



Politecnico  
di Torino

# La QUALITÀ nell'AEROSPACE

Le sfide e i risultati

4-5 MAGGIO  
2023  
Politecnico di Torino



Le nuove sfide della propulsione e dei sistemi di lancio  
spaziali in Avio  
Francesco Betti

# European Launchers – product range evolution roadmap



Capacity  
Reference Orbit

10,5 t  
GTO

1,5 t  
LEO

2,3 t  
LEO

6 t  
GTO

11 t  
GTO

0,8 t  
LEO

TBD  
LEO

2,8 t  
LEO

12 t  
GTO

SSMS  
Payload  
Adapter

Launch &  
Re-entry



P120

P120

TODAY

2023

2024  
Space  
Rider

2026

Ariane 5

Vega

Vega C

Ari62

Ari64

IFD

Vega E+ A6 Evo

Established legacy and  
track record

Commonalities and cost  
reduction

Broader offering and  
flexibility

# Vega C: the S/M European Launch Vehicle

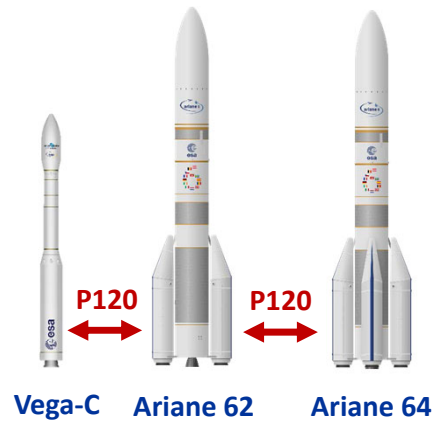


## Maiden Flight on 13° July 2022

Characteristic	P120C	Z40	Z9	AVUM+
Length [m]	11.7	7.6	3.9	-
Diameter [m]	3.4	2.3	1.9	1.5
Propellant Mass [ton]	143.6	36.2	10.5	0.74
Dry Mass [kg]	11000	3006	906	606
Vacuum Thrust [kN]	4500	1304	314	2.42
Vacuum Specific Impulse [s]	278.5	293.5	295.2	314.6
Firing Time [s]	132.8	92.9	117.1	940

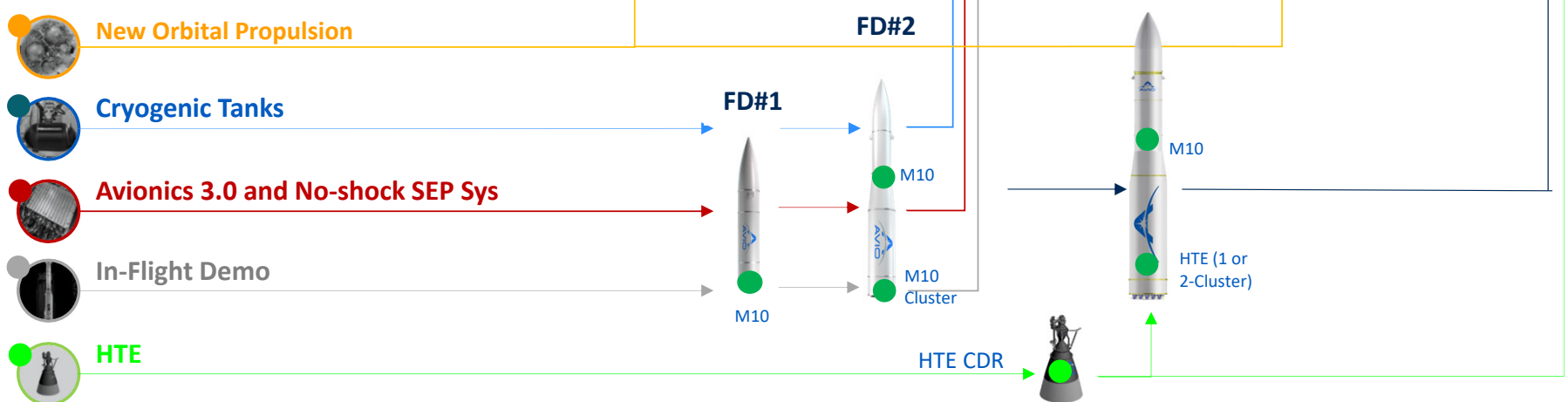
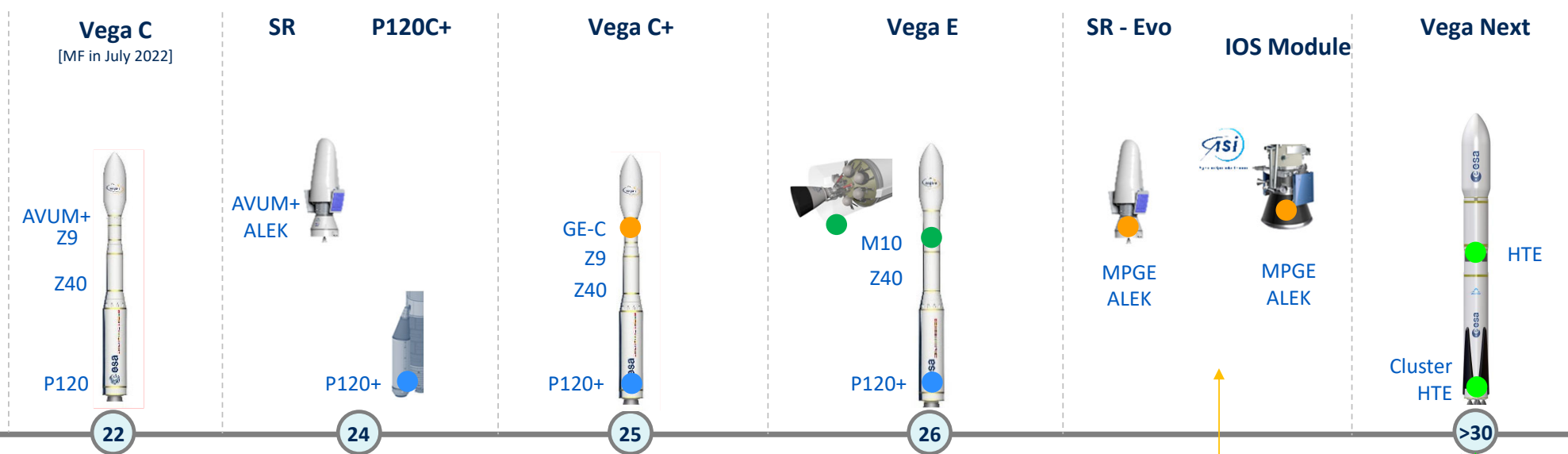


# P120C : the common European Launcher Solid Rocket Motor



Characteristic	P120C
Length [m]	11.7
Diameter [m]	3.4
Propellant Mass [ton]	143.6
Dry Mass [kg]	11000
Vacuum Thrust [kN]	4500
Vacuum Specific Impulse [s]	278.5
Firing Time [s]	132.8

# Product Development Roadmap → From full 'Solid' to 'Liquid'



# Product Development Roadmap vs Funding Source → From full 'Solid' to 'Liquid'



## Vega C

[MF in July 2022]

