: to check the deterioration of electronic components, based on bipolar transistors, when exposed to in-flight space radiation
- **UniCubeSat-GG** built by the Sapienza University of Rome: to study the effects of orbital eccentricity through the Earth's gravity gradient.
- **Xatcobeo** developed by Agrupación Estratéxica Aeroespacial (currently Alén Space) of the University of Vigo in collaboration with the Instituto Nacional de Técnica Aeroespacial (INTA): research related with communications and with solar power in satellites.(1st Galician artificial satellite)

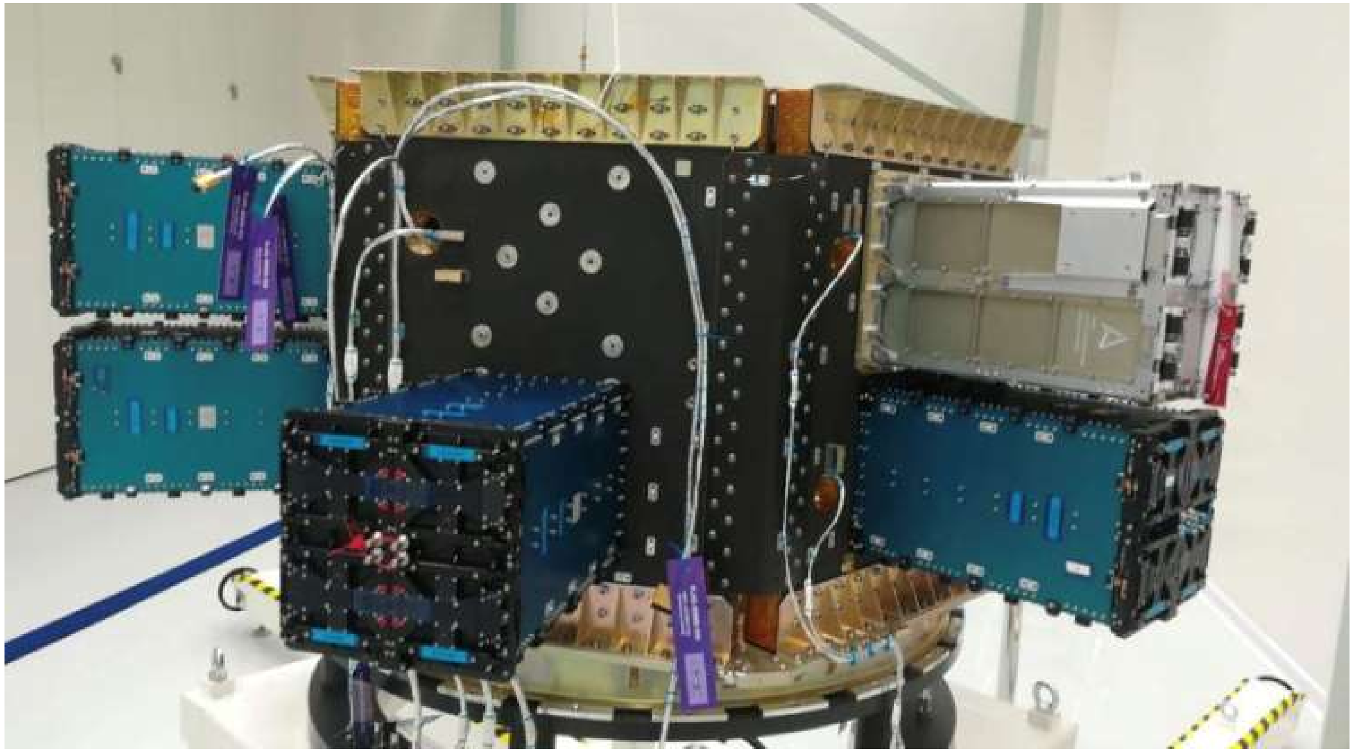
VEGA Second Flight - VV02

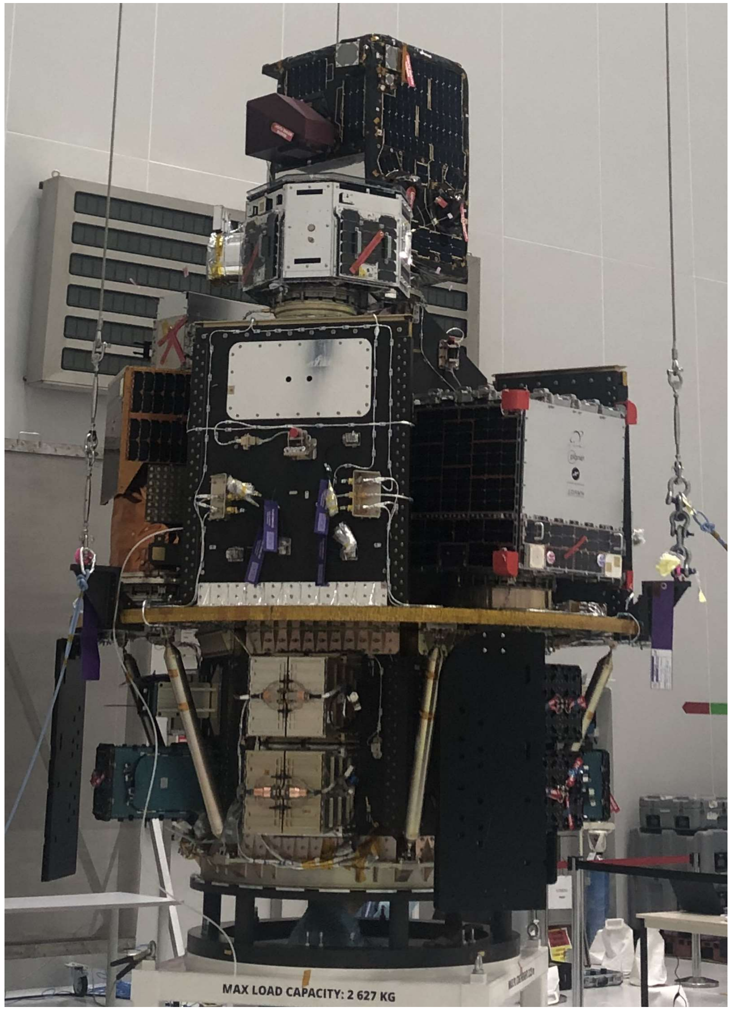
Estcube: managed by University of Tartu: to use and test an electric solar wind sail (E-sail) (1st Estonian satellite)

