

Ariane 5 and the European Launcher Family

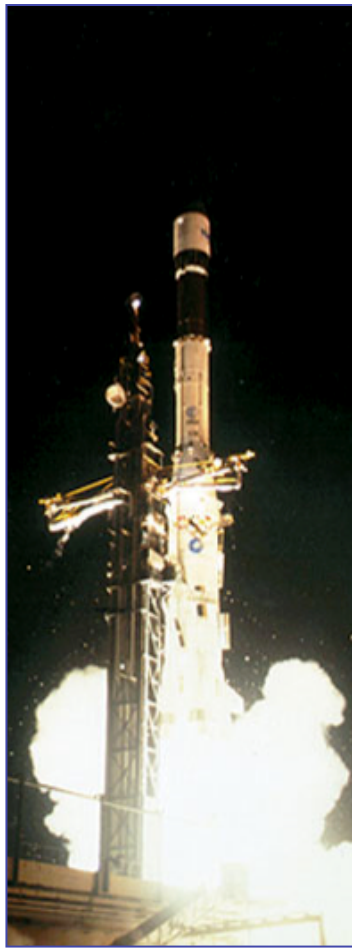
Ariane 1, Ariane 2-3 & Ariane 4



1er AR1 . LO1
1979
11 Lancements
2 Echecs



1er AR3 . V10
1984
11 Lancements
1 Echec



1er AR2 . V20
1986
6 Lancements
1 Echec



1er AR4 . V22
1988



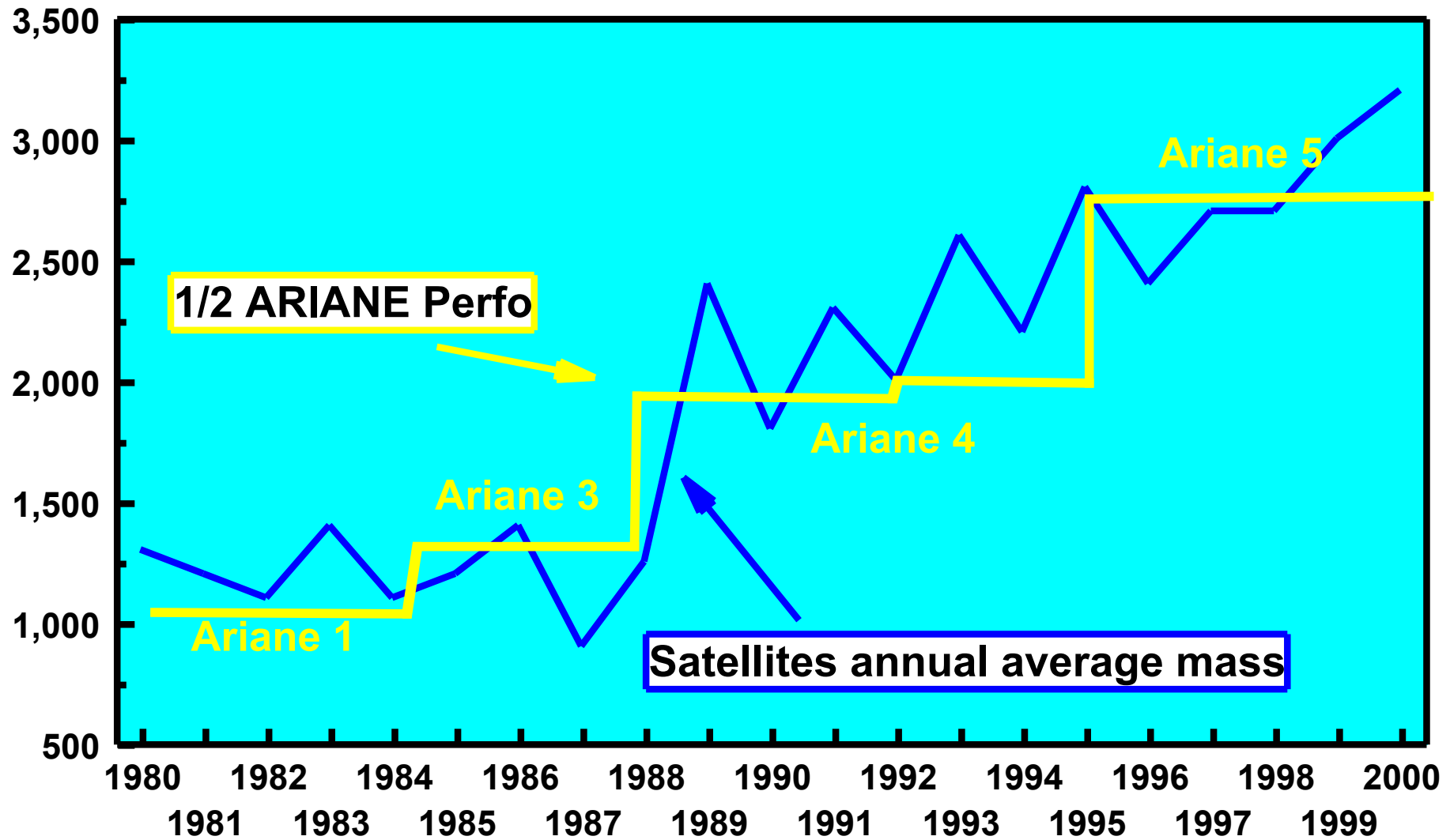
100e AR4 . V134
2000

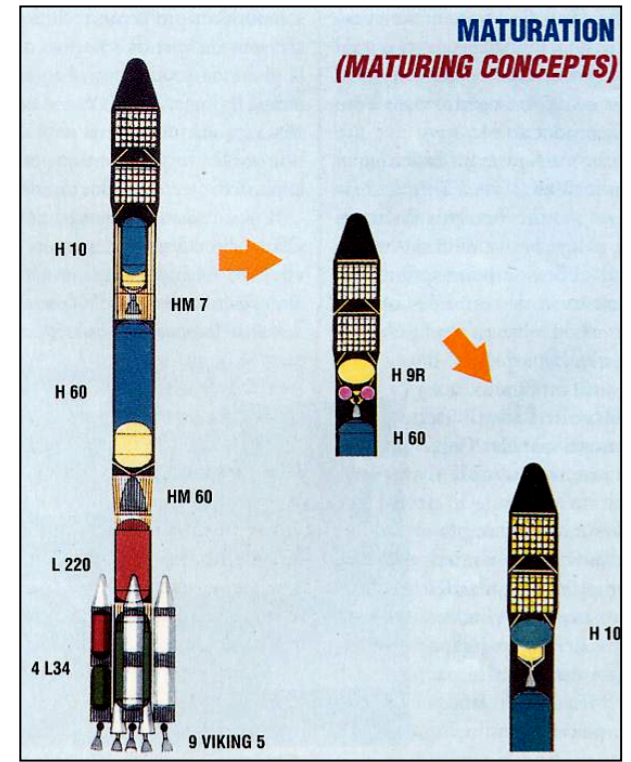
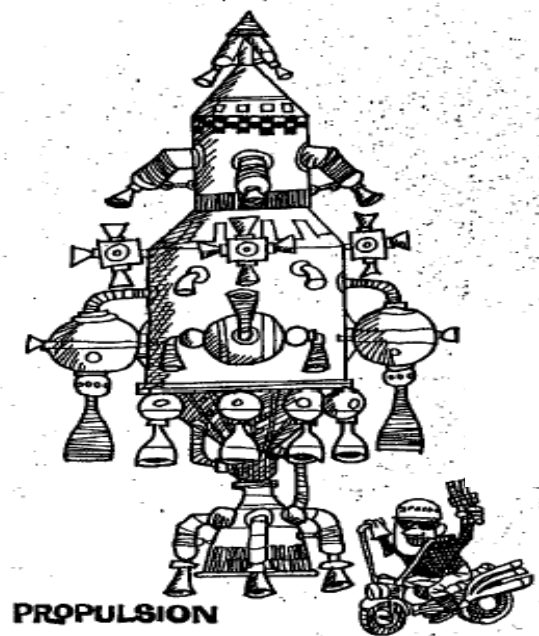
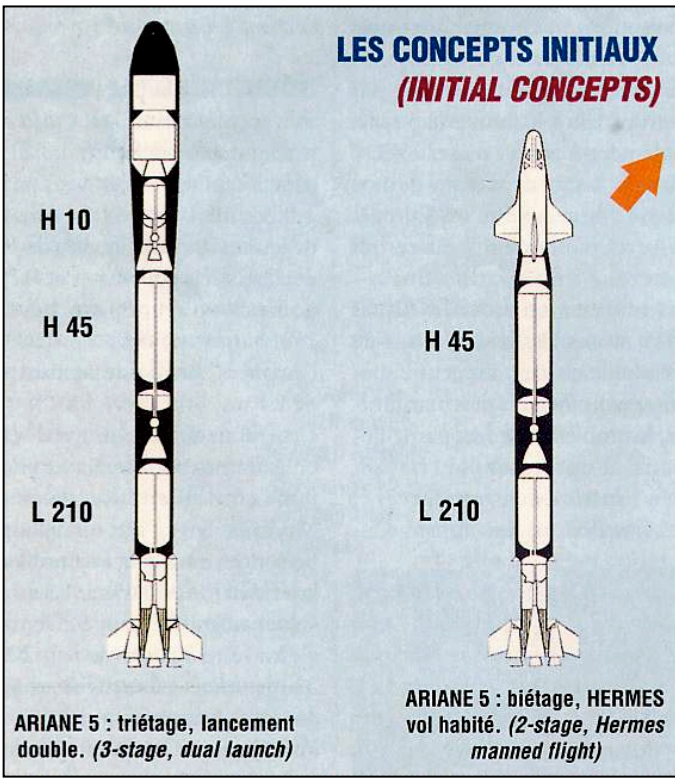
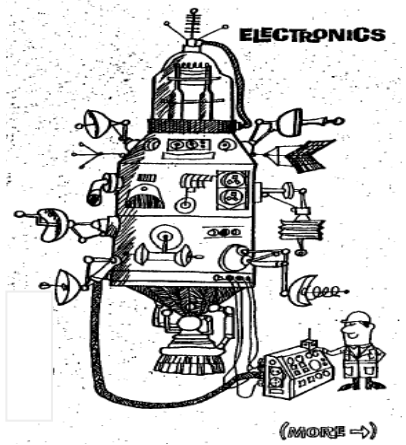
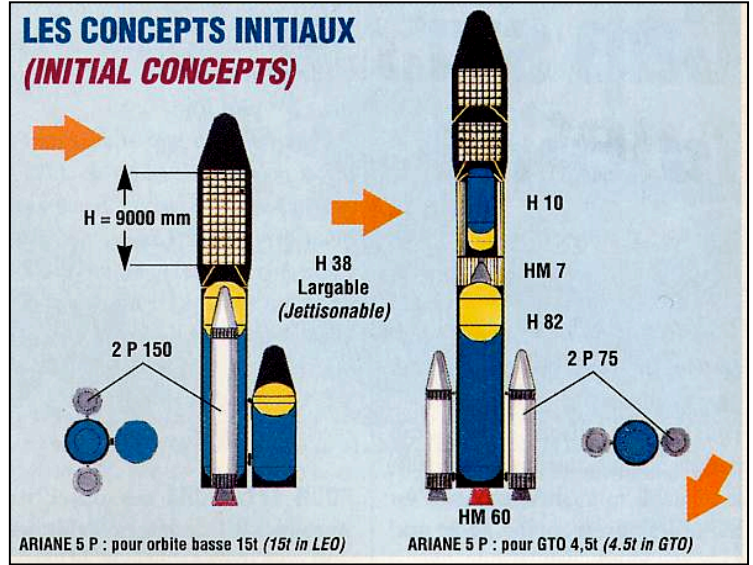
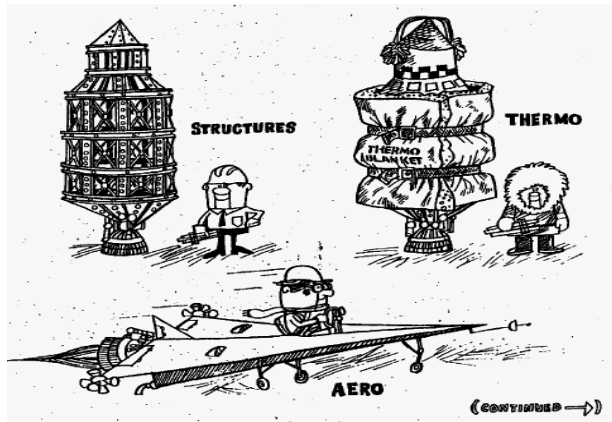


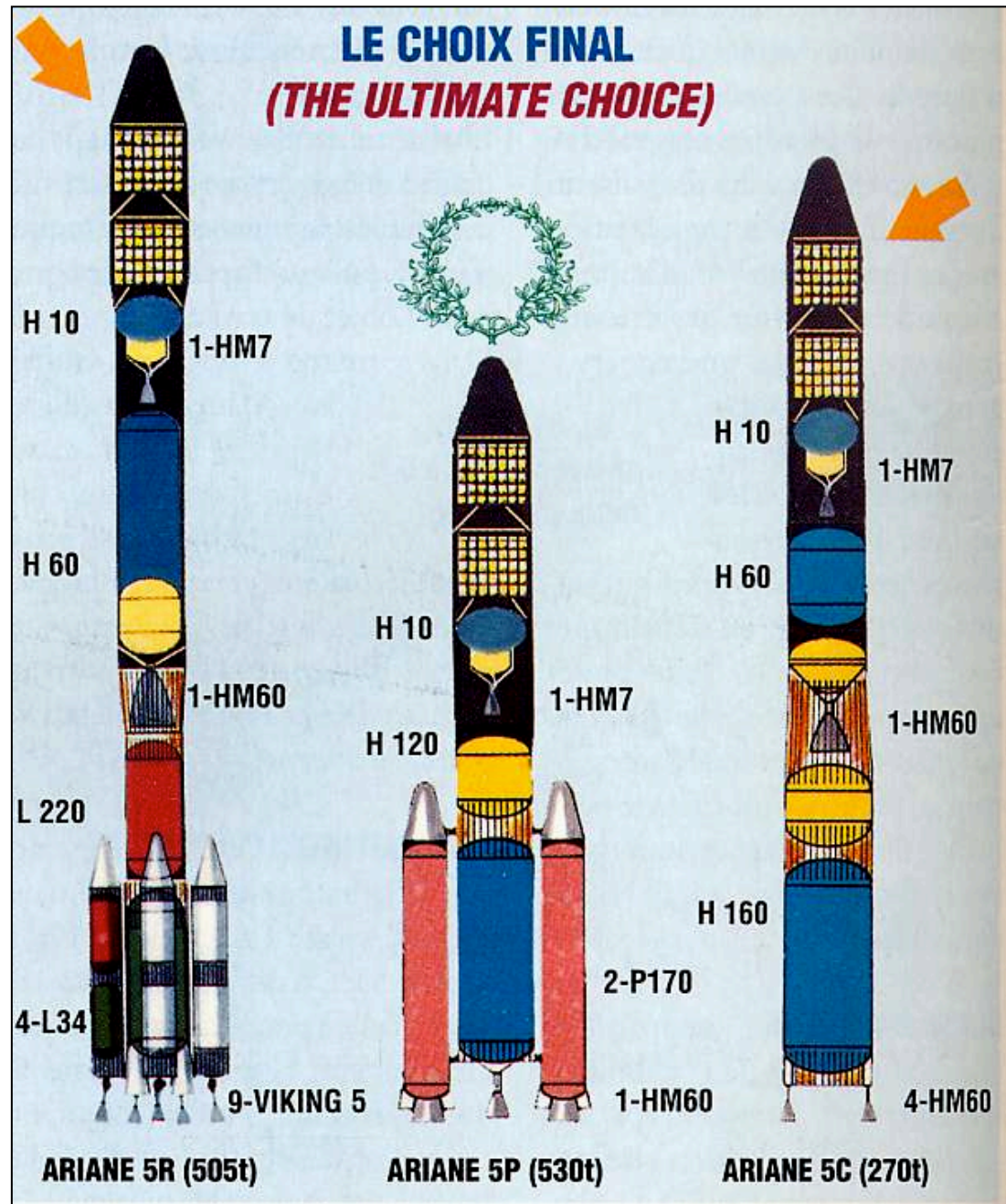
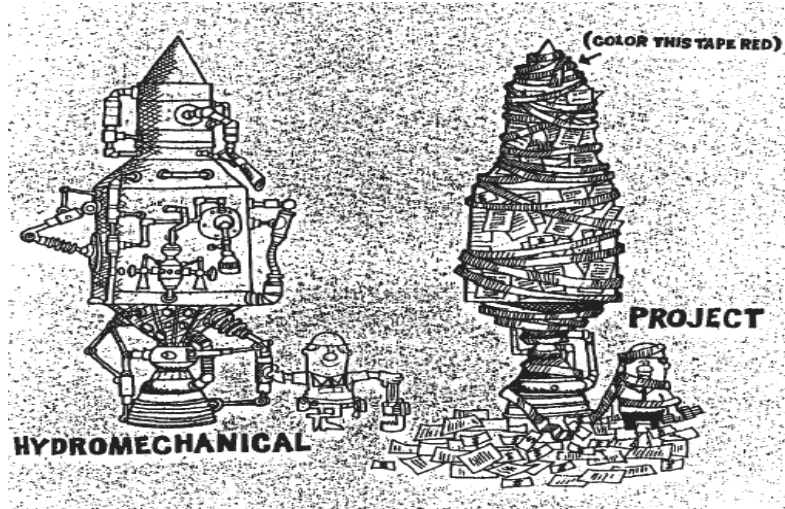
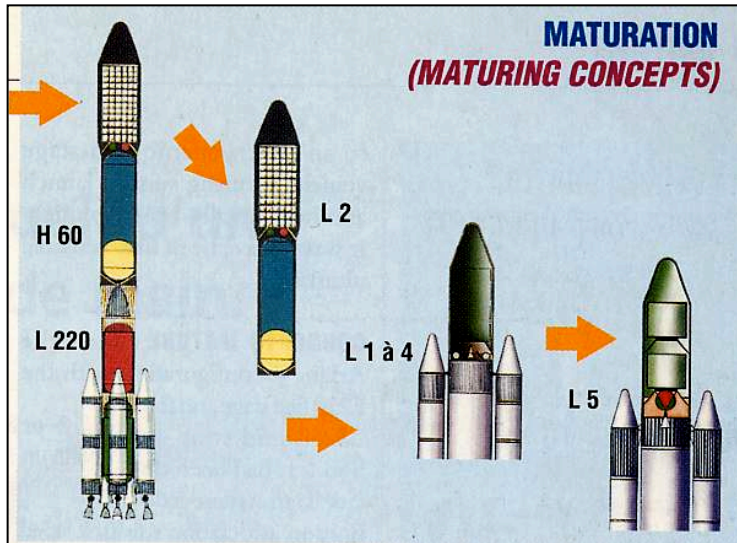
Der. AR4 . V159
2003