AVUM+  
Z9  
Z40

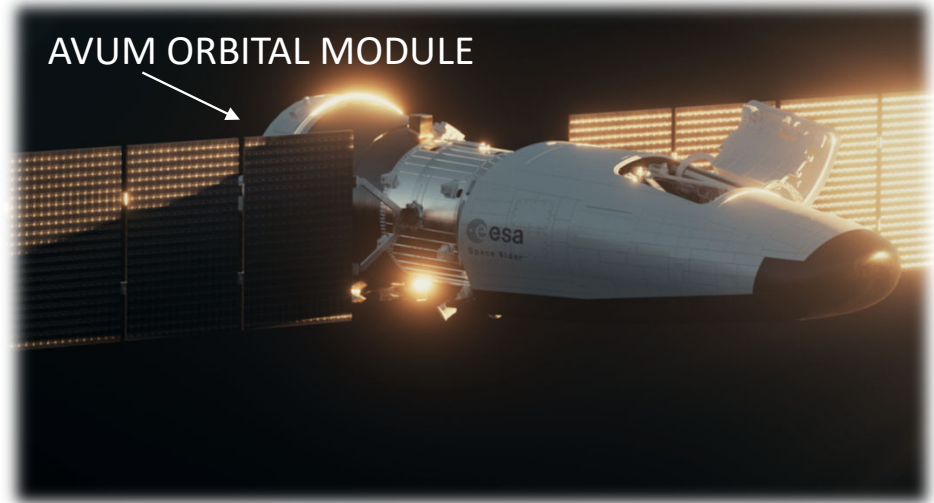
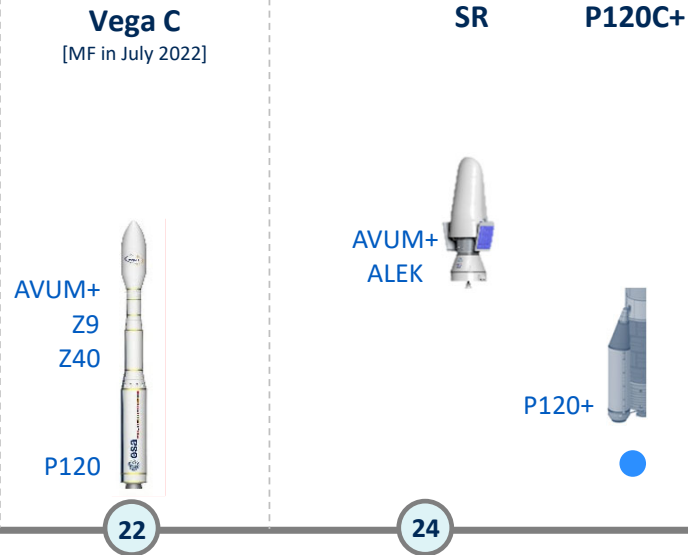
P120

22



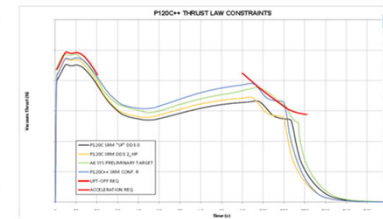
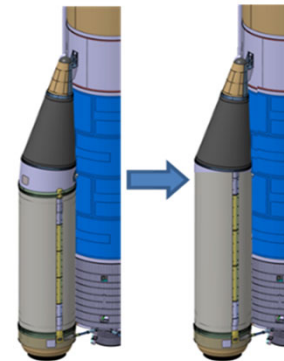