NEXT LAUNCH – VV16 CARRYING 46 CUBESATS

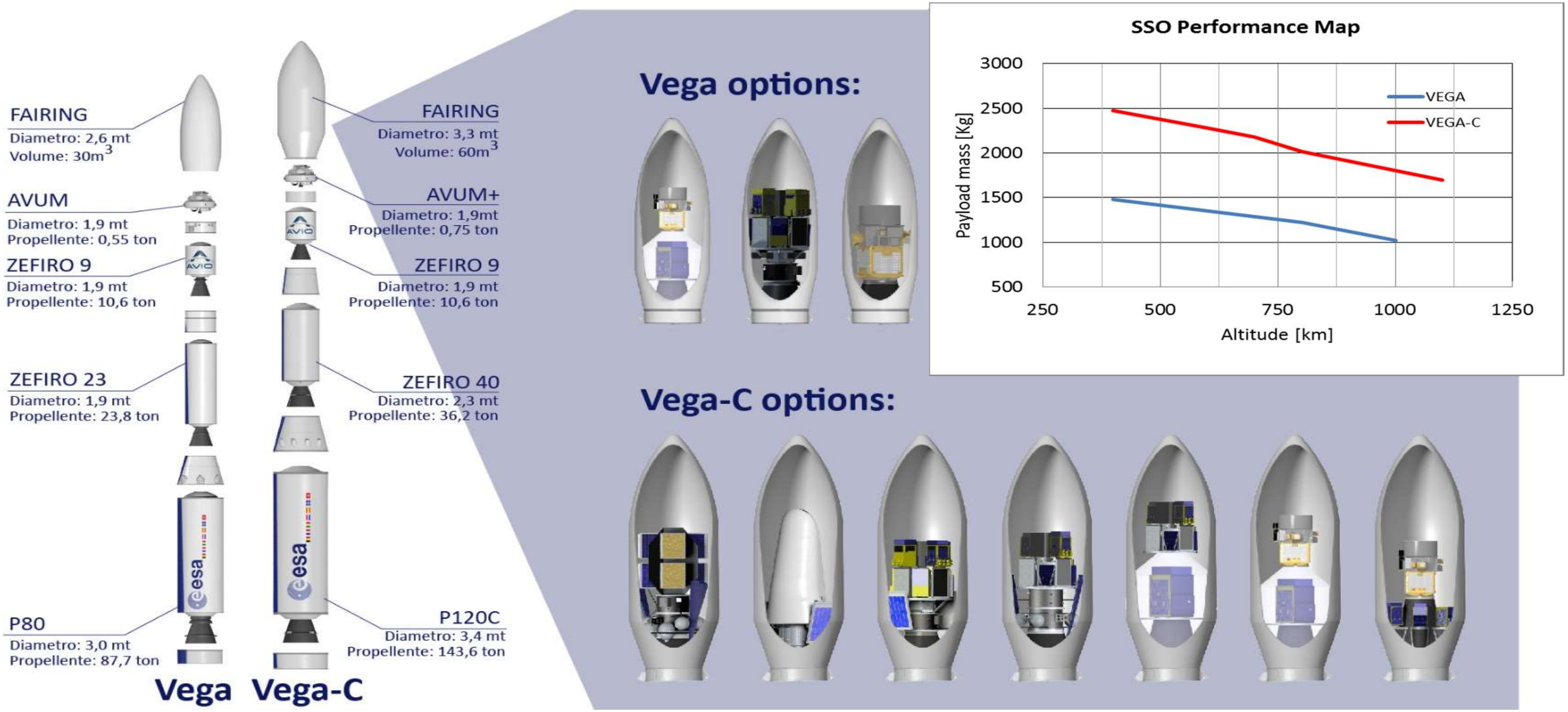
Sun-synchronous Orbit at 530km altitude

For Flight VV16, the launcher will carry seven microsatellites (from 15 kg. to 150 kg.) on the upper portion, along with 46 smaller CubeSats on the lower portion's Hexamodule: 26 satellites of 3 U; 12 satellites at 1/4 U; six satellites of 6 U; one satellite at 2 U; and one satellite at 1 U





VEGA – VEGA C COMPARISON



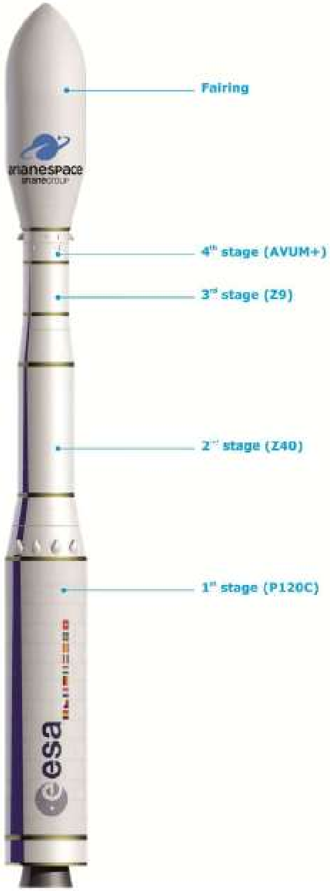
VEGA C OVERVIEW

Vega C will bring to market better launch performance at comparable price

Improved performance with respect to Vega:

- ✓ same launcher **concept**
- ✓ larger **fairing**
- ✓ increased **performance**, through larger SRM on the lower composite (P120C&Z40)
- ✓ additional **versatility** on upper stage: 8 ignitions and larger tanks

Controlled re-entry for all stages



PAYLOAD FAIRING

Diameter:	3.317 m
Length:	9.374 m
Mass:	860 kg
Structure:	Two halves - Sandwich panels CFRP sheets and aluminum honeycomb core
Separation:	Vertical separations by means of leak-proof pyrotechnical expanding tubes and horizontal separation by a clamp-band

PAYLOAD ADAPTERS, MULTIPLE LAUNCH STRUCTURE

VAMPIRE 937		**VAMPIRE 1194**	
Height (mm):	2 596	**Height** (mm):	1 861
Mass (kg):	120 TBC	**Mass** (kg):	95 TBC
VESPA C – Short version		**VESPA C – Long version**	
Height (mm):	3 222 TBC	**Height** (mm):	4 552 TBC
Diameter (mm):	2 620 TBC	**Diameter** (mm):	2 620 TBC
Mass (kg):	390 TBC	**Mass** (kg):	455 TBC
SSMS			
Piggy-Back			
Ride-Share			