<----- 116 Lancements, 3 Echecs, 74 Succès consécutifs ----->

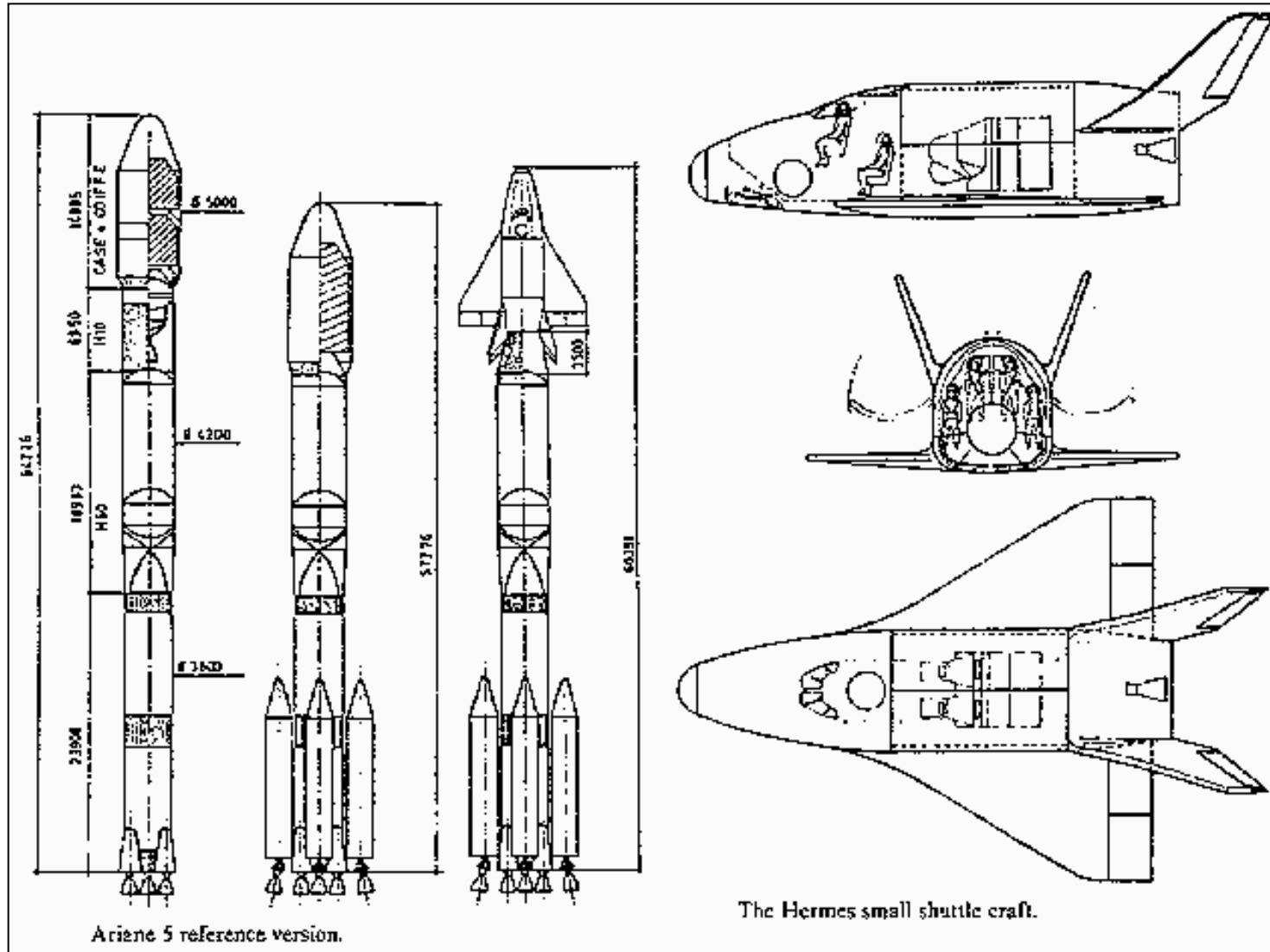
Success of Ariane 1, Ariane 2-3 & Ariane 4



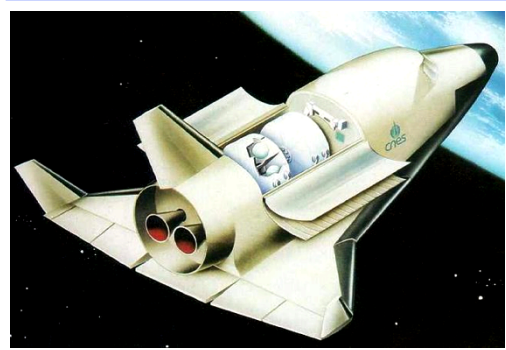
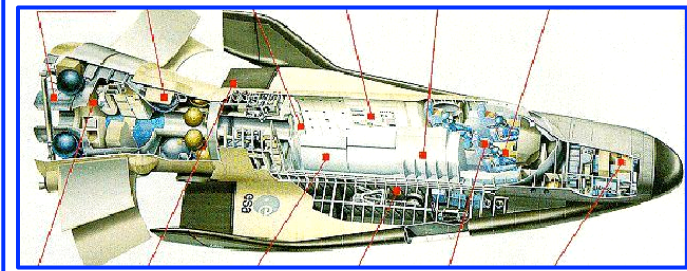
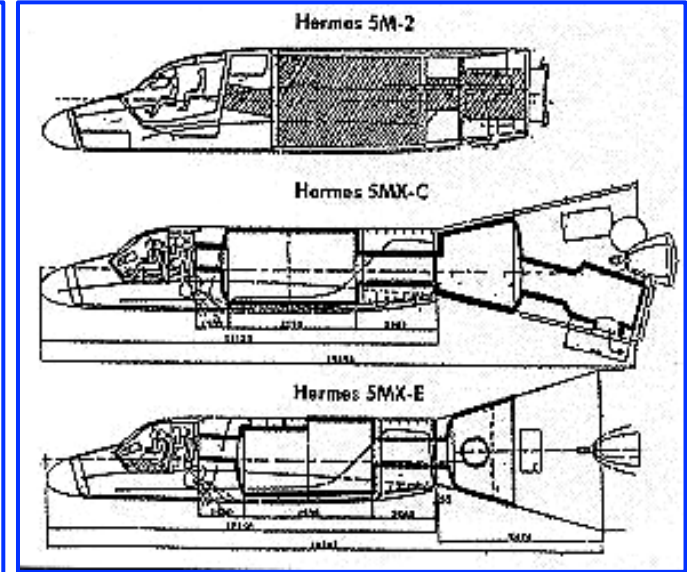
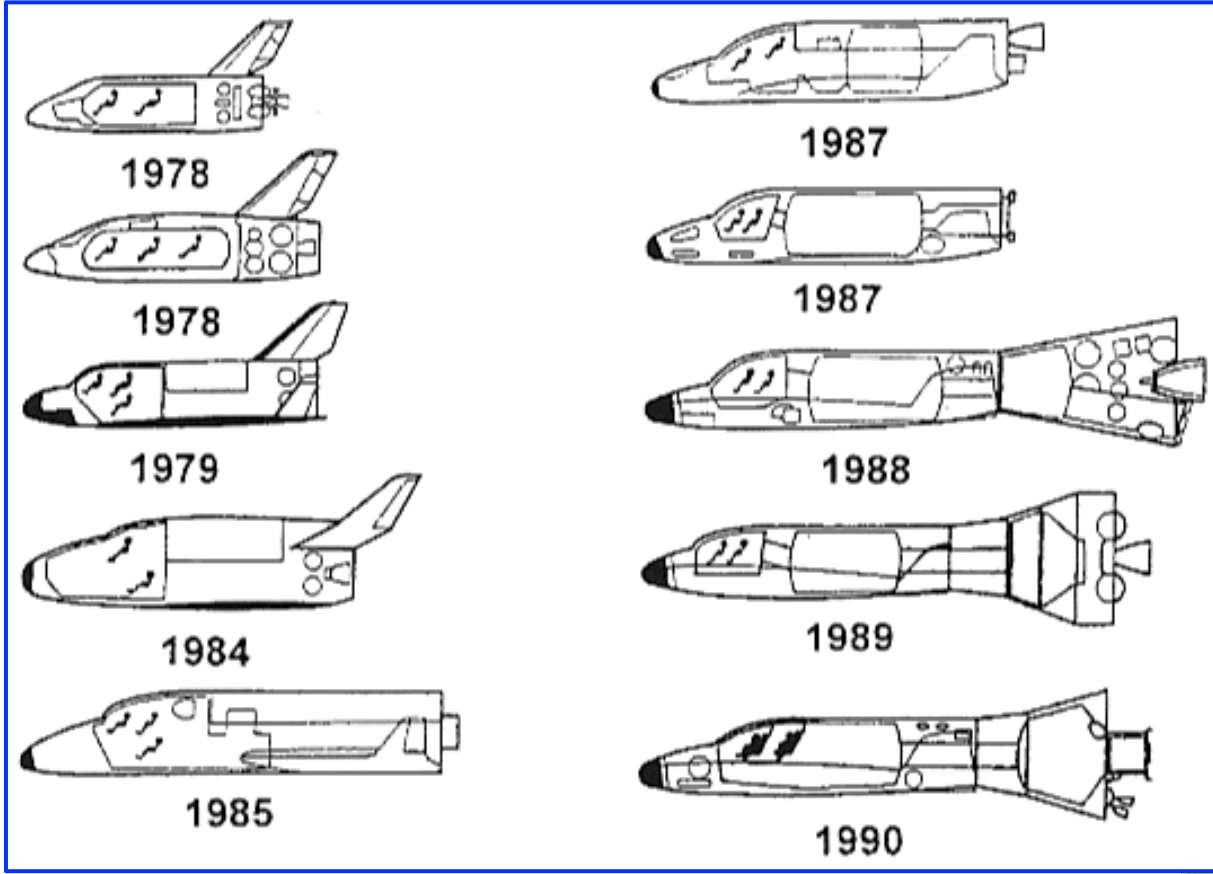




Ariane 5 for Hermes



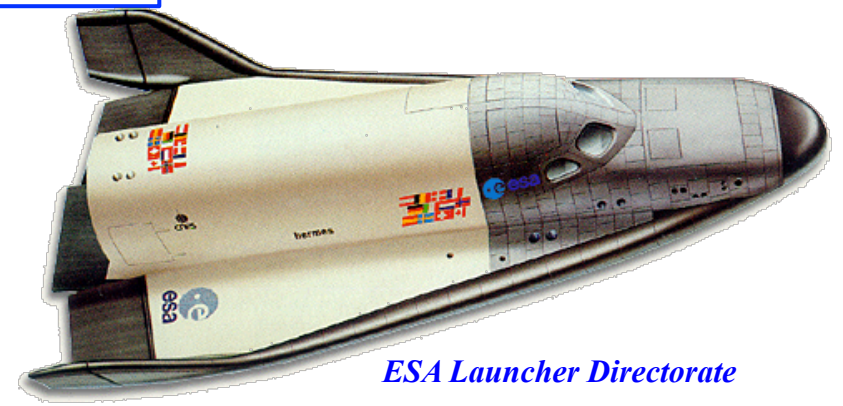
Hermes Evolution 1978 - 1990



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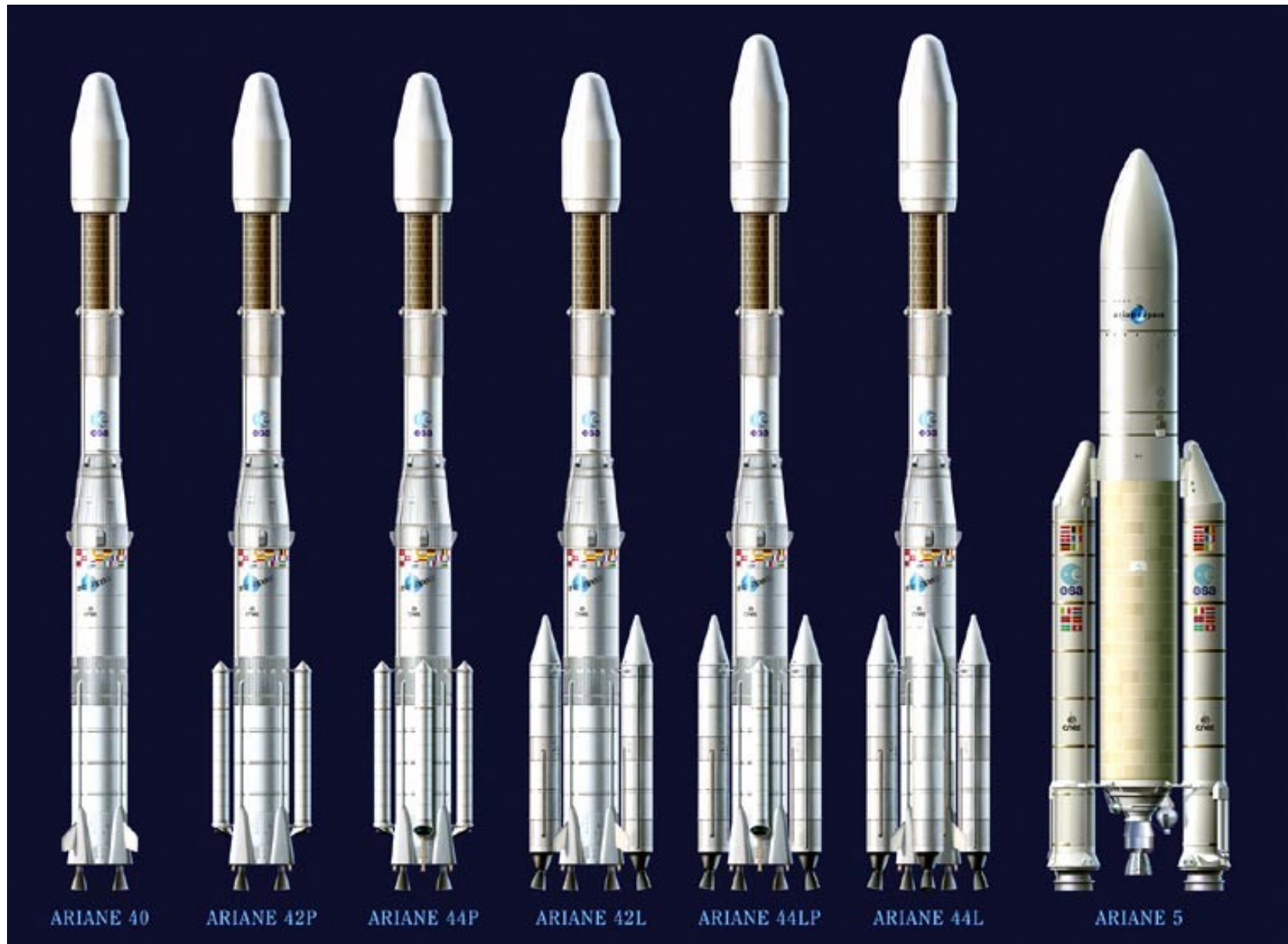