# Product Development Roadmap vs Funding Source → From full 'Solid' to 'Liquid'

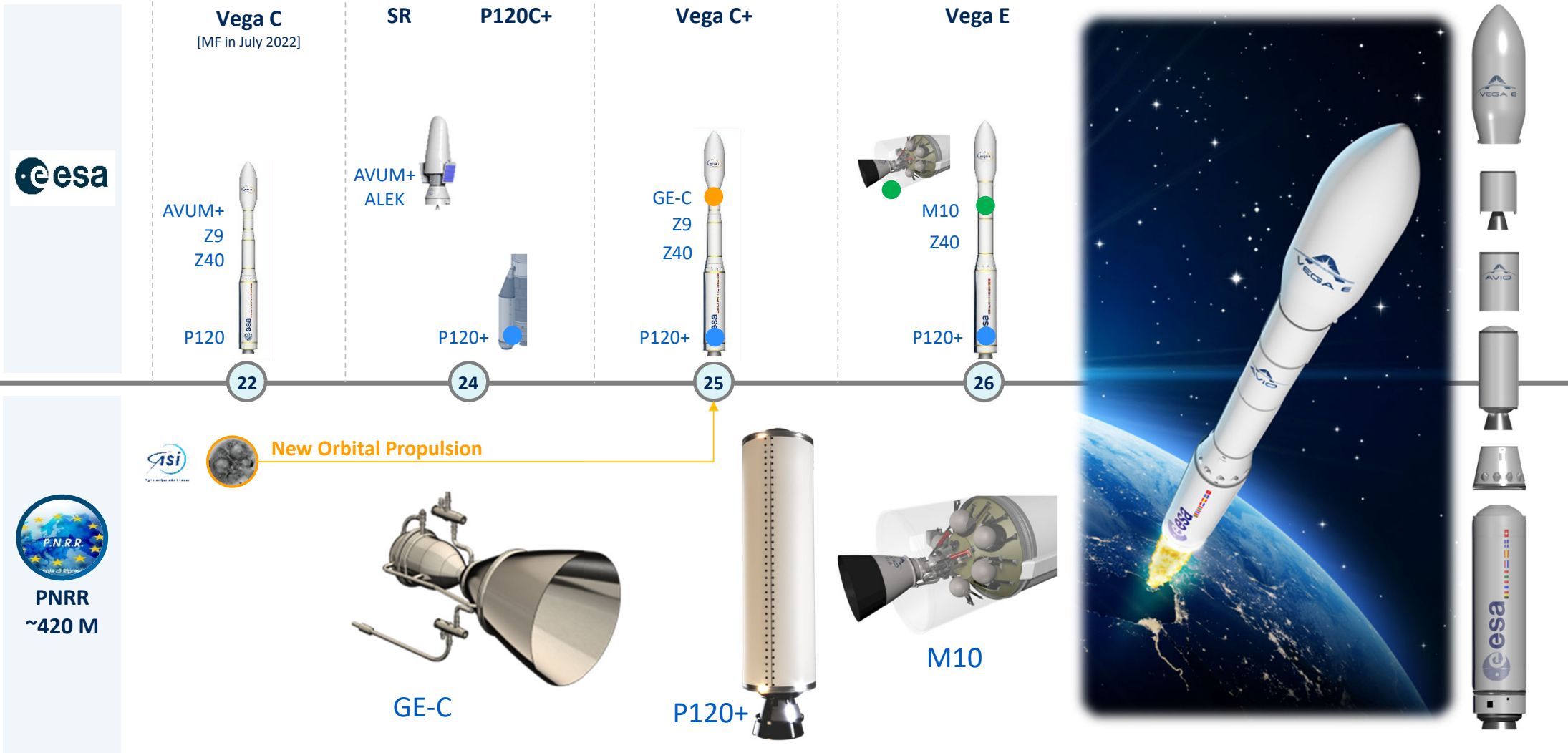


- IMC: 1m longer, iso-diam.
- LMC: +14t prop. loading

- Δperfo Vega C+: +200 kg
- Price/kg reduction: 10%



# Product Development Roadmap vs Funding Source → From full 'Solid' to 'Liquid'



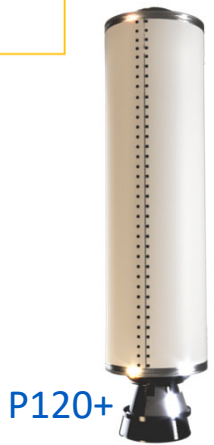
PNRR  
~420 M



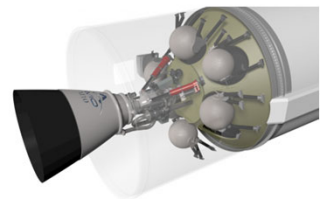
New Orbital Propulsion



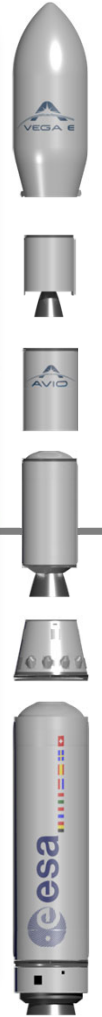
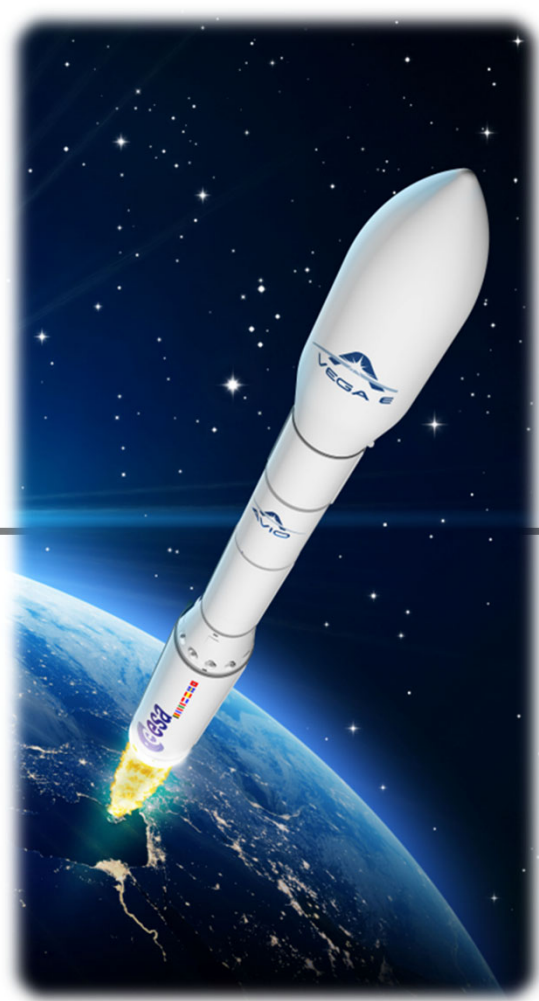
GE-C