AVUM+ UPPER STAGE

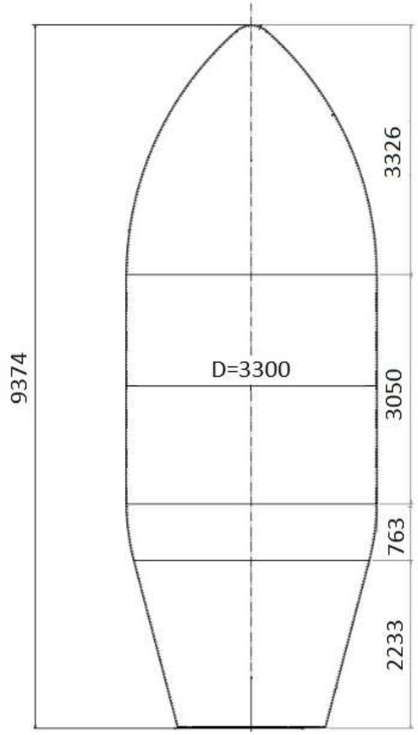
Size:	2.18-m diameter × 2.04-m height
Dry mass:	698 kg TBC
Propellant:	492 kg/248 kg of NTO/UDMH
Subsystems:	
Structure:	Aluminium cylindrical case with 4 Aluminium propellant tanks and supporting frame
Propulsion:	MEA (evolution of RD-869) – 1 chamber
- Thrust	2.45 kN – Vacuum
- Isp	315.8 s – Vacuum
- Feed system	Regulated pressure-fed 108 l (4.8 kg) GHe tank MEOP 328 barA
- Burn time/restart	Up to 612.5 s (max. cumulative firing time: 924.8 s) / up to 5 controlled or depletion burns
RACS:	Six 240 N hydrazine thrusters N_2H_4 ; 39 l (38.6 kg) N_2H_4 tank MEOP 26 barA
Avionics:	Inertial 3-axis platform, on-board computer, TM & RF systems, Power
Attitude control:	
- Pitch, yaw	*Main engine ±10 deg gimbaled nozzle → boosted phases* *Six RACS thrusters → ballistic phases*
- Roll	*Roll rate and attitude controlled by four of the six RACS thrusters*

	1st STAGE (P120C)	2nd STAGE (Z40)	3rd STAGE (Z9)
Size:	3.40-m diameter x 13.38-m length	2.40-m diameter × 8.07-m length	1.90-m diameter x 4.12-m length
Gross mass:	155 027 kg	40 477 kg	12 000 kg
Propellant:	141 634 kg of HTPB	36 239-kg of HTPB	10 567-kg of HTPB
Subsystems:			
Structure	Carbon-epoxy filament wound monolithic motor case protected by EPDM	Carbon-epoxy filament wound monolithic motor case protected by EPDM	Carbon-epoxy filament wound monolithic motor case protected by EPDM
Propulsion	P120 Solid Rocket Motor (SRM)	ZEFIRO 40 Solid Rocket Motor (SRM)	ZEFIRO 9 Solid Rocket Motor (SRM)
- Thrust	4 323 kN Max Vac thrust	1 304 kN Max Vac thrust	317 kN – Max Vac thrust
- Isp	279 s – Vac	293.5 s – Vac	295.9 s – Vac
- Burn time	135.7 s	92.9 s	119.6 s
Avionics		Actuators I/O electronics, power	Actuators I/O electronics, power
Attitude control:			
- Pitch, yaw	*Gimbaled ±5.9 deg nozzle with electro mechanical actuators*	*Gimbaled ±5.9 deg nozzle with electro mechanical actuators*	*Gimbaled ±6 deg nozzle with electro mechanical actuators*
- Roll	*Roll rate limited by four of the six RACS thrusters*	*Roll rate limited by four of the six RACS thrusters*	*Roll rate and attitude controlled by four of the six RACS thrusters*
Interstage:	**0/1 interstage:** Structure: Cylinder aluminum shell/inner stiffeners Housing: Actuators I/O electronics, power, safety/destruction subsystem **1/2 interstage:** Structure: Conical aluminum shell/inner stiffeners Housing: TVC local control equipment; safety/destruction subsystem		**2/3 interstage:** Structure: Composite grid structure Housing: TVC local control equipment; safety/destruction subsystem **3/AVUM+ interstage:** Structure: Aluminium cylinder with integral machined stringers Housing: TVC control equipment; safety/destruction subsystem, power distribution, RF and telemetry subsystems
Stage separation:	Linear cutting charge/Retro rocket thrusters		Linear cutting charge/springs Pyrotechnic tight expansible tube/springs