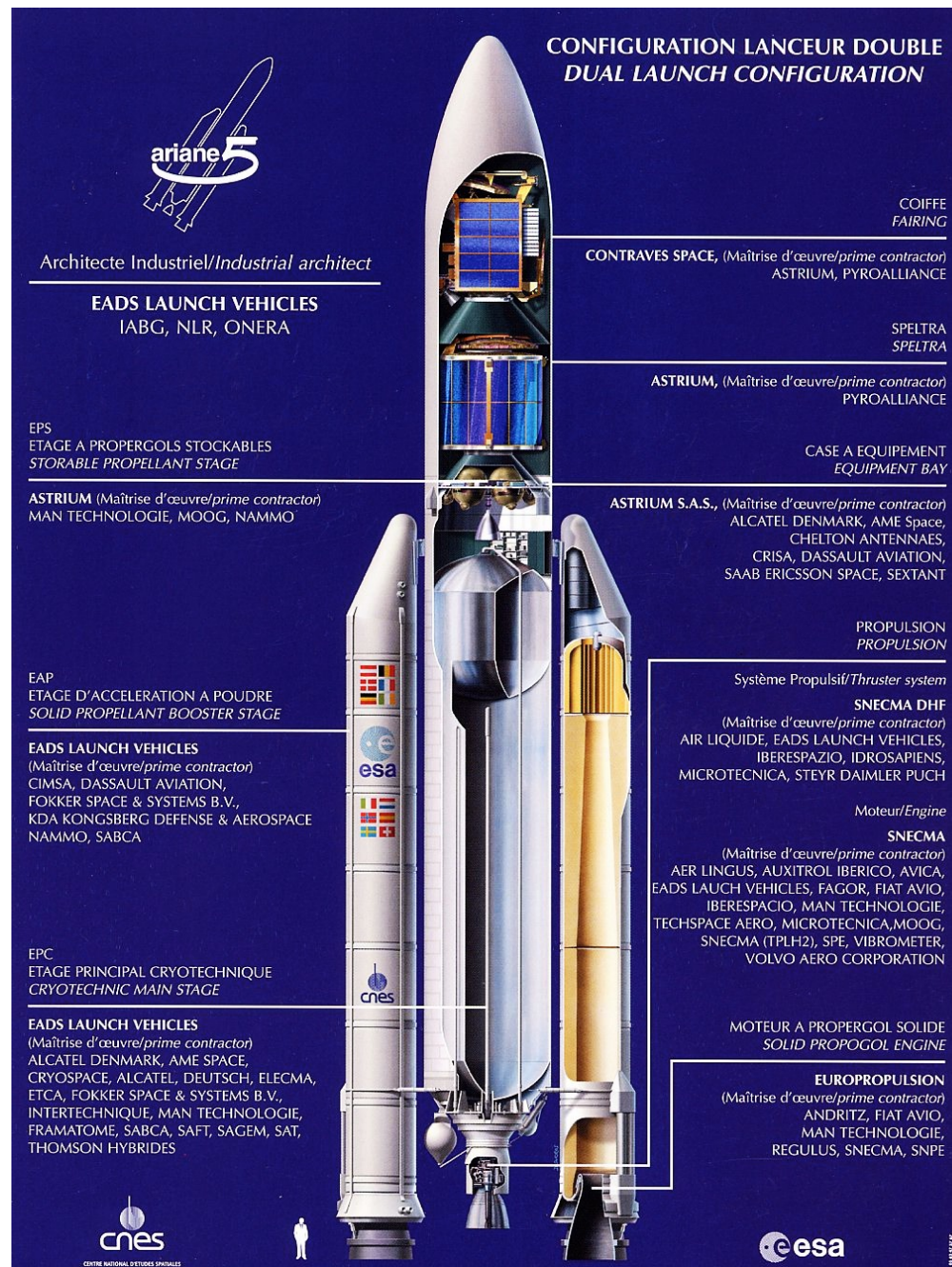
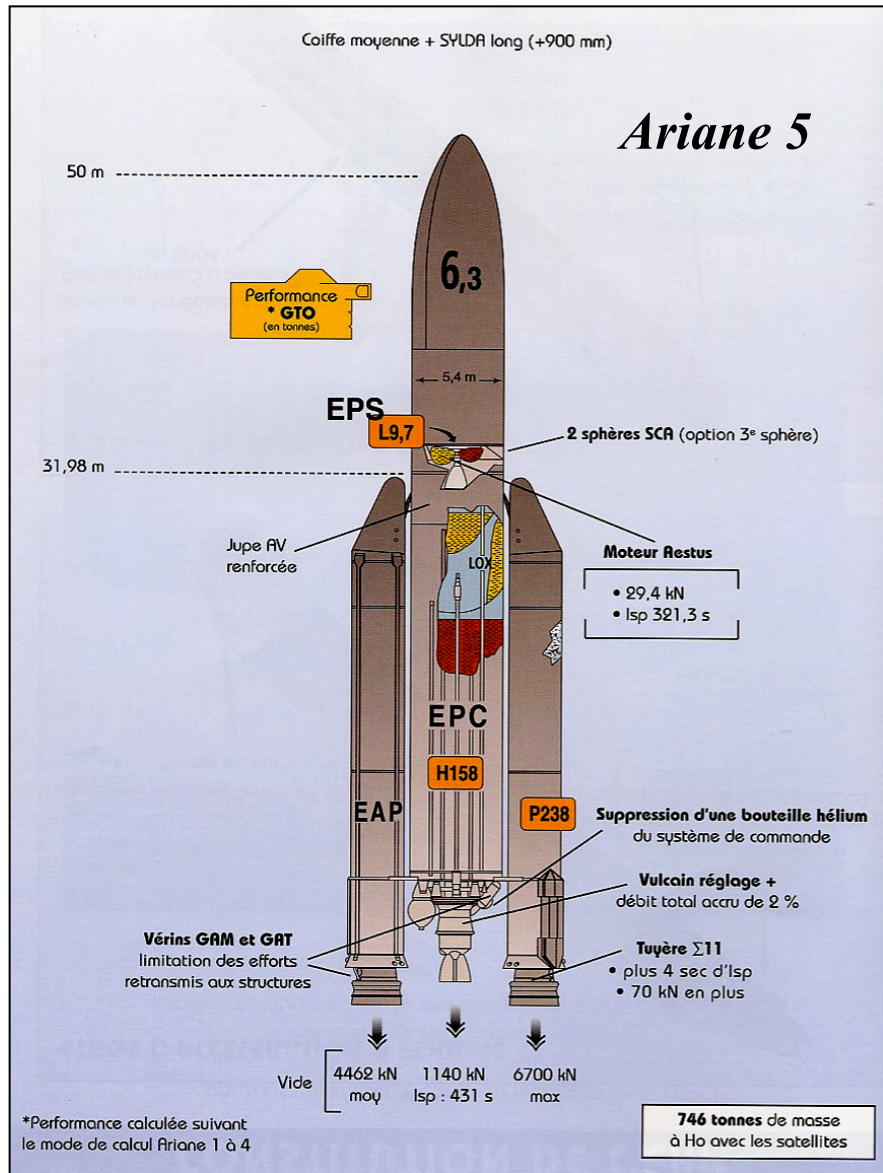
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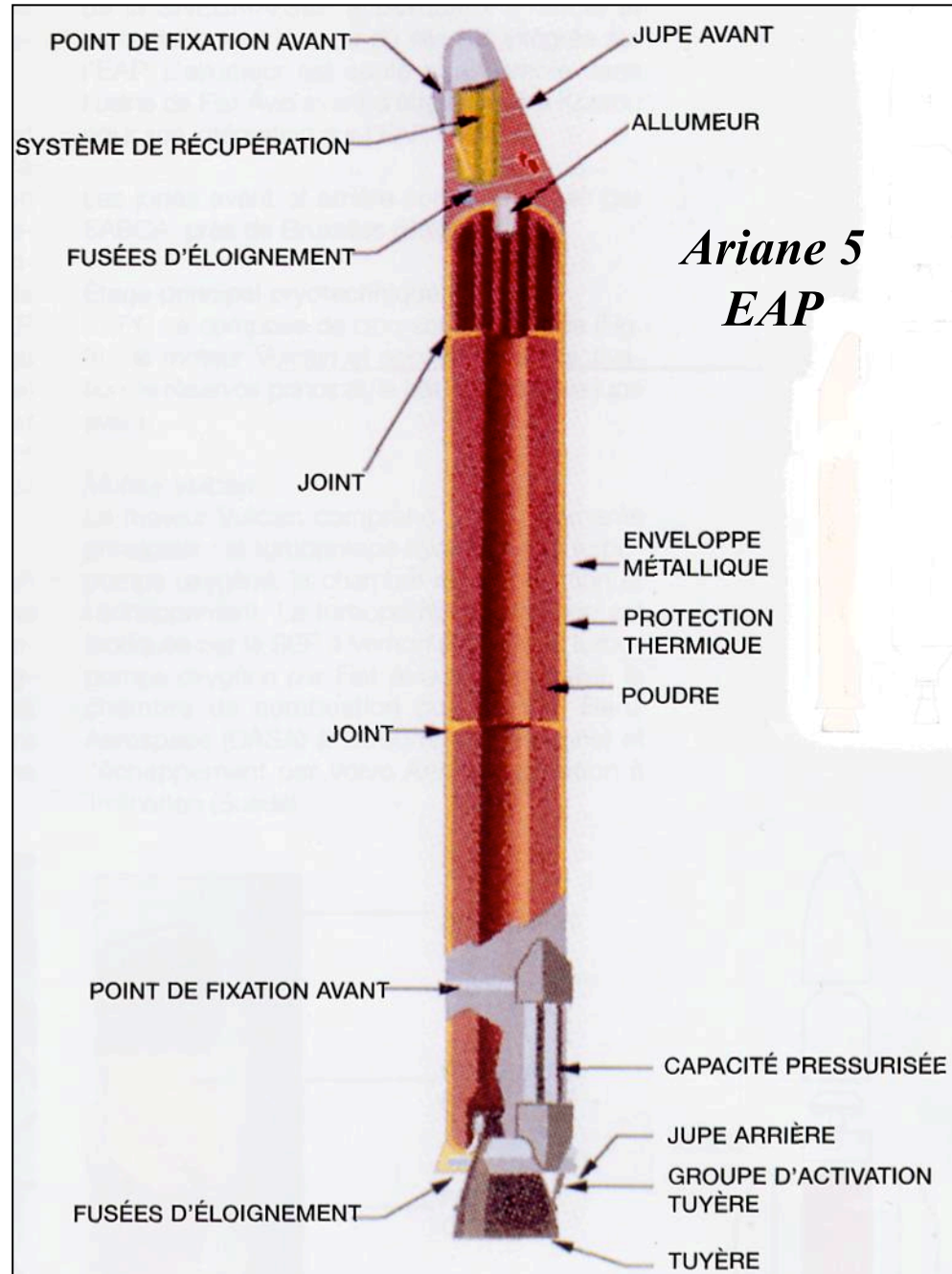
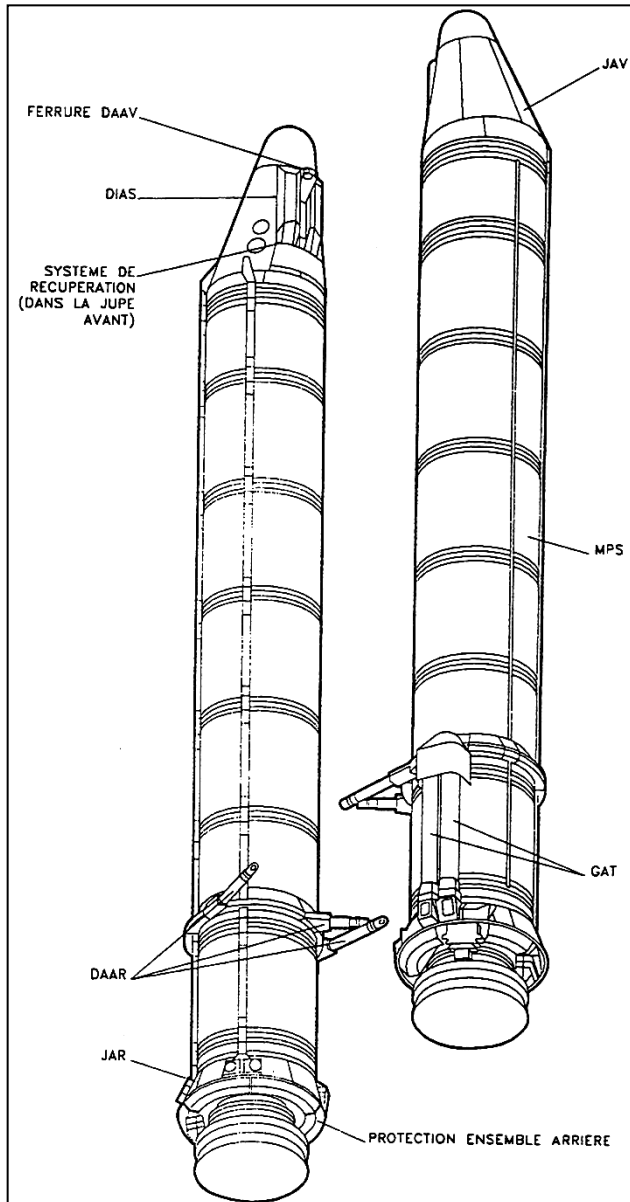