P120+

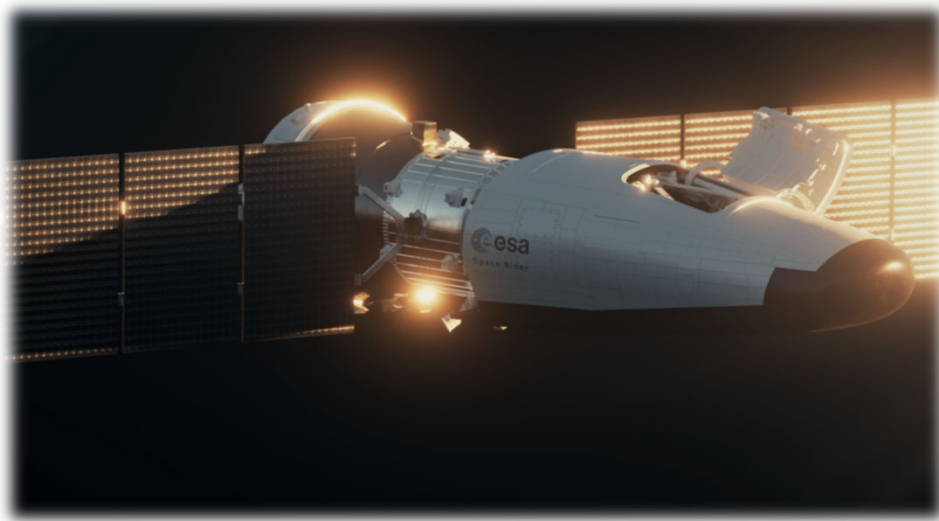


M10





# Product Development Roadmap vs Funding Source → From full 'Solid' to 'Liquid'



SR - Evo

IOS Module



MPGE  
ALEK

MPGE  
ALEK



New Orbital Propulsion



PNRR  
~420 M



GE-C

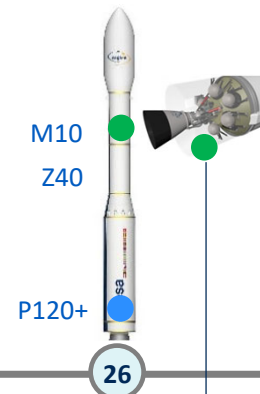


MPGE

# Product Development Roadmap vs Funding Source → From full 'Solid' to 'Liquid'



Vega E



Vega Next



Cryogenic Tanks



Avionics 3.0 and No-shock SEP Sys



In-Flight Demo

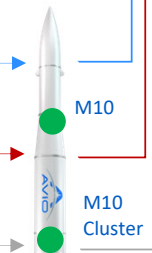


HTE

FD#1



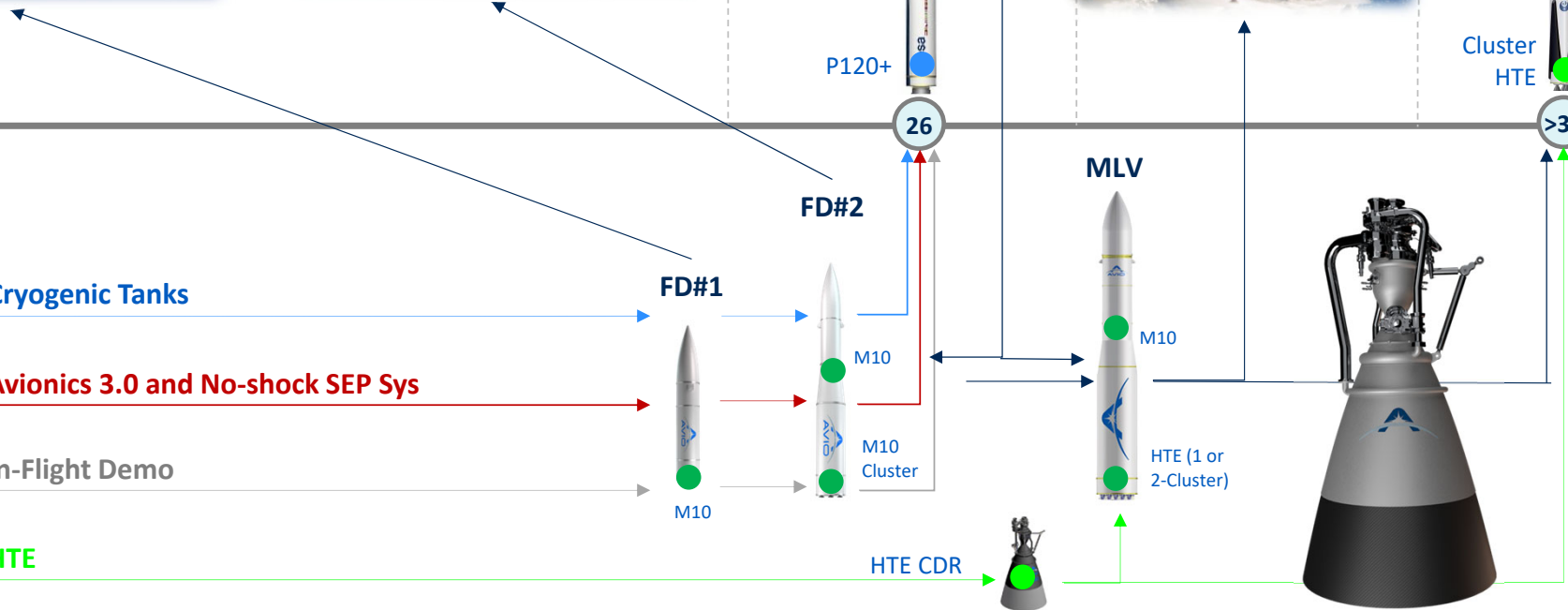
FD#2



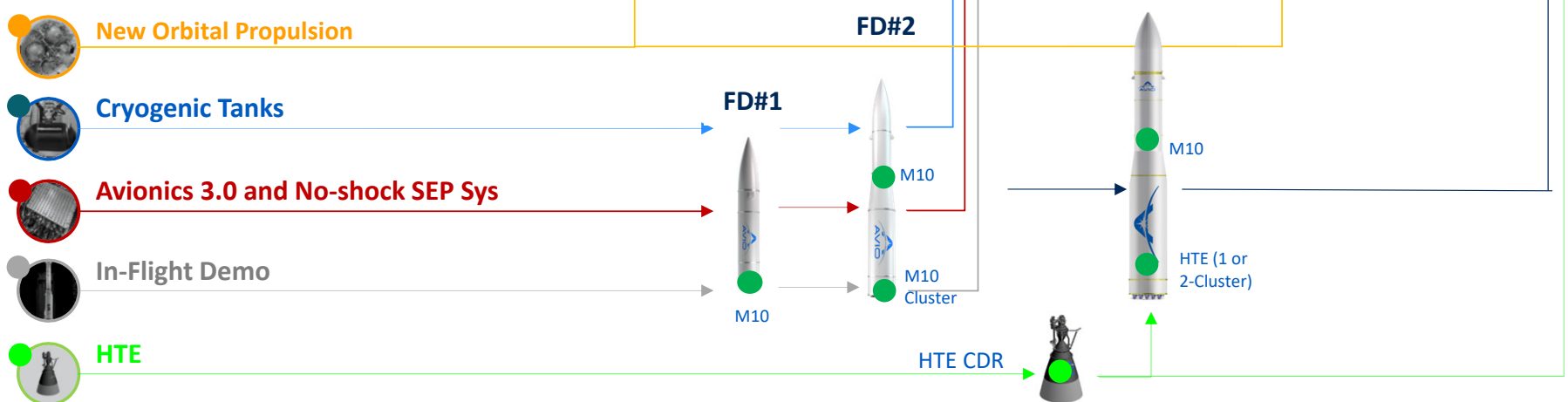
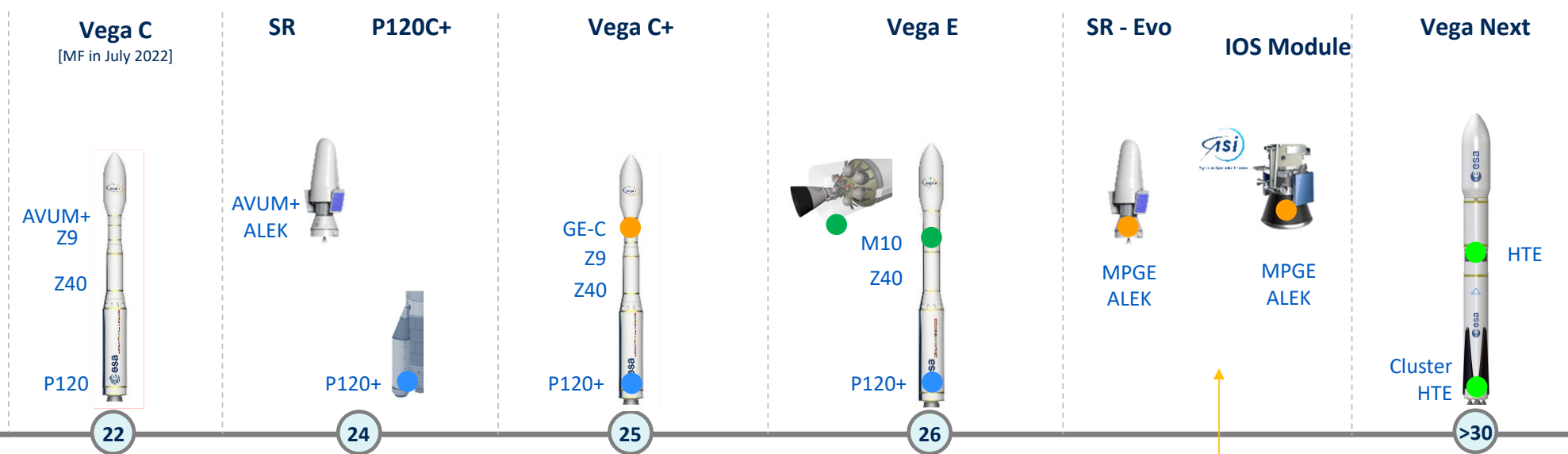
MLV