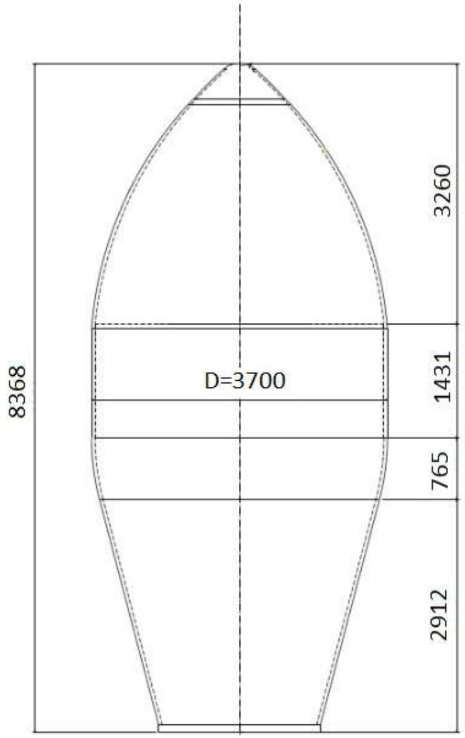
✓ **User manual available for more performance details**

A FULL SPECTRUM OF PAYLOAD ACCOMMODATIONS SOLUTIONS

Baseline Payload Fairing



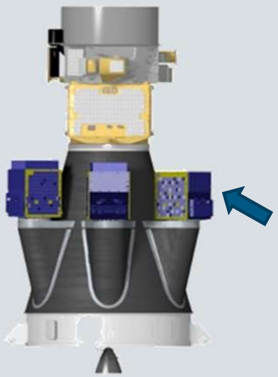
XL Payload Fairing (to be developed)



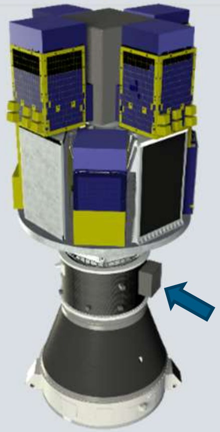
Rideshare or piggyback, under qualification:

1500 kg plus 120 kg (6x)

1 to 400 kg (any aggregate)



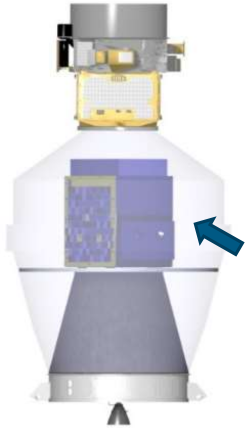
Vampire
937H + aux PL



SSMS

In phases of development:

100 to 1000 kg (twice)



Vespa C

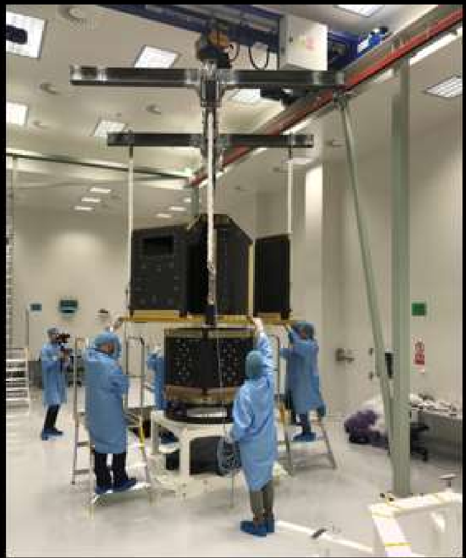
For CubeSats deployers and support to AIT AVIO will rely on D-Orbit and SAB

SAB-LS Activities on Populated Deployers

The services offered by SAB-LS include the management and performance of the following activities:

- Incoming & Acceptance of the VEGA Payload Adapter, populated deployers, deployers harness and sequencers
- Storage of Populated Deployers and Support to the customers
- Integration of the Deployers on the VEGA Payload Adapter
- Integration and routing of the deployers harness cables on the VEGA Payload Adapter
- Termination and Insulation tests on the deployers harness
- Test on the grounding cables of the deployers
- Integration of the sequencers on the Payload Adapter
- First Addressing test of Sequencers
- VEGA Payload Adapter Packaging into dedicated Transport Container
- Shipment of VEGA Payload Adapter, fully equipped, from the Facility to Cayenne airport
- Unpacking of the VEGA Payload Adapter in CSG
- Incoming inspection of the VEGAPayload Adapter in CSG.