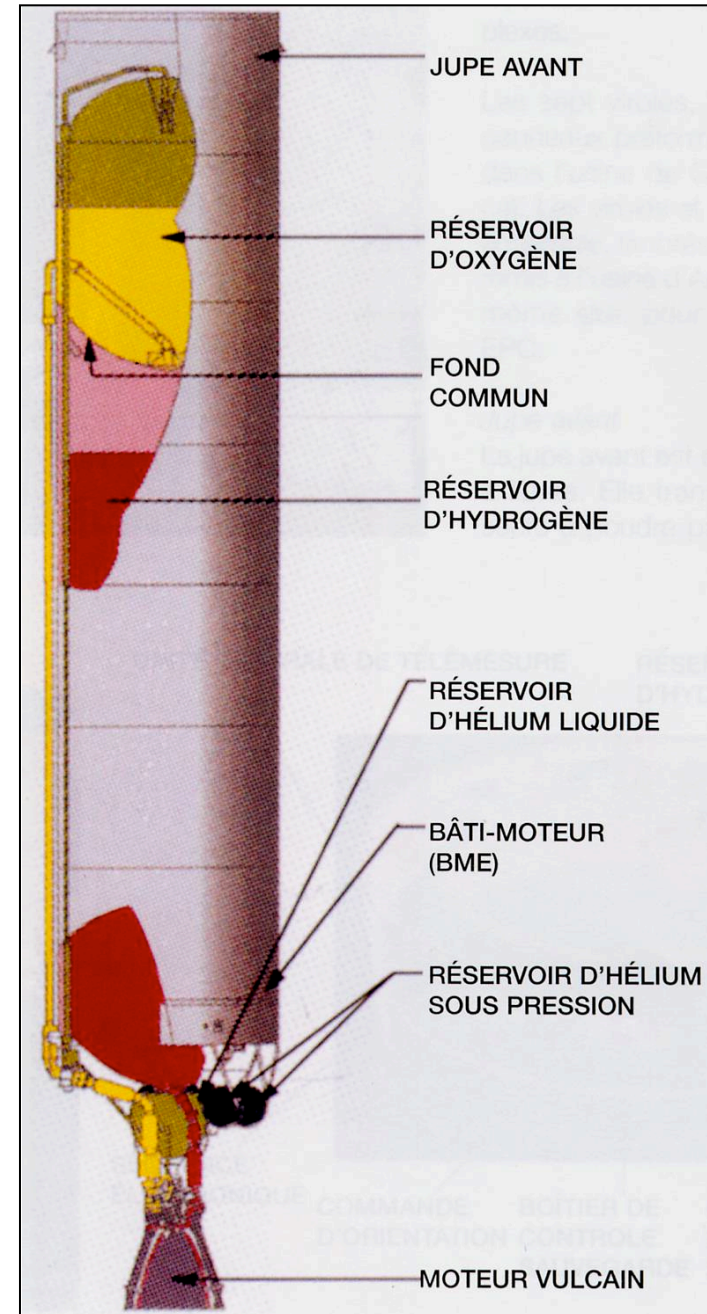
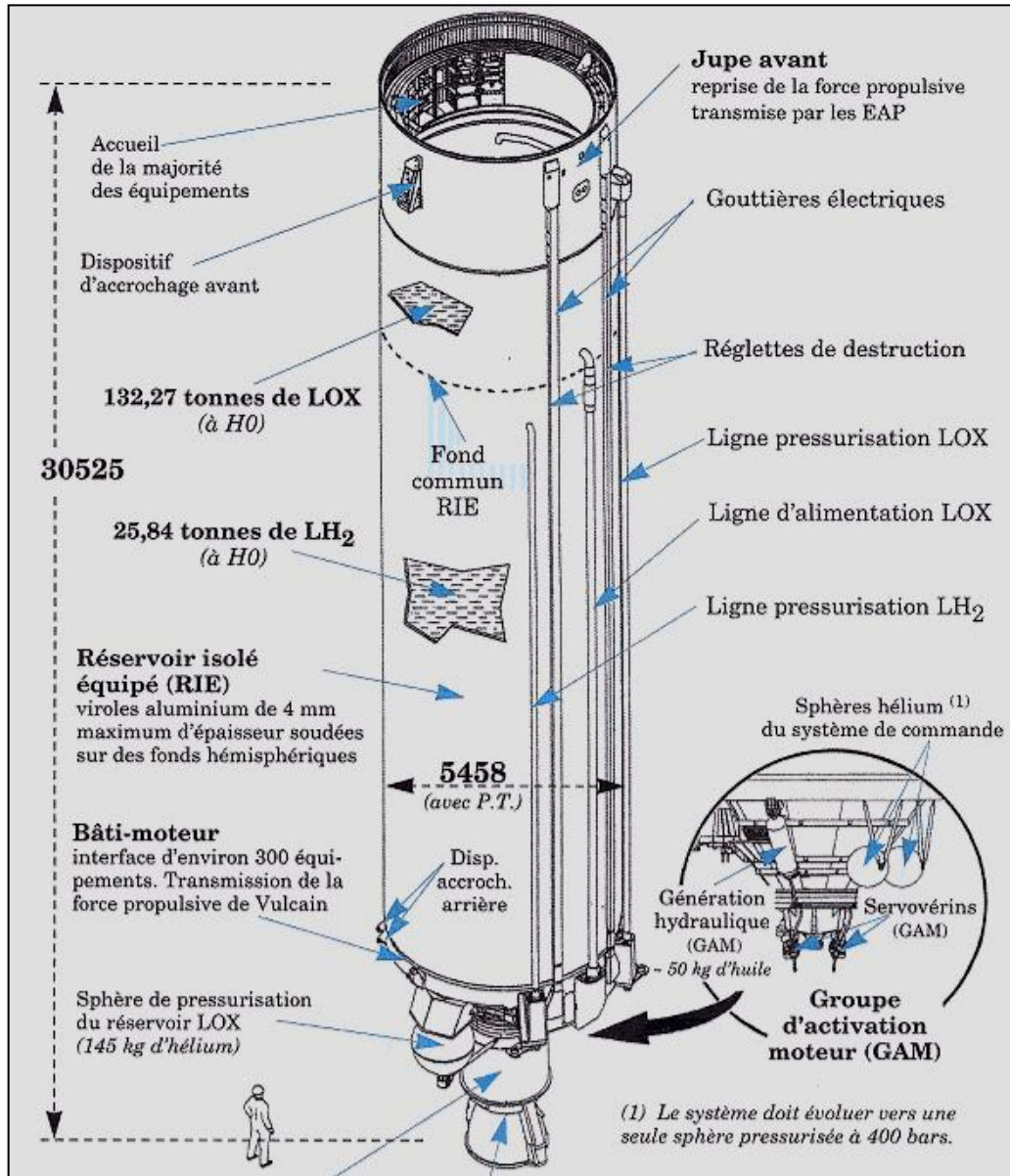
ESA Launcher Directorate

Ariane 4 and its Successor

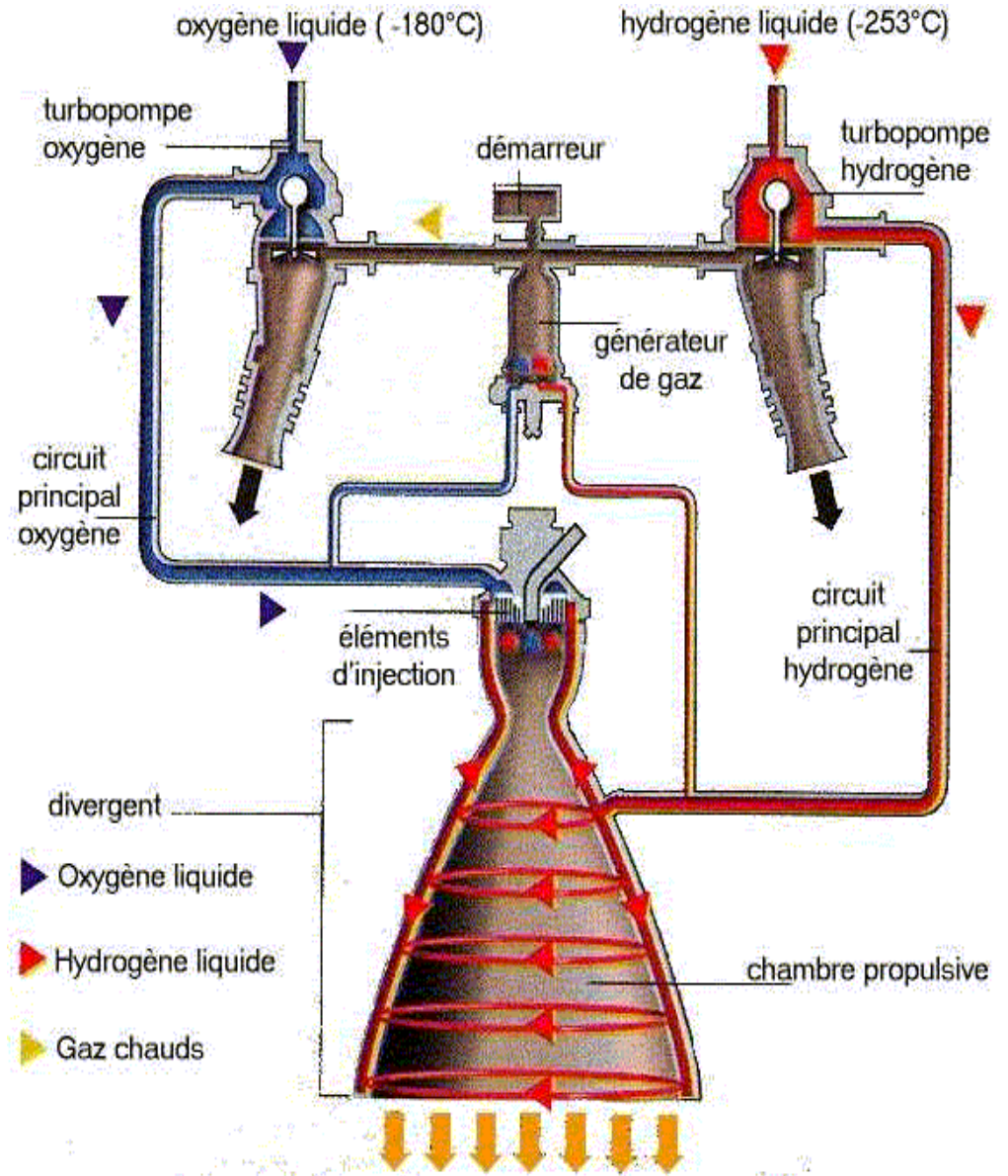
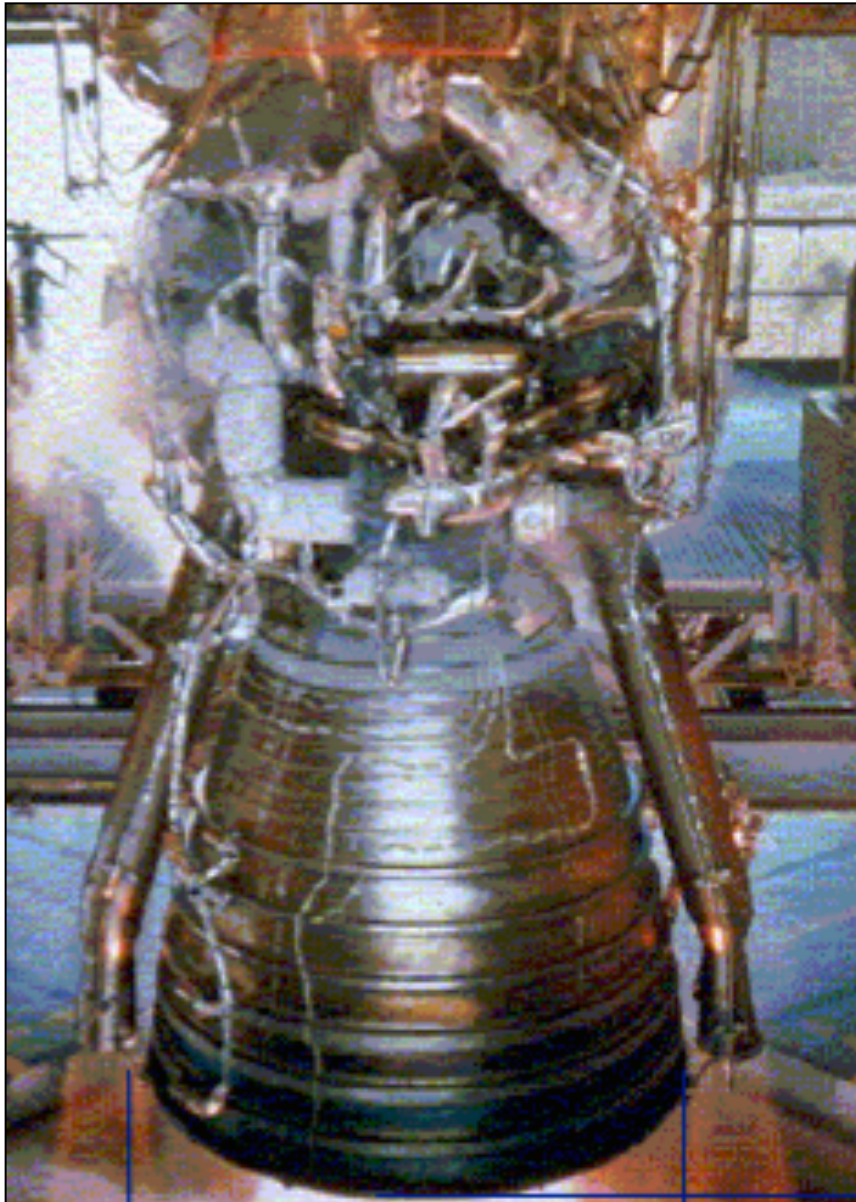