HTE CDR



# Product Development Roadmap → From full 'Solid' to 'Liquid'





## P120C+: Vega C performance increase (1/2)



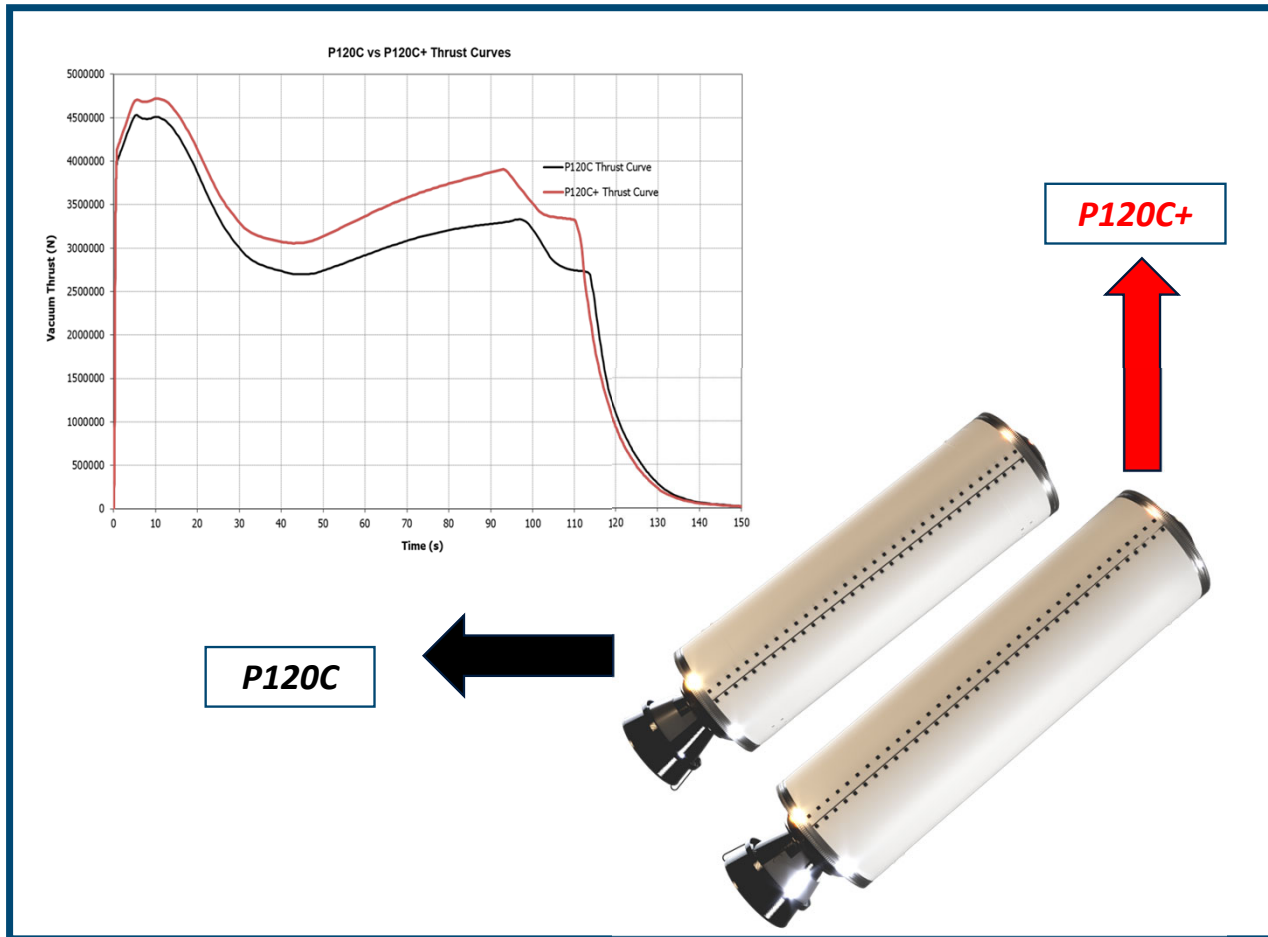
**P120C**



- IMC: 1m longer, iso-diam.
- LMC: +14t prop. loading

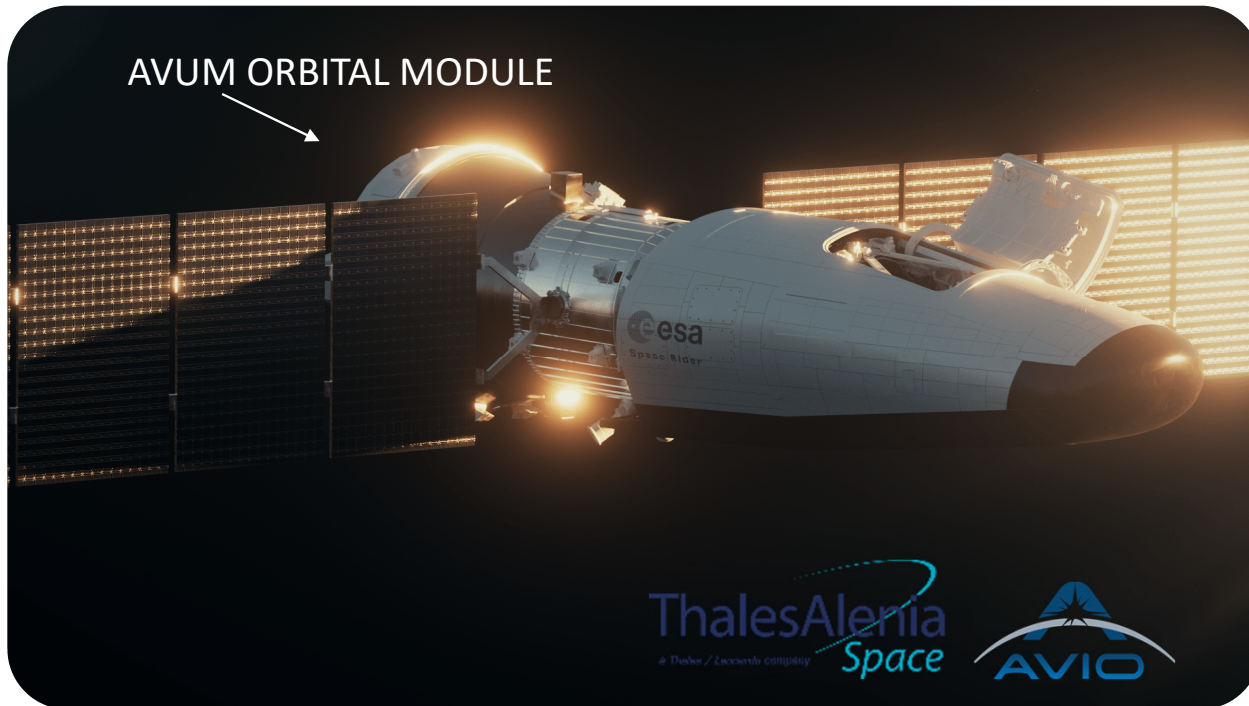
- $\Delta$ perfo Vega C+: +200 kg
- Price/kg reduction: 10%

# P120C+: Vega C performance increase (2/2)



Characteristic	P120C	P120C+
Length [m]	11.7	12.7
Diameter [m]	3.4	3.4
Propellant Mass [ton]	143.6	156.2
Dry Mass [kg]	11000	11700
Vacuum Thrust [kN]	4500	4700
Vacuum Specific Impulse [s]	278.5	278.5
Firing Time [s]	132.8	143.5

# Space Rider: the European Re-entry Vehicle



Characteristic	Space Rider
Total Length [m]	8
Launch Mass [kg]	4900
Maximum Flight Time [days]	60
AOM Vacuum Thrust [kN]	2.42
AOM Vacuum Specific Impulse [s]	314.6
AOM Firing Time [s]	940
PayLoad Max Performance [kg]	620
PayLoad Cargo Bay [l]	1200
Use Cases	IOD/IOV/Microgravity