LAUNCH CAMPAIGN IN EUROPE



D-Orbit Today

D-ORBIT
InOrbit NOW

75+ PEOPLE

Aerospace company providing:

- Satellite platforms
- Satellite hardware (e.g. ADCS suite, OBC)
- Innovative launch services solutions – InOrbit NOW Launch services
- Operations for nano to microsatellites
- Satellite and on ground software solutions
- End of life strategies

InOrbit NOW Launch Service - DPOD

DPOD and DCUBE are designed to be integrated:

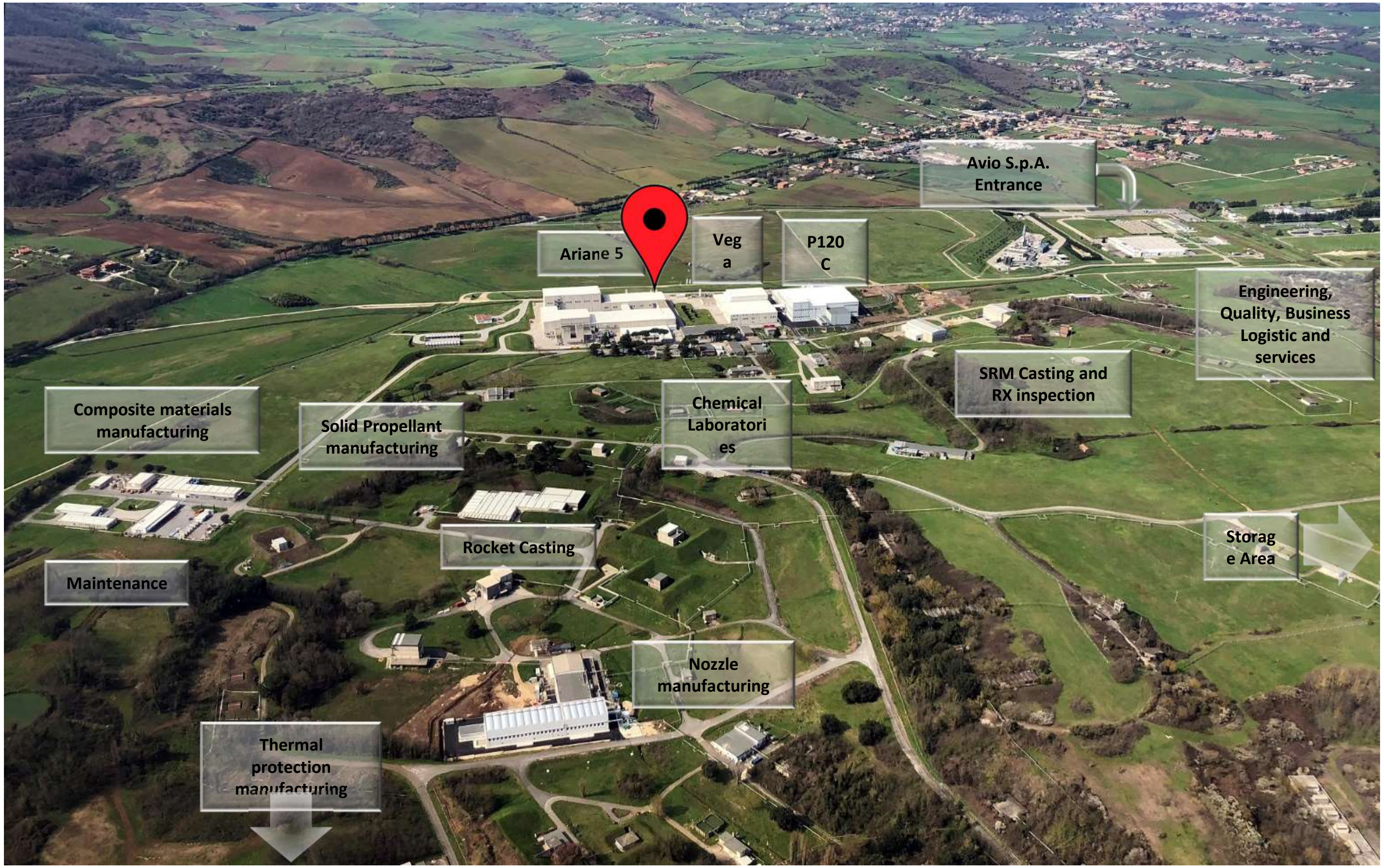
- Directly on the launch vehicle
- On our interface plate
- On other interfaces with launch vehicles developed by D-Orbit or third party providers
- On our ION Satellite Carrier