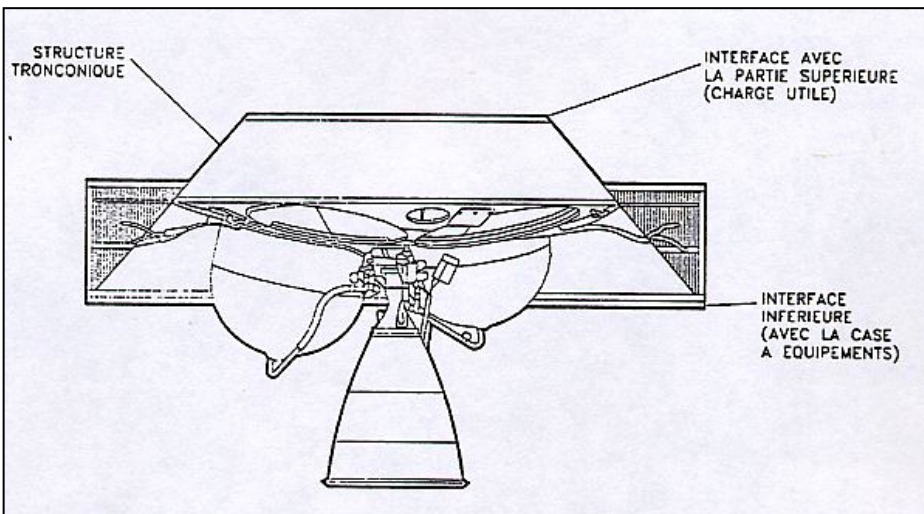
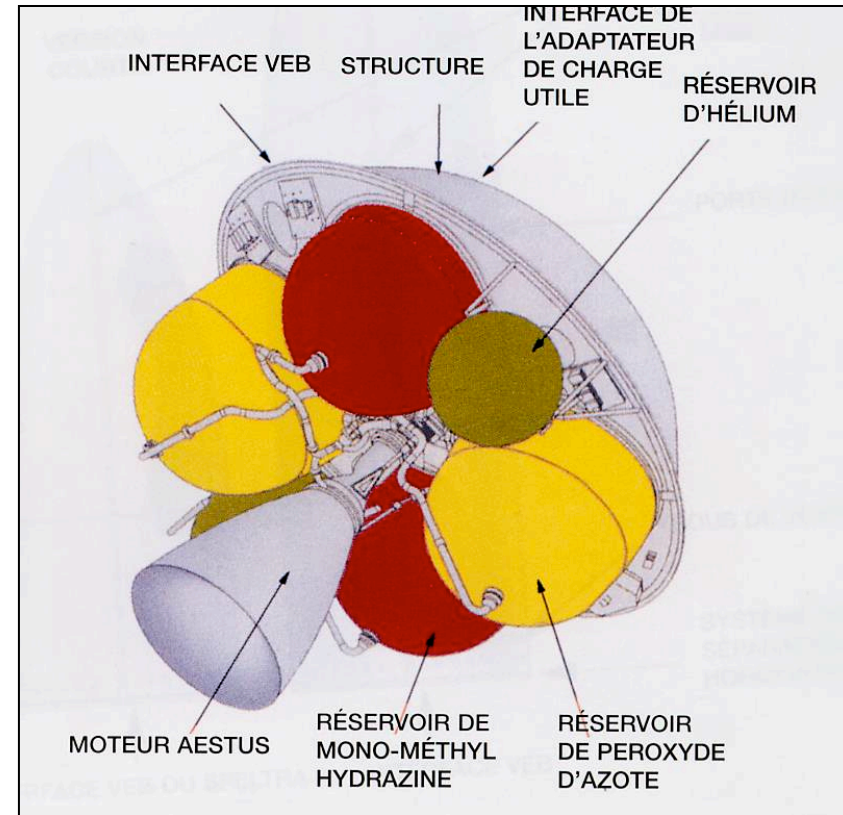
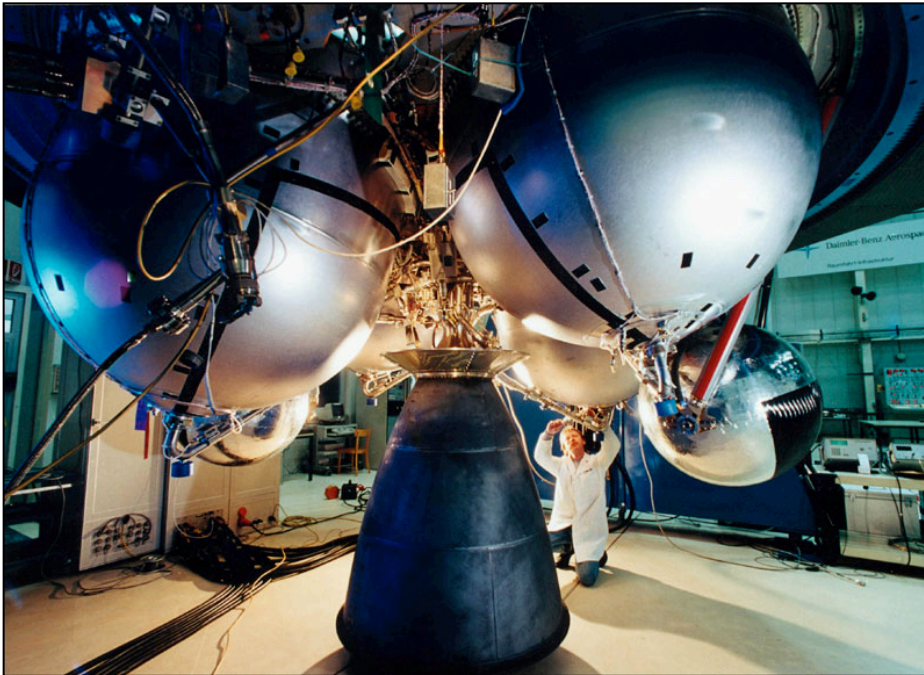






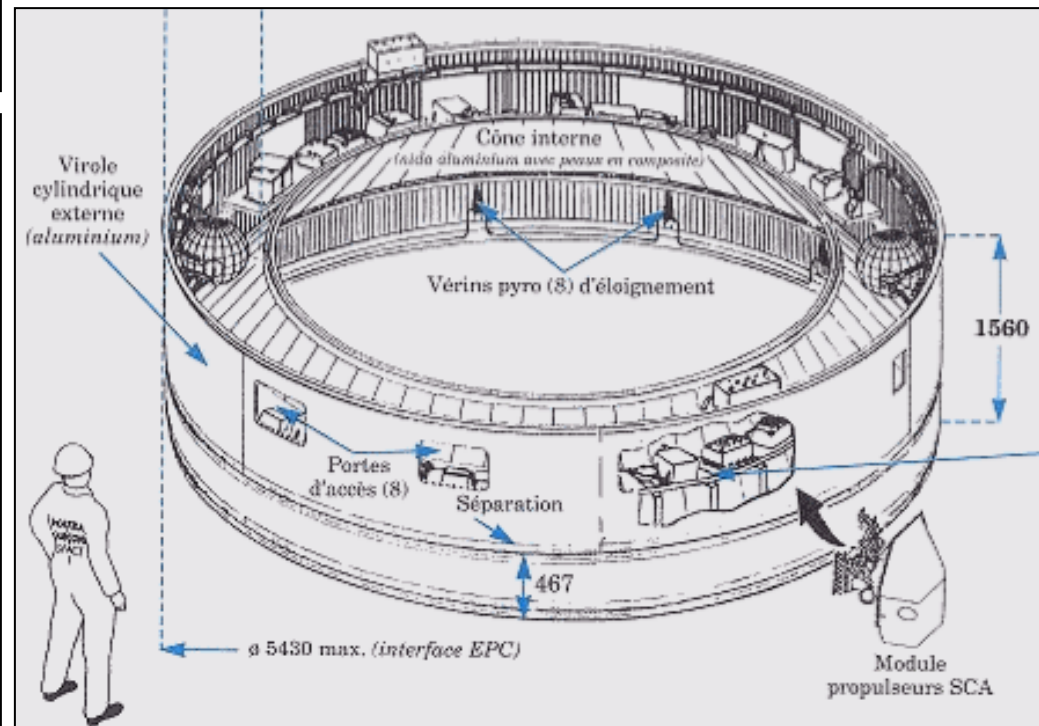
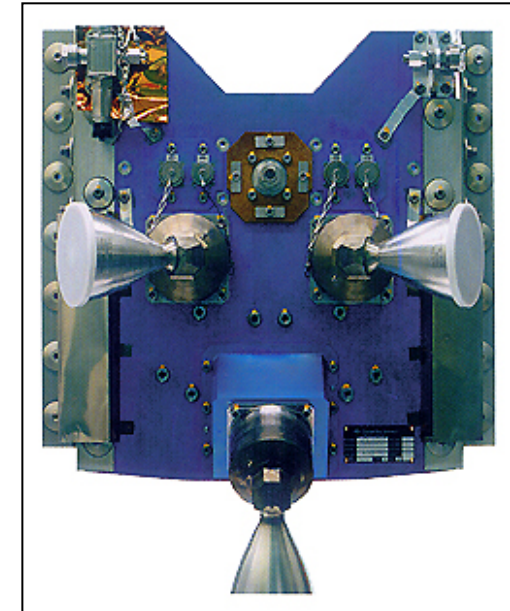
Ariane 5 - Vulcain 1



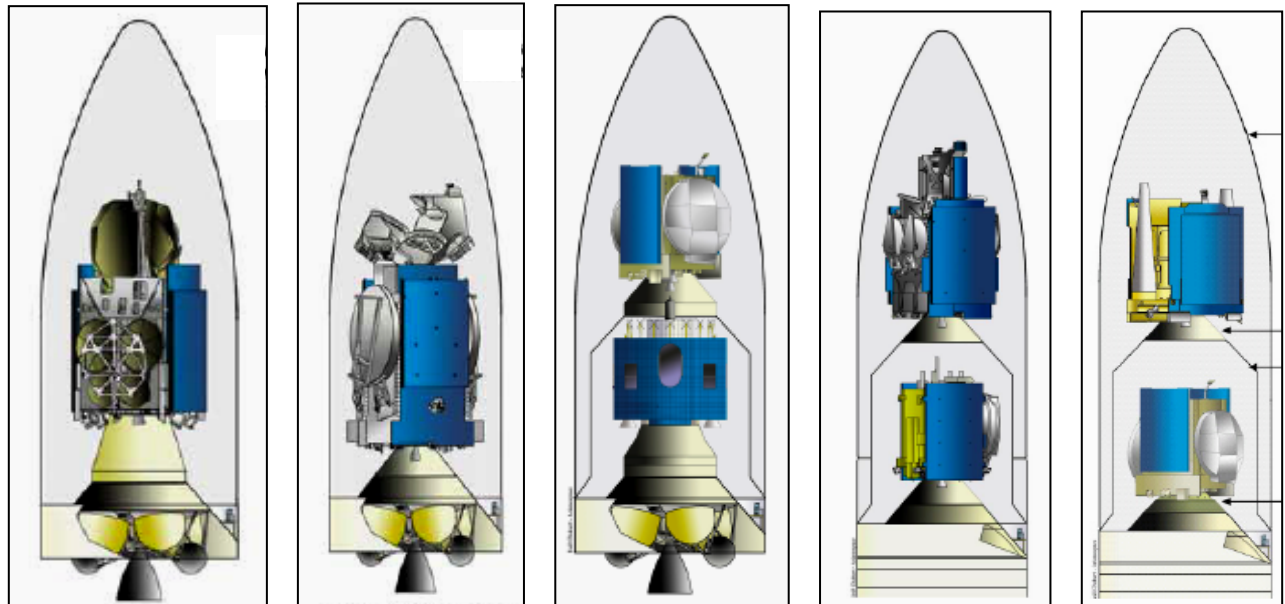
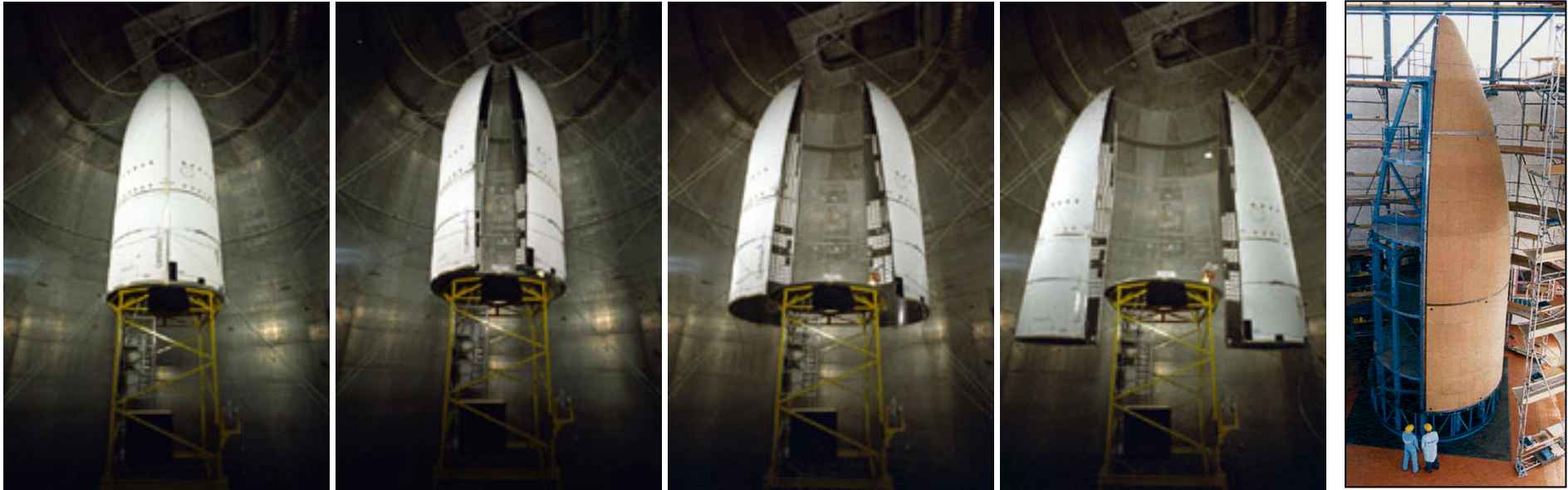




*Ariane 5 - VEB
Vehicle
Equipment
Bay with SCA*



Ariane 5 - SYLDA & Fairing



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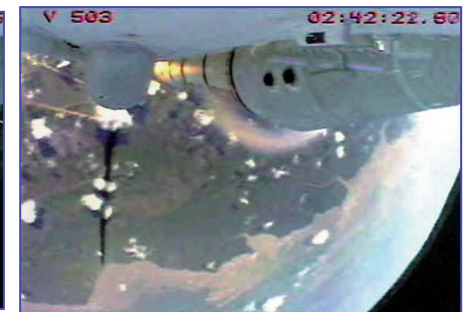
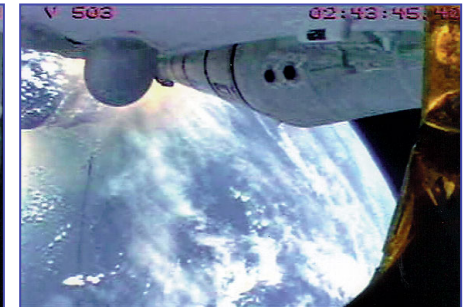
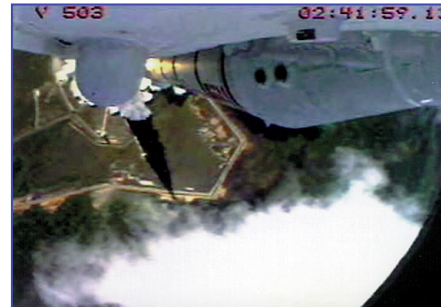
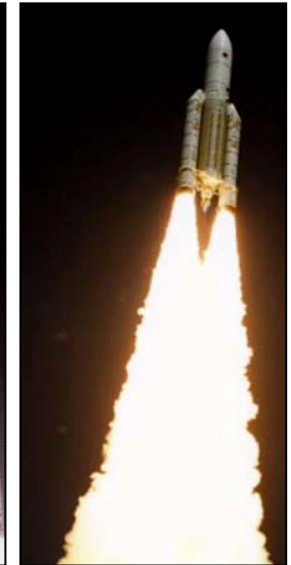
Ariane 5 - Flights



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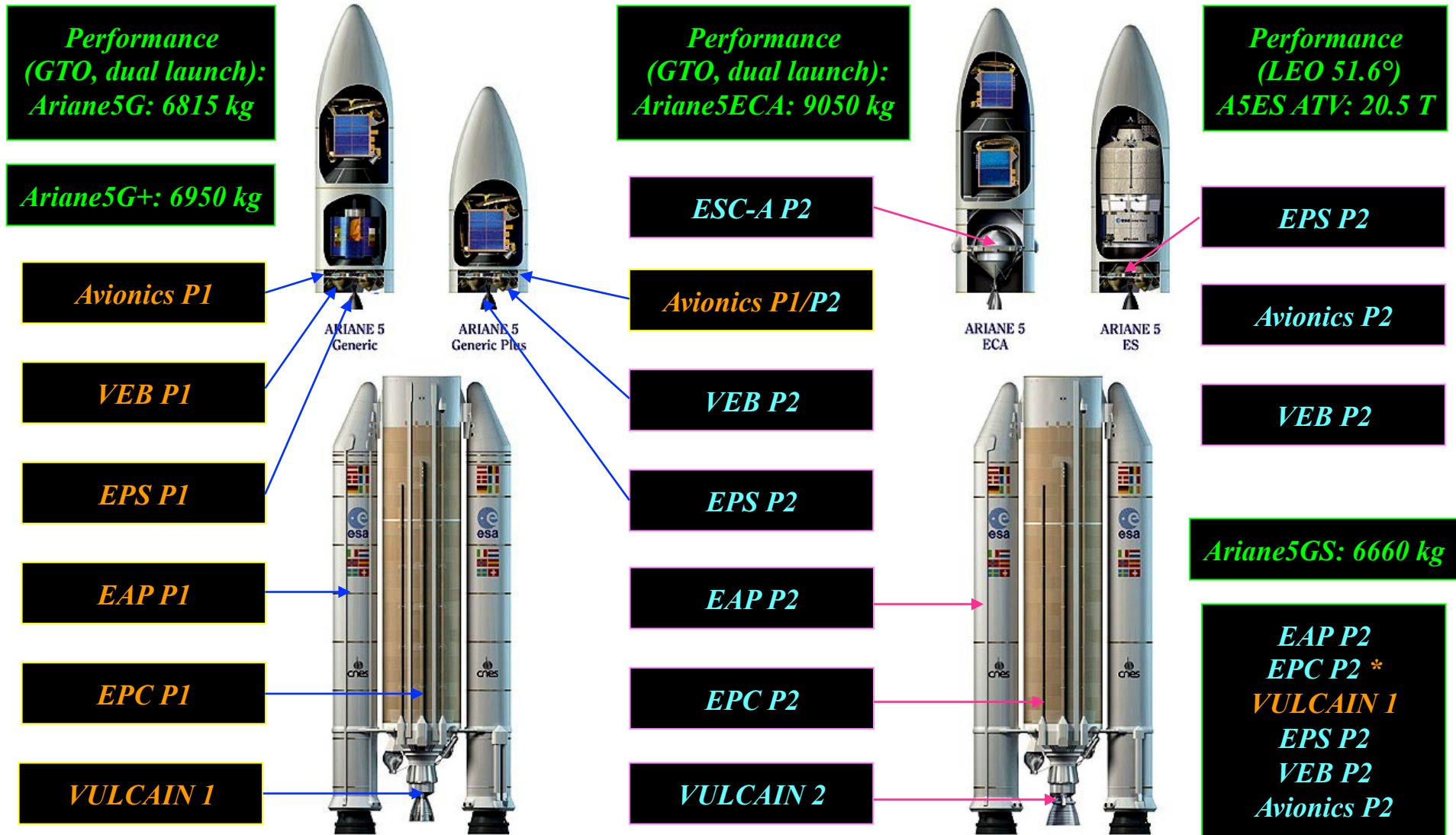