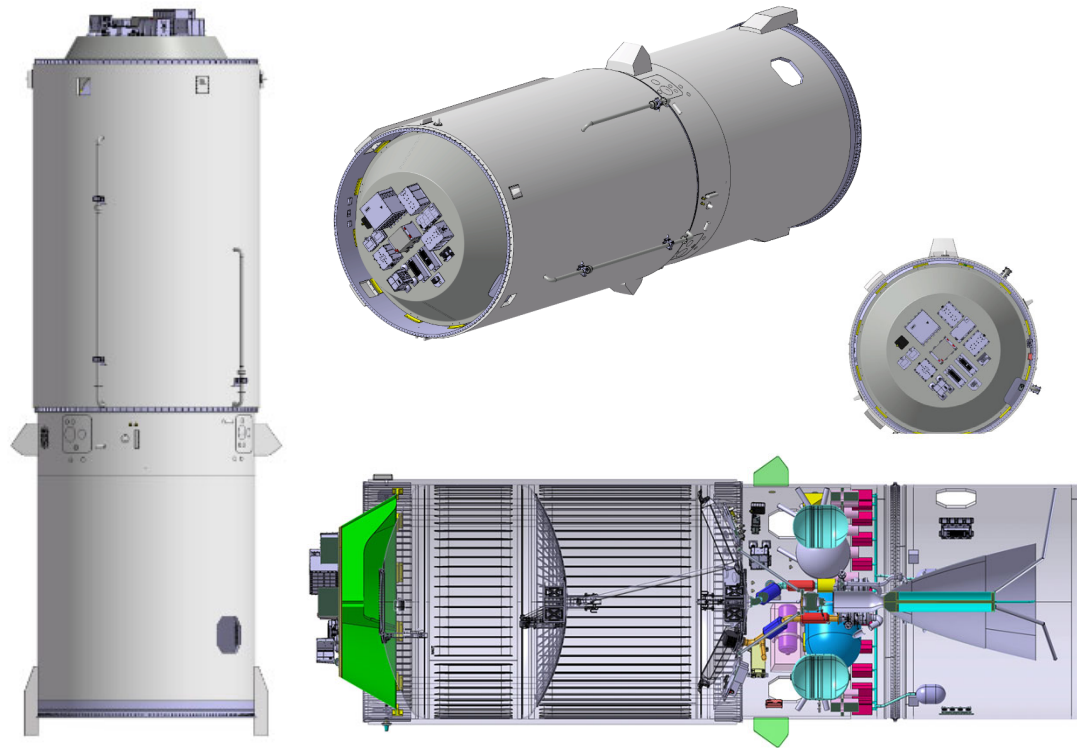
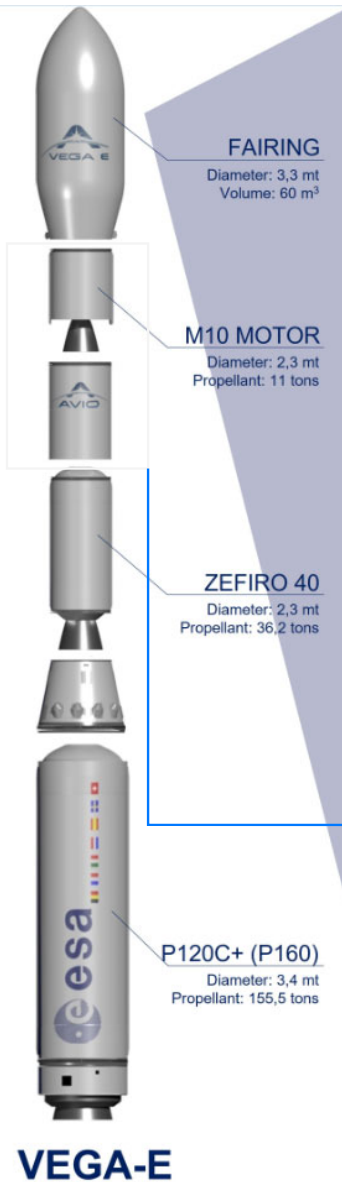
# Vega E: a first step towards green, liquid propulsion (1/2)



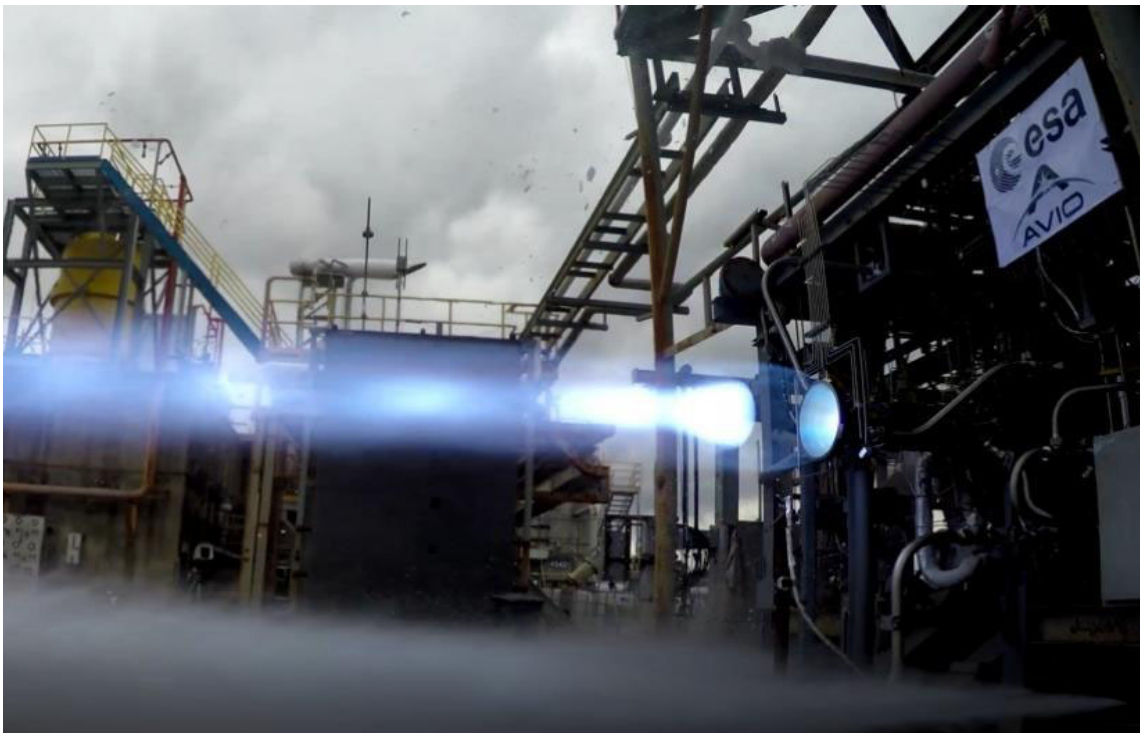
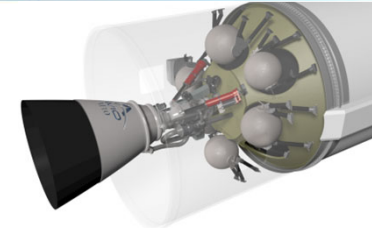
Characteristic	P120C+	Z40	VUS (M10)
Length [m]	12.7	7.6	-
Diameter [m]	3.4	2.3	2.36
Propellant Mass [ton]	156.2	36.2	10.5
Dry Mass [kg]	11700	3006	1840
Vacuum Thrust [kN]	4700	1304	98.1
Vacuum Specific Impulse [s]	278.5	293.5	316.5
Firing Time [s]	143.5	92.9	379.4

## Vega E: a first step towards green, liquid propulsion (2/2)

- Differently from Vega and Vega C, Vega E will have a three-stage configuration. The first two, P120 C and Zefiro 40 will be the same of Vega C. The upper stage will have a innovative engine which will burn liquid oxygen and methane. The rocket will be capable of releasing multiple satellites into different orbits during a single mission, maintaining the remarkable reliability and precision standards of the Vega family.