DPOD-3

Integration of DPOD-3U XL on ION Satellite Carrier

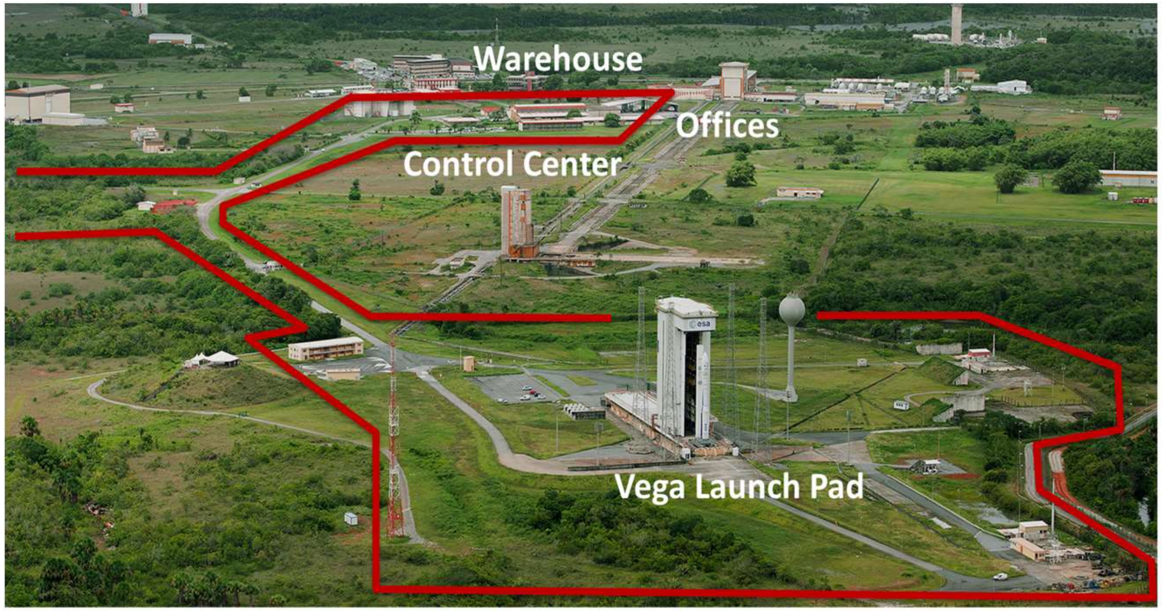
Form Factors	
DPOD-3	For 3U/3U+ (or combination of 1U and 2U)
DPOD-8	For 8U/8U+ (or any combination of smaller CubeSat formats)
DCUBE-12	For 12U/12U+ (or any combination of smaller CubeSat formats)
DCUBE-16	For 16U/16U+ (or any combination of smaller CubeSat formats)

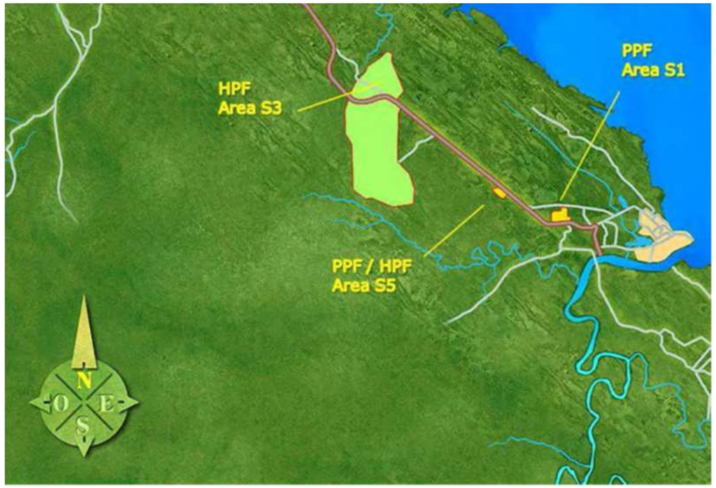
Overview of the Colleferro Plant



The VEGA C Launch Site – Centre Spatial Guyanais

The CSG is governed under an agreement between France and the European Space Agency (ESA) and managed by the French National Space Agency (CNES "Centre National d'Etudes Spatiales") on behalf of ESA.
The CSG mainly comprises:
· the **CSG arrival area** through the sea and airports (managed by local administration);
· the **Payload Preparation Complex** (EPCU "Ensemble de Preparation Charge Utile") where the spacecraft are processed, shared between Ariane 5, Soyuz and Vega;
· the **Upper Composite Integration Facilities** where the Payload Assembly Composite (PAC) is constituted;
· the dedicated **Launch Sites** for each LV including launch pad, LV integration buildings, launch center (CDL "Centre De Lancement") and support buildings;
· The **Mission Control Center** (MCC) "Jupiter 2".