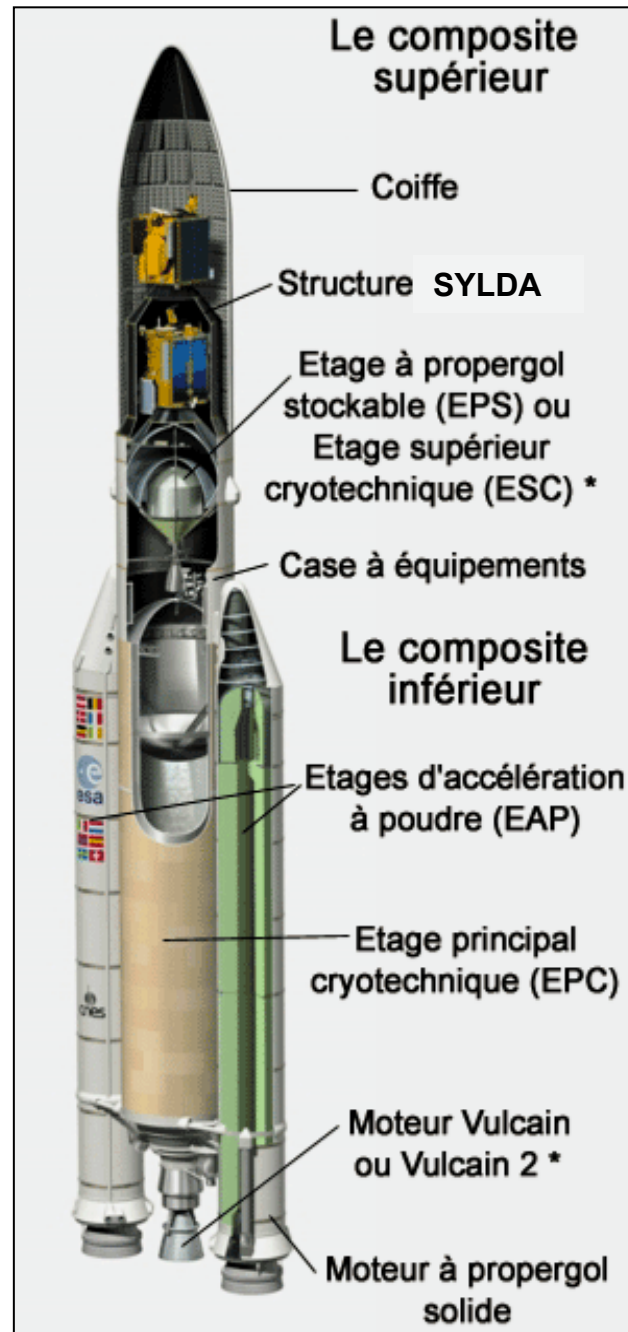
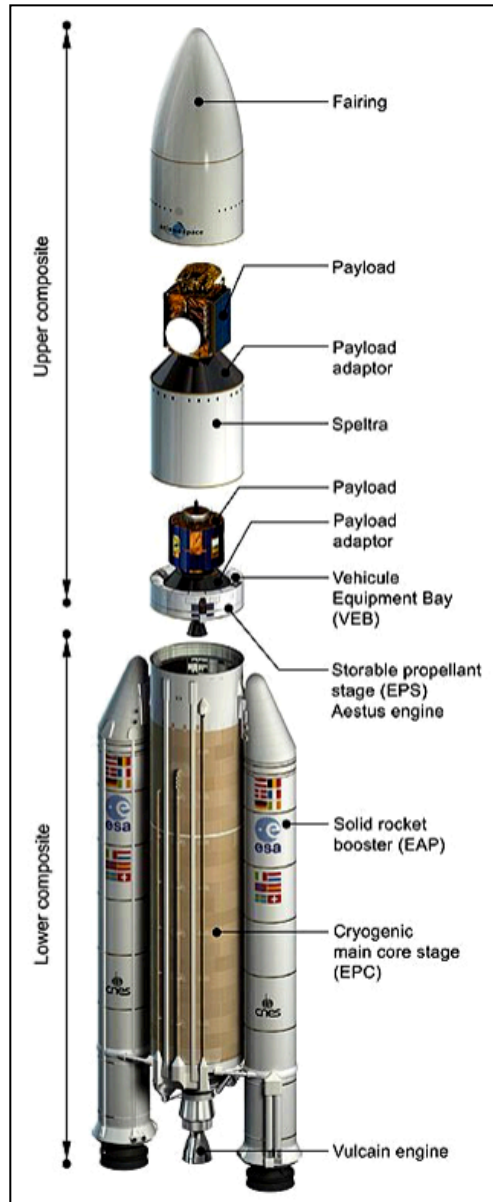
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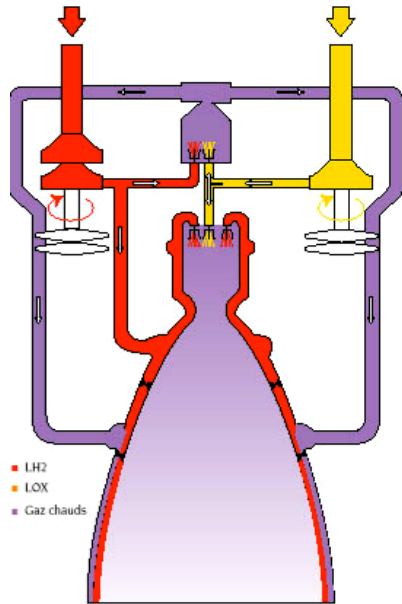


ESA Launcher Directorate

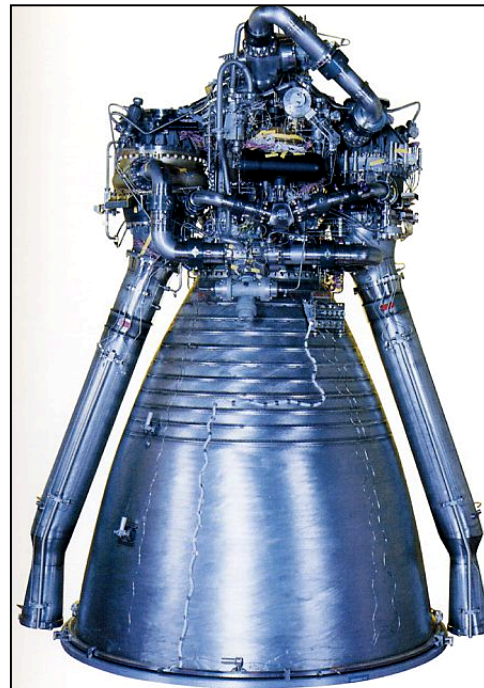
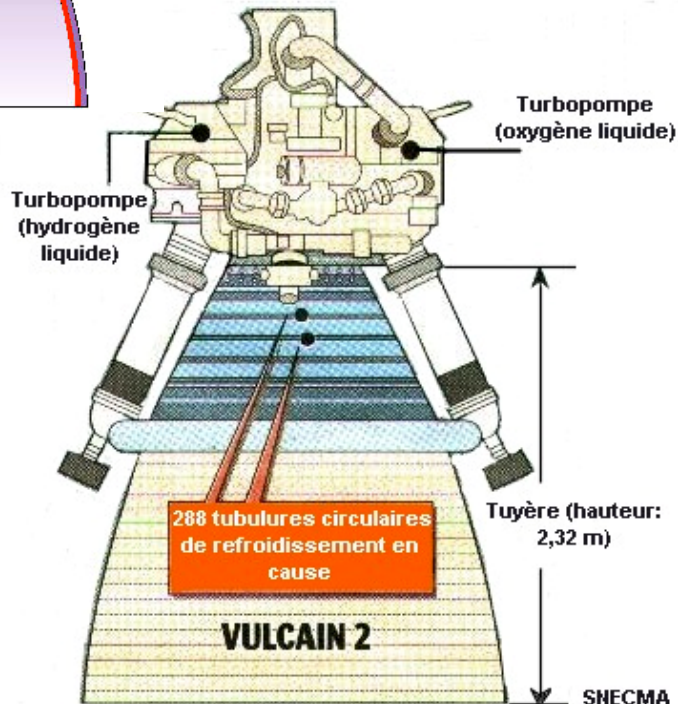
Ariane 5 Launcher Family Evolution







Ariane 5 Evolution From Vulcain 1 to Vulcain 2

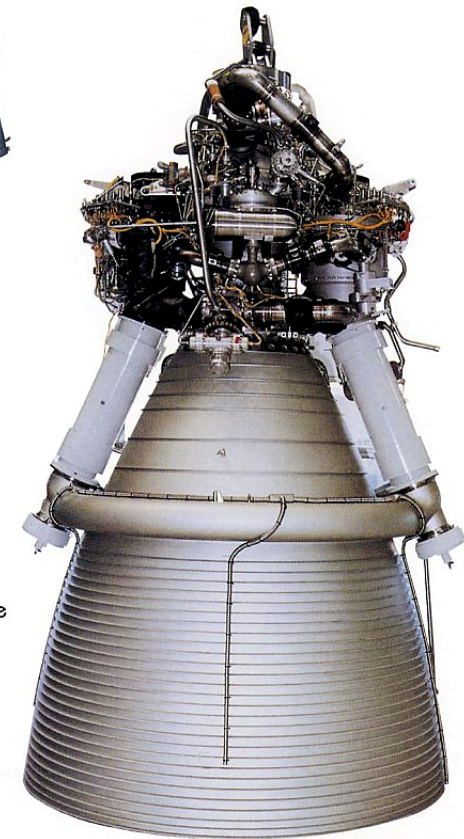


MOTEUR VULCAIN
(jusqu'en 2001)

Poussée : 1 140 kN
Impulsion spécifique : 431 s

MOTEUR VULCAIN 2
(en 2002)

Poussée : 1 355 kN (+20%)
 Impulsion spécifique : 433,7 s
 – Turbopompe LOX, 46% plus puissante
 – Nouvelle chambre simplifiée
 – Nouveau concept de divergent plus performant
 – Aménagement moteur simplifié