# The M10 Engine, characteristics and test campaign



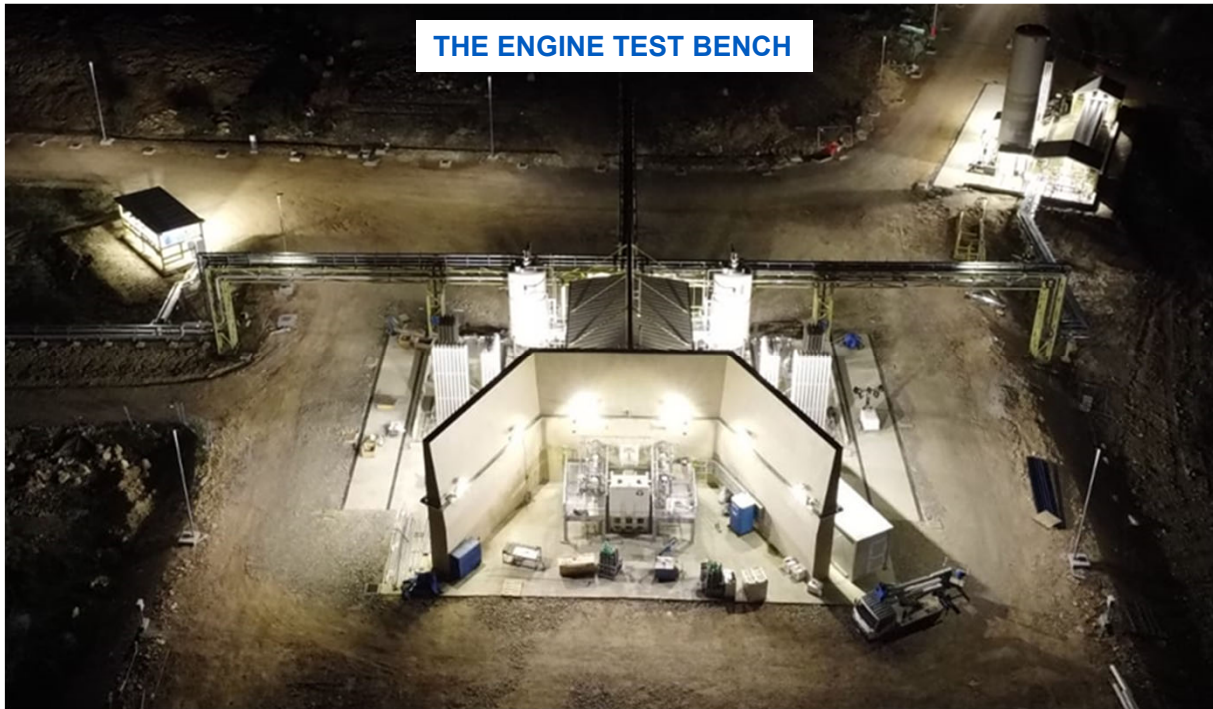
## M10 LOX/Methane Engine

Characteristic	M10 Sea Level	M10 Vacuum
Length [mm]	1450	2400
Weight [kg]	200	230
Nozzle Exit Diameter [mm]	480	1180
Vacuum Thrust [kN]	90.7	98.1
Vacuum Specific Impulse [s]	334	361.5



# The SPTF

THE ENGINE TEST BENCH



Operational since 2021

- 1\ Able to bench-test 10-tons, LOX/Methane liquid-fueled Engines (can be enhanced up to 150 tons)
- 2\ First M10 Test Campaign early 2022
- 3\ Set for hosting the future Carbon-Carbon manufacturing Plants