VEGA C – MAIN CHARACTERISTICS

Standard Mission Range

Mission	# orbits	perigee	apogee	inclination
	[#]	[Km]	[Km]	[deg]
SPL/MPL	1	[400 2000]	[400 2000]	[5,2 SSO]
MPL	2	[400 2000]	[400 2000]	[SSO]

Extended Mission Range

Mission	# orbits	perigee	apogee	inclination
	[#]	[Km]	[Km]	[deg]
SPL/MPL	1	[400 8000]	[400 8000]	[0 SSO]
MPL	3	[400 1000]	[400 1000]	[0 SSO]

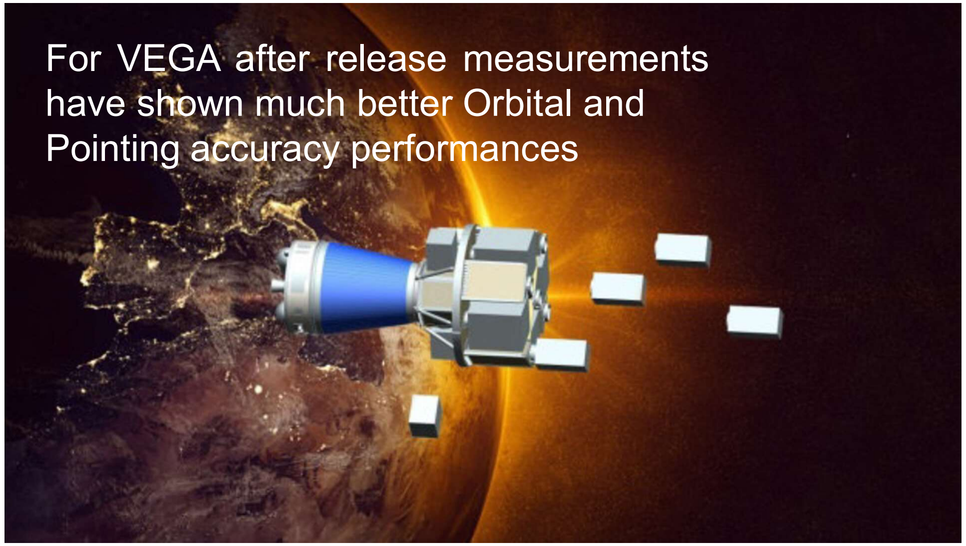
Orbital accuracy requirement

	Semi major axis	Eccentricity	Inclination	RAAN
1st Orbit Release	± 15 km	+/-0.0025	+/- 0.15°	+/-0.3°
2nd Orbit Release	± 20 km	+/-0.0025	+/- 0.15°	+/-0.3°

Pointing accuracy requirement

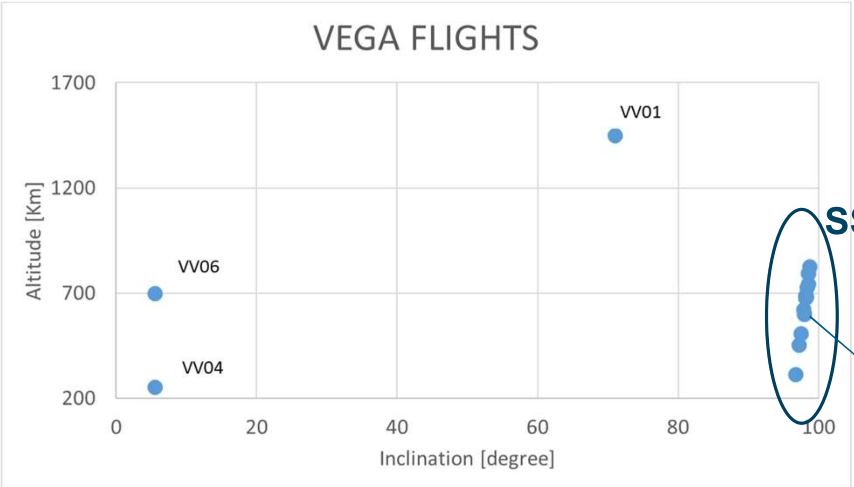
For 3-axis stabilized 1,5t class satellites:

- Geometrical axis de-pointing (on each axis) ≤ 1,5 deg
- Angular tip-off rates along longitudinal axis ≤ 1,5 deg/s
- Angular tip-off rates along transversal axes ≤ 1,5 deg/s



VEGA C OPPORTUNITIES – POSSIBLE MISSIONS

VEGA Statistics



- After its maiden flight, the VEGA C launch rate shall be from 3 to 4 per year
- Along the period 2022-2023 the launch opportunities for CubeSats may be up to 5
- Most of them will be done at altitudes from 400km to 810km in Sun-synchronous orbit
- One or two of them may be at higher altitudes and different inclinations (intermediate or pseudo-equatorial)