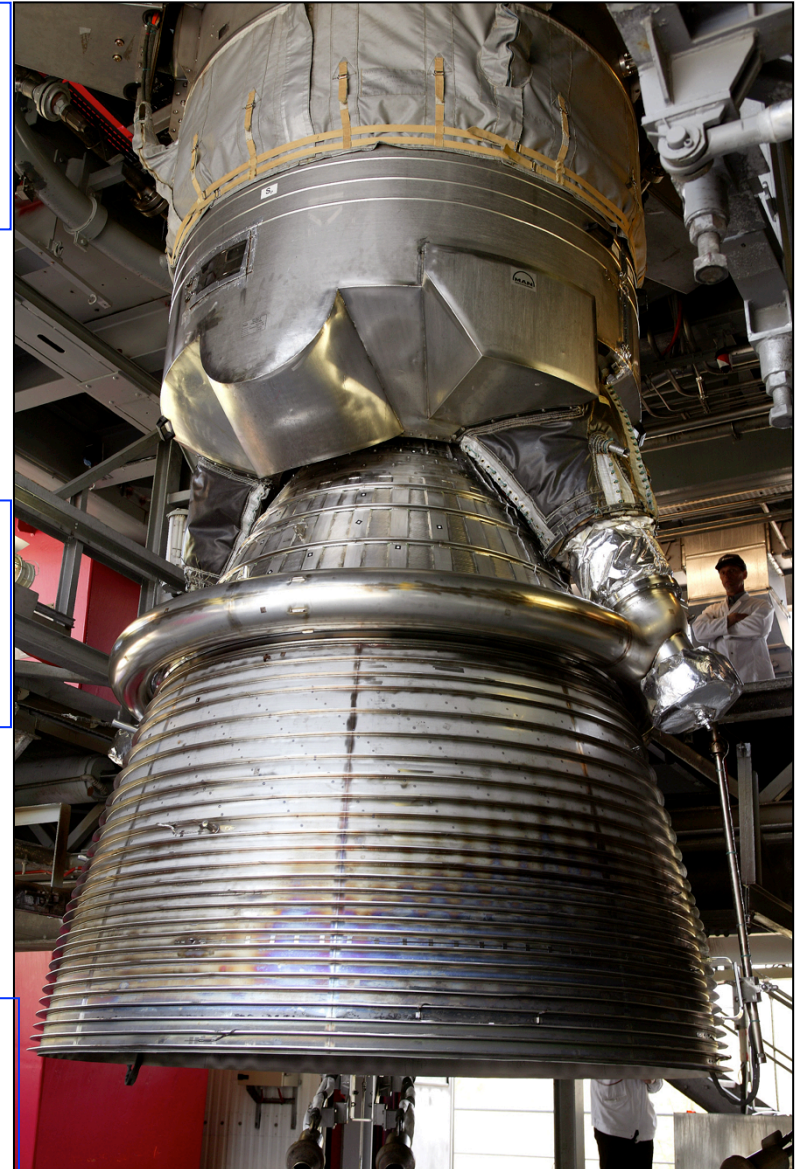
*EARLIER
VULCAIN 2
DESIGN*



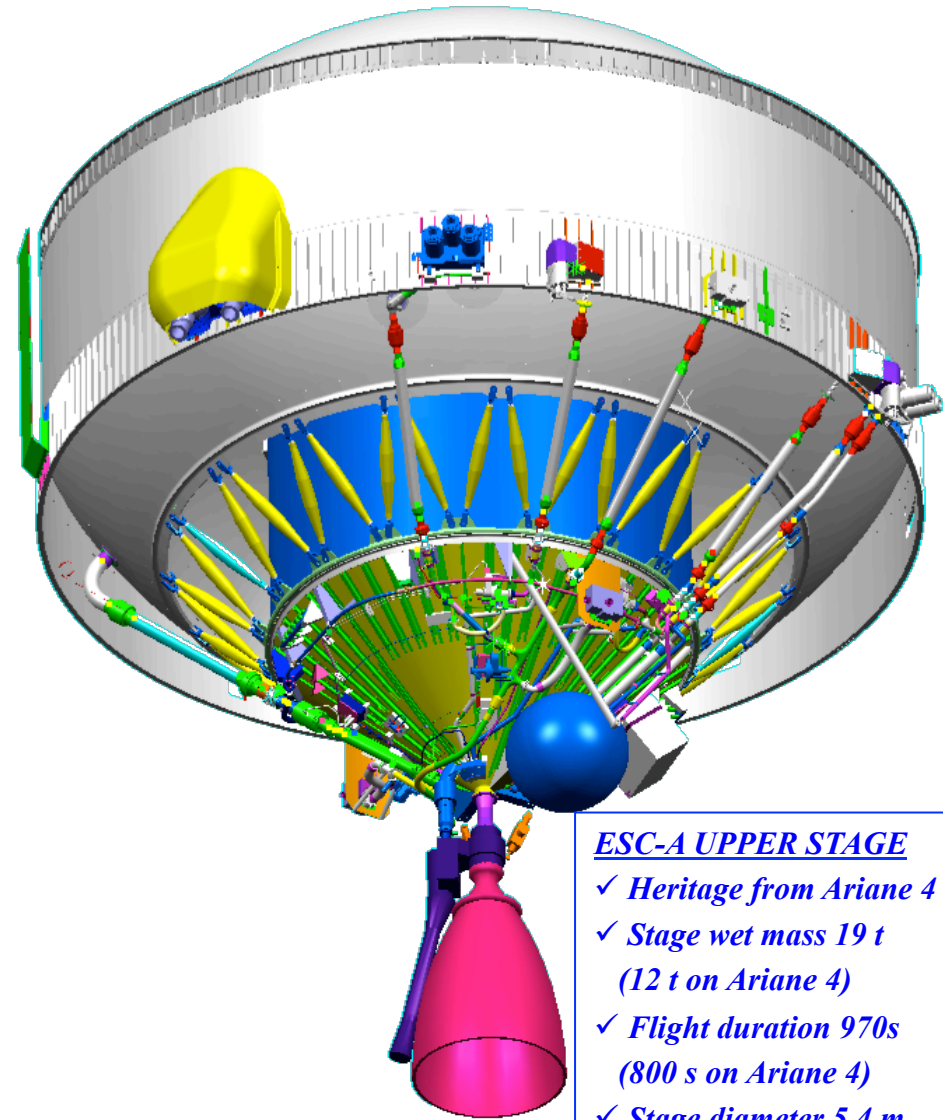
*REINFORCED
VULCAIN 2
DESIGN*



*VULCAIN 2 <> 1
THRUST GAIN
135 T <> 115 T*



Ariane 5 Evolution - New ESCA Upper Stage



- ESC-A UPPER STAGE**
- ✓ Heritage from Ariane 4
 - ✓ Stage wet mass 19 t
(12 t on Ariane 4)
 - ✓ Flight duration 970s
(800 s on Ariane 4)
 - ✓ Stage diameter 5.4 m
(2.6 m on Ariane 4)

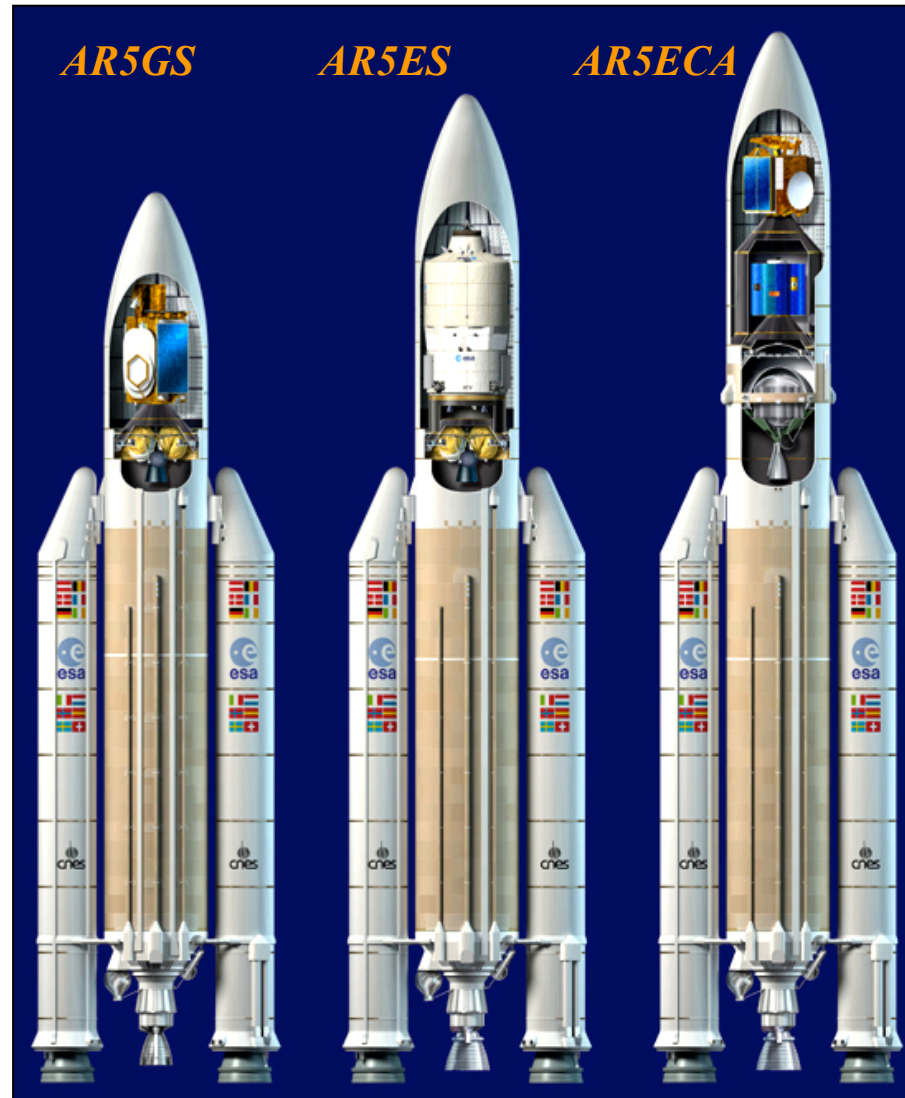
ARIANE 5 ECA
LAUNCH
ROM DATA

- *EAP Mass : 560 T*
- *Thrust : 2 * 650 T*

- *EPC Mass : 188 T*
- *Thrust : 135 T*

- *ECA+VEB : 20 T*
- *Thrust : 6.6 T*

- *LO Mass : 780 T*
- *LO Thrust: 1400 T*



ARIANE 5 ECA
LAUNCH SEQUENCE

- *H0 : Vulcain2 Ignition*
- *H0 + 00:00:07
EAP Ignition*

- *H0 + 00:02:21
EAP Separation*

- *H0 + 00:03:09
Fairing Jettisoning*

- *H0 + 00:08:53
EPC Separation*

- *H0 + 00:08:57
ESC-A Ignition*

- *H0 + 00:24:47
ESC-A Injection*

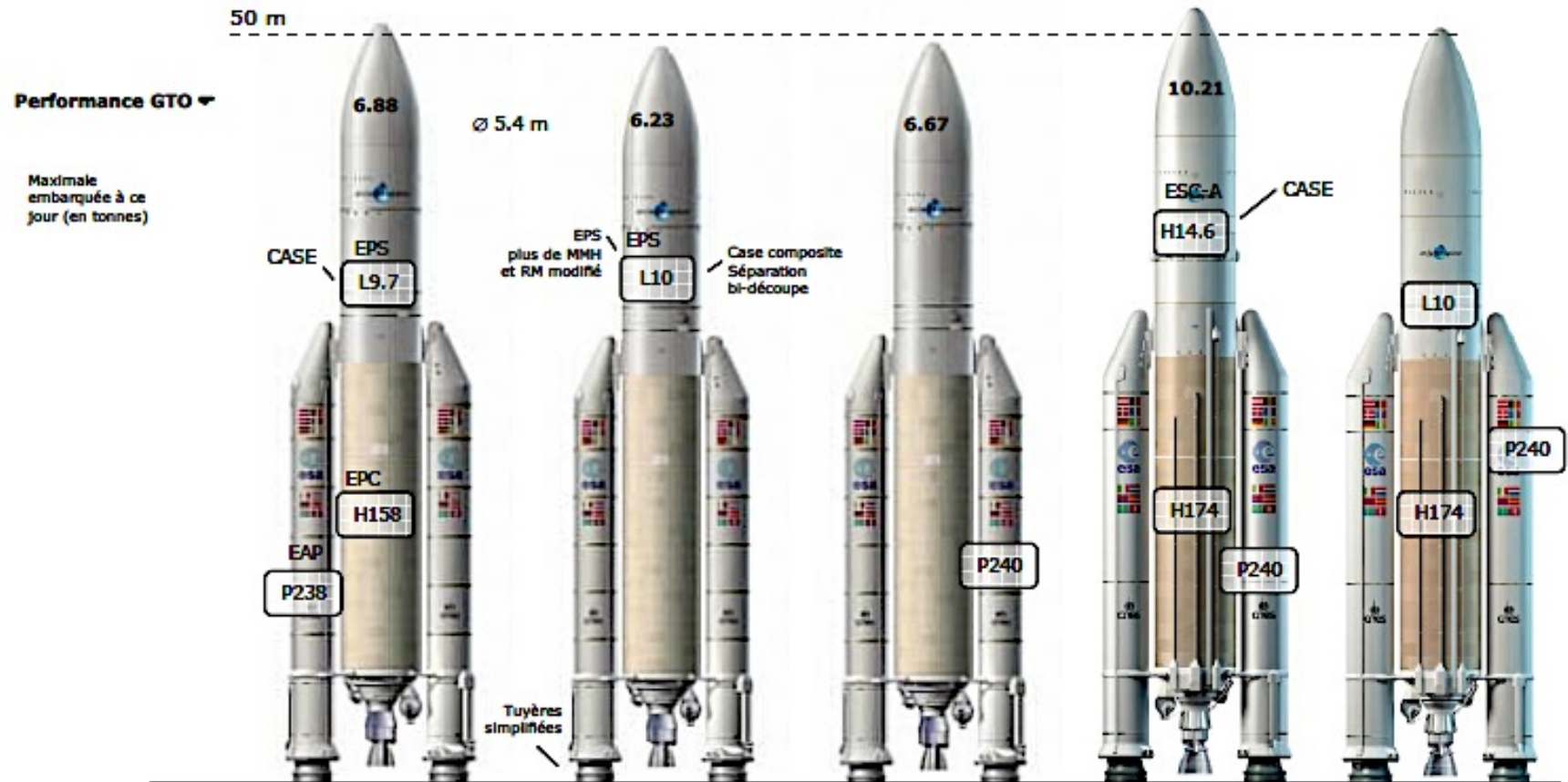






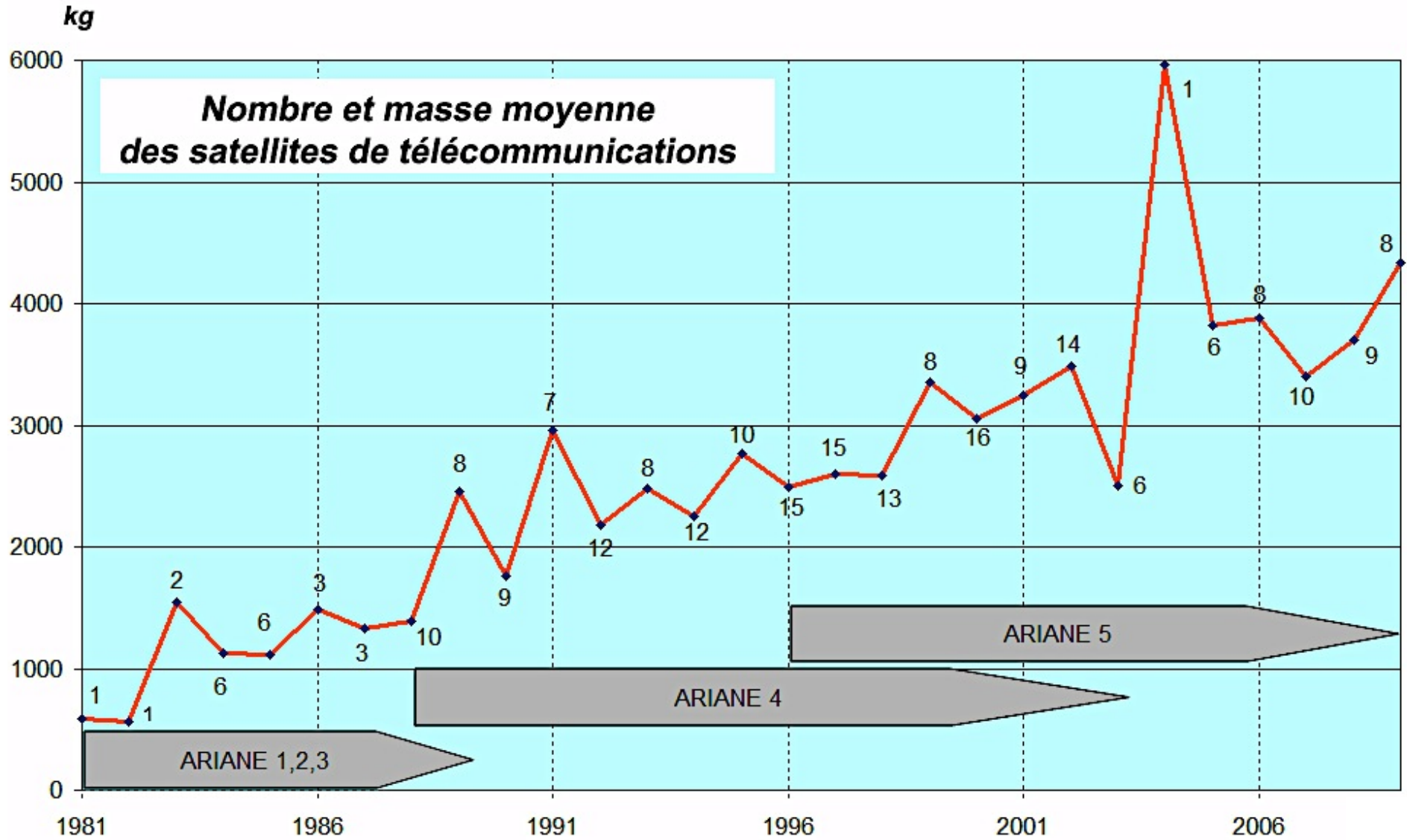
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Ariane 5 Versions



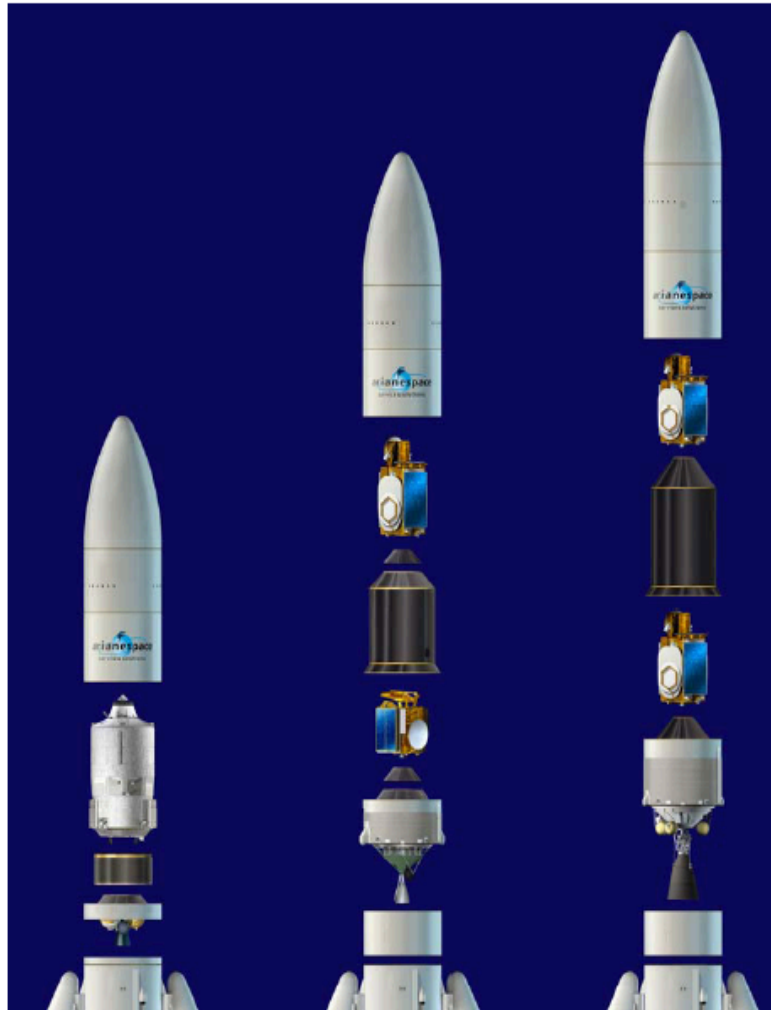
Ariane	ASG	ASX+	ASXS	SECA	A5ES/ATV
Années d'exploitation	1996-03	2004	2005-2009	2002-2012	2008-2012
Mise en œuvre	16 ex	3 ex	6 ex	38 ex	3 ex
Hauteur suivant PH	46.07 à 51.73 m	46.27 à 47.36 m	47.36 à 47.37 m	53.65 à 54.83 m	50.55
Masse à H0	747 t	747 t	752 T	780 t	777 t
Poussée au décollage	12000 kN	12000 kN	12000 kN	13000 kN	13000 kN
	Rupture de la filière avec ce nouveau concept Modèle de base ASG dit « Générique »	Initialement développé pour assurer la transition ASG → A5ECA	Décidé à la suite de l'échec 517, il utilise un EPC renforcé ECA dont le fond commun est adapté au rapport de mélange Vulcain 1, ainsi que 2 EAP ECA. L'ASGS doit permettre de couvrir la période de mise en place opérationnelle de l'A5ECA	Ariane 5 repensé pour obtenir les 10 tonnes en GTO	Ariane 5 équipée d'un EPS rallumable. Version basée sur la partie basse d'une A5ECA et sur un EPS de type G+.