LOX SIDE

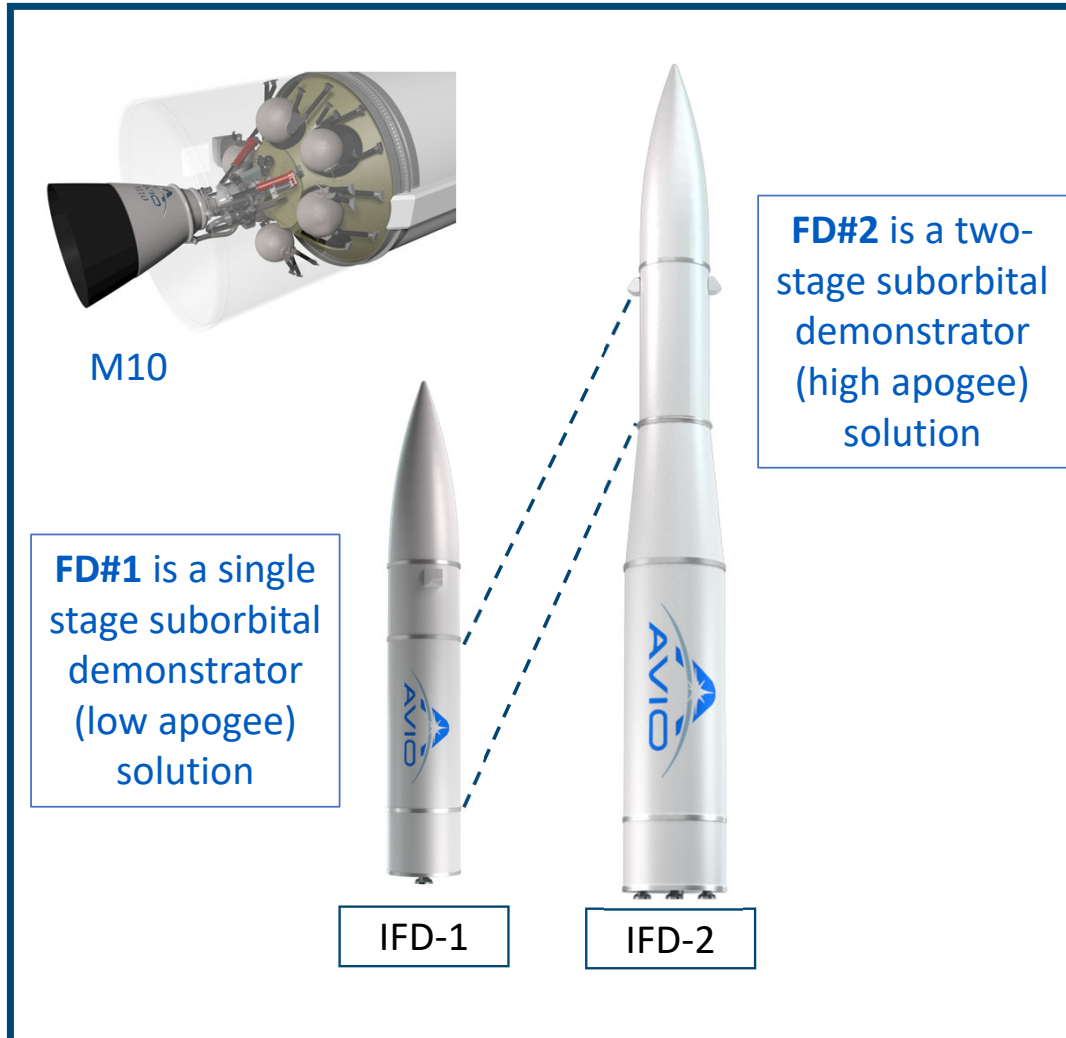
LNG SIDE



ENGINE SIDE



## In Flight Demo missions

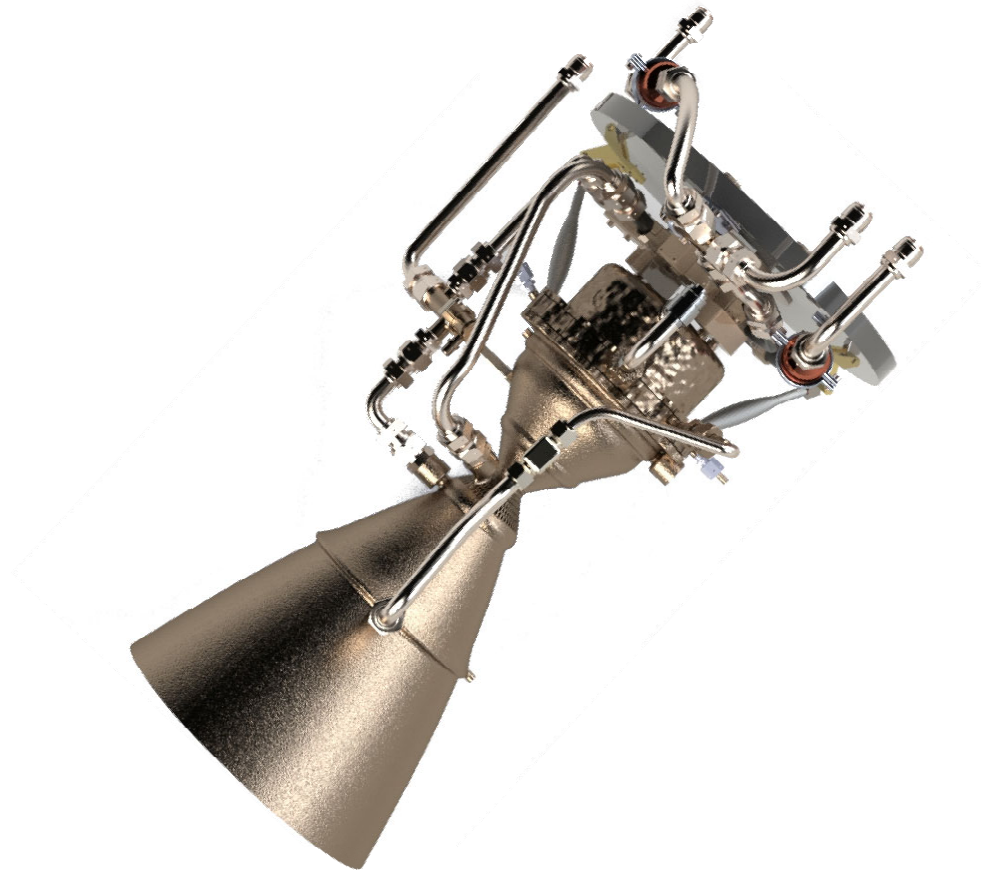


## Demo Missions in 2025-2026

Develop, manufacture and launch demo missions embarking the development models from the various technology streams:

- 1) **FD#1**, a sub-orbital flight also exploring re-ignitability under microgravity conditions and possible recovery of the stage
- 2) **FD#2**, a sub-orbital flight precursor of a future MLV, capitalizing on IFD1 and exploring multiple re-ignitability capability under microgravity conditions

# The new Green Engine for Vega C (GEC) replacing MEA



## GEC (Green Engine Vega C)

Characteristic	GEC
Vacuum Thrust [kN]	2.5
Vacuum Specific Impulse [s]	≥303



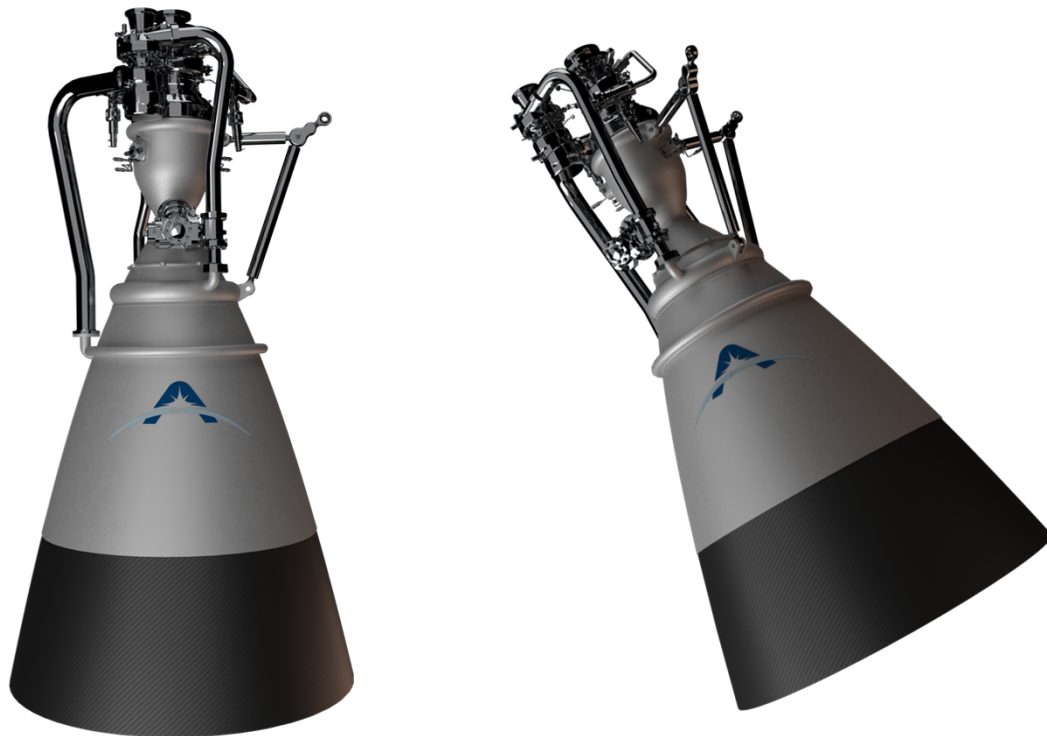
# MPGE (Multi Purpose Green Engine), suited for IOS and kick stage



## MPGE as evolution of GEC

Characteristic	MPGE
Nominal Vacuum Thrust [kN]	4
Vacuum Specific Impulse [s]	$\geq 305$
Propellants	Green Combination
Feeding System	Electro-pump fed
Thrust Throttleability	Yes
Multi Ignitions	Yes
Versatility	Multi Mission
Long Orbital Time	Yes

# The HTE LOX/Methane Liquid Engine



## HTE LOX/Methane Engine

Characteristic	HTE Sea Level	HTE Vacuum
Length [mm]	2195	3749
Nozzle Exit Diameter [mm]	839	1978
Vacuum Thrust [kN]	585	640
Vacuum Specific Impulse [s]	338.4	370.4

# Beyond 2030 - Vega Next