Ariane 5 Market Evolution



Ariane-5 Launcher Configurations

Ariane-5 Upper Part Configurations



A5-ES

A5-ECA

A5-ME

EPS / Aestus

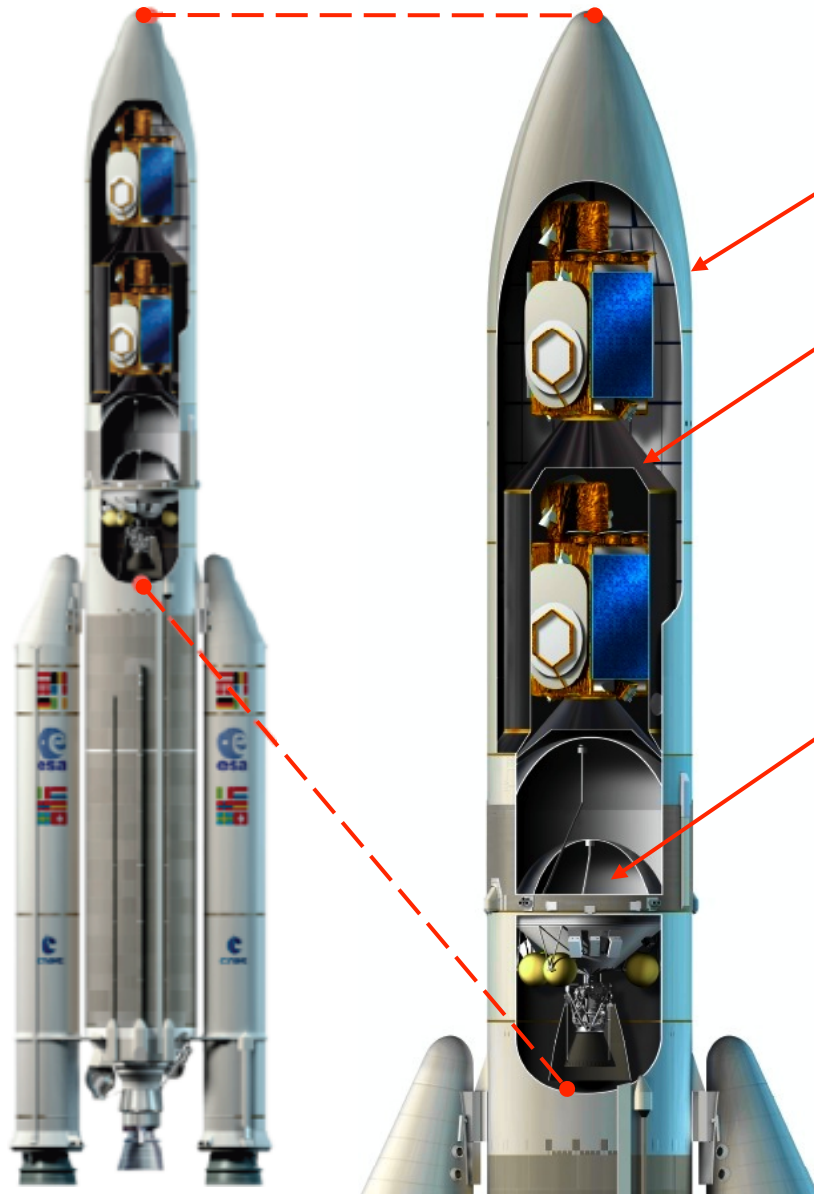
ECA / HM7-B

ME / VINCI

- About 100+ European upper stages, launched in the last two decades, will de-orbit to earth in the coming ten to twenty years, without any control.
- Debris can reach the Earth surface, as illustrated again in February 2012 by the impact in Brazil of an Ariane 4 upper stage helium tank.
- Controlled de-orbiting will become a must. The versatility offered by Adapted A5ME's new upper stage is a key element for better protection of space and earth environment.



Adapted ARIANE-5 ME Configuration



New Payload Fairing (20m)

New Very long Syllda (8 m)

New generation On Board Computer (OBC) & Modernized avionics

**New Cryogenic Upper Stage
Vinci engine (180 kN)
With Deployable Nozzle
Propellants: 28 t (LH2 & Lox)
Common Bulkhead Design**

**Lower Composite (EAP & EPC)
Identical to A5ES & A5ECA**

Launch Base: Reused of ELA3



New

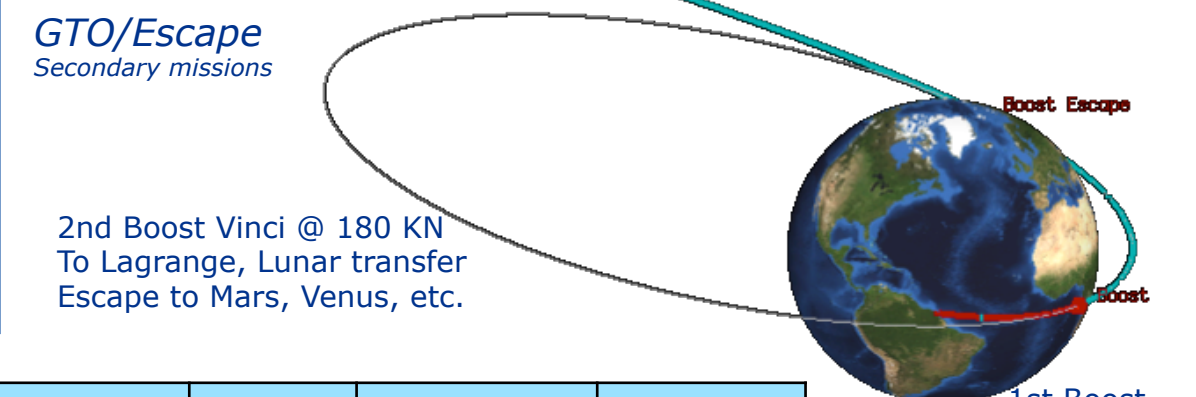
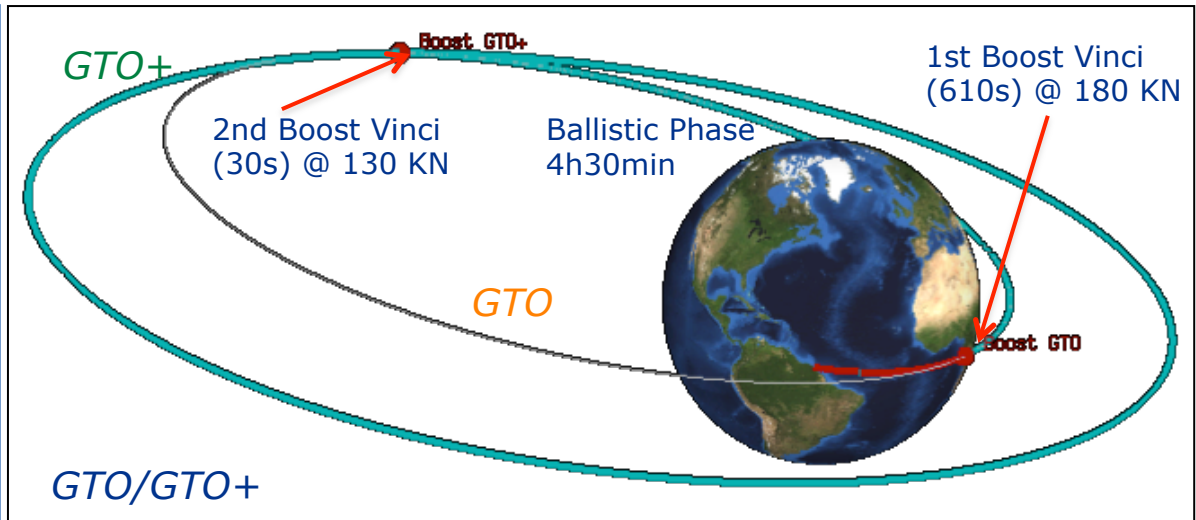
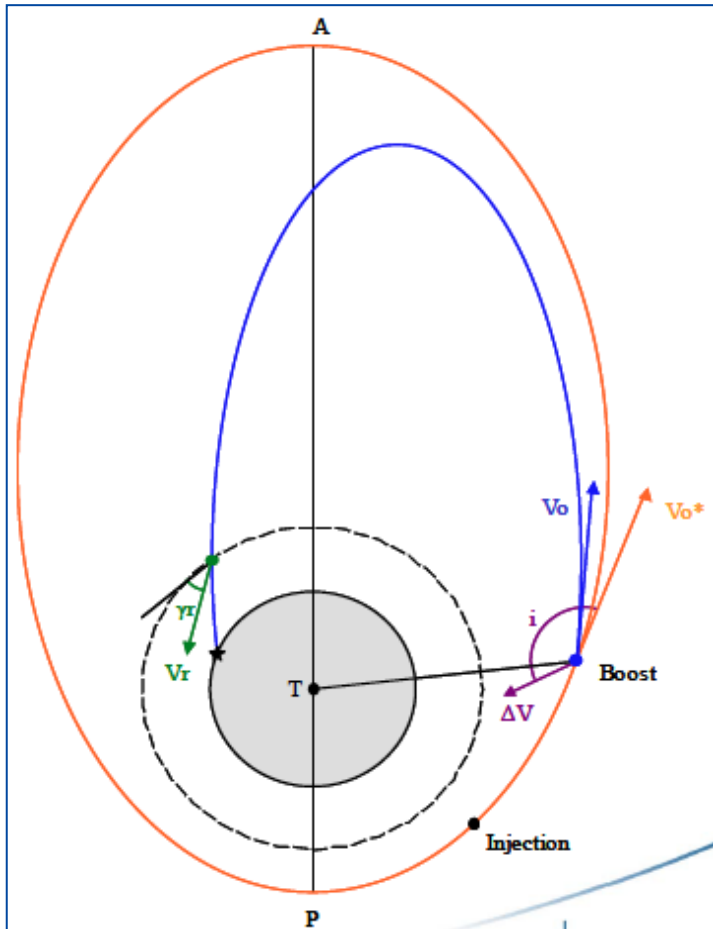


Existing



**Upper Composite
in Ballistic Phase**

Extension of Ariane-5 Missions Domain



Missions	Apogee	Perigee	Incl.	Remarks	Perfo.
GTO/GTO	35.286/36.286 km	180/250 km	0°- 6°	Both S/C	12.0 T +
GTO/DDO *	35.286/36.286 km	180/250 km	0°- 6°	* De-orbiting	11.5 T +
GTO/GTO+	35.286/36.286 km	5.850/7.550 km	0°- 6°	Lower S/C	8.6 T +

Introduction of Ariane-6 (2012)



Marc Toussaint – ESA HQ-D



4 Solid P135 Boosters
3 for 1st Stage, 1 for 2nd Stage



PPH Configuration



Single Payload / Higher Launch Rate
Performance: 3 to 6.5 T GTO
New Ground Segment (Launch Pad)
New Production Facilities

Introduction of Ariane-6 (2012)



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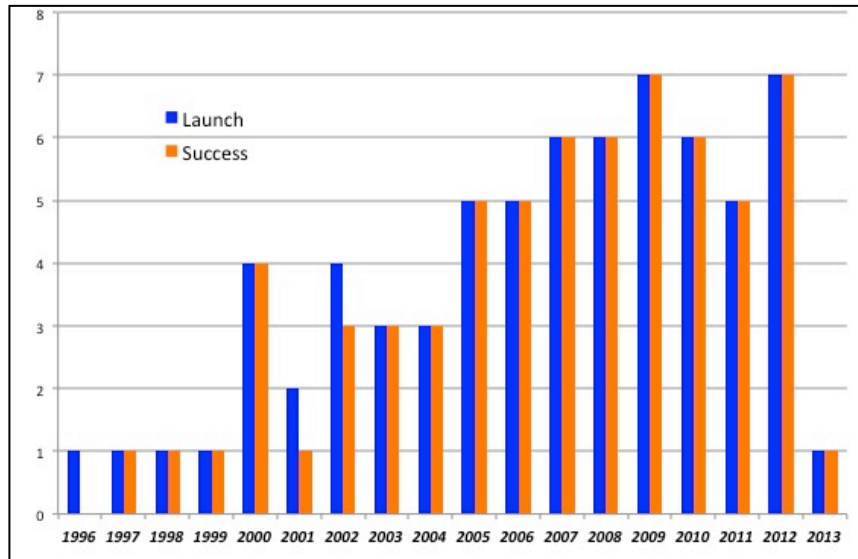
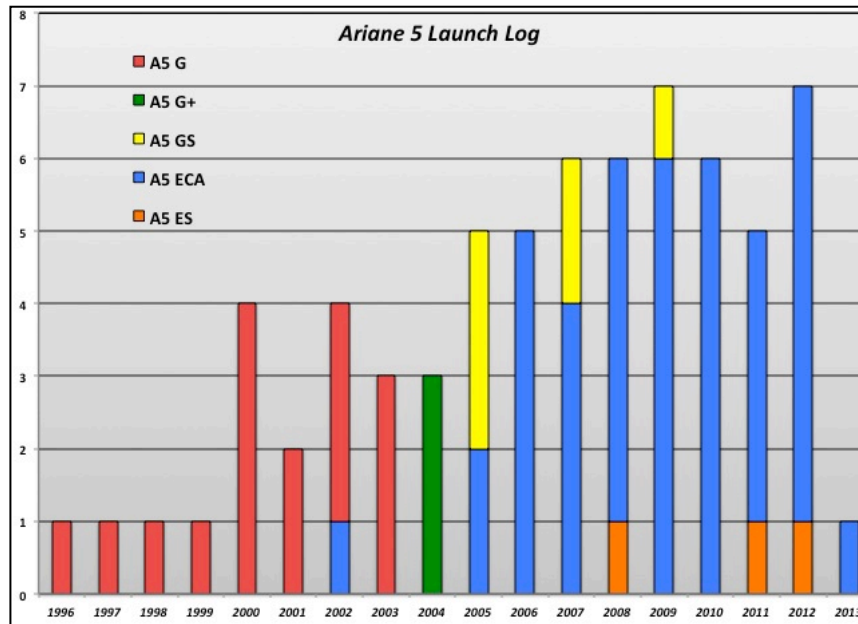


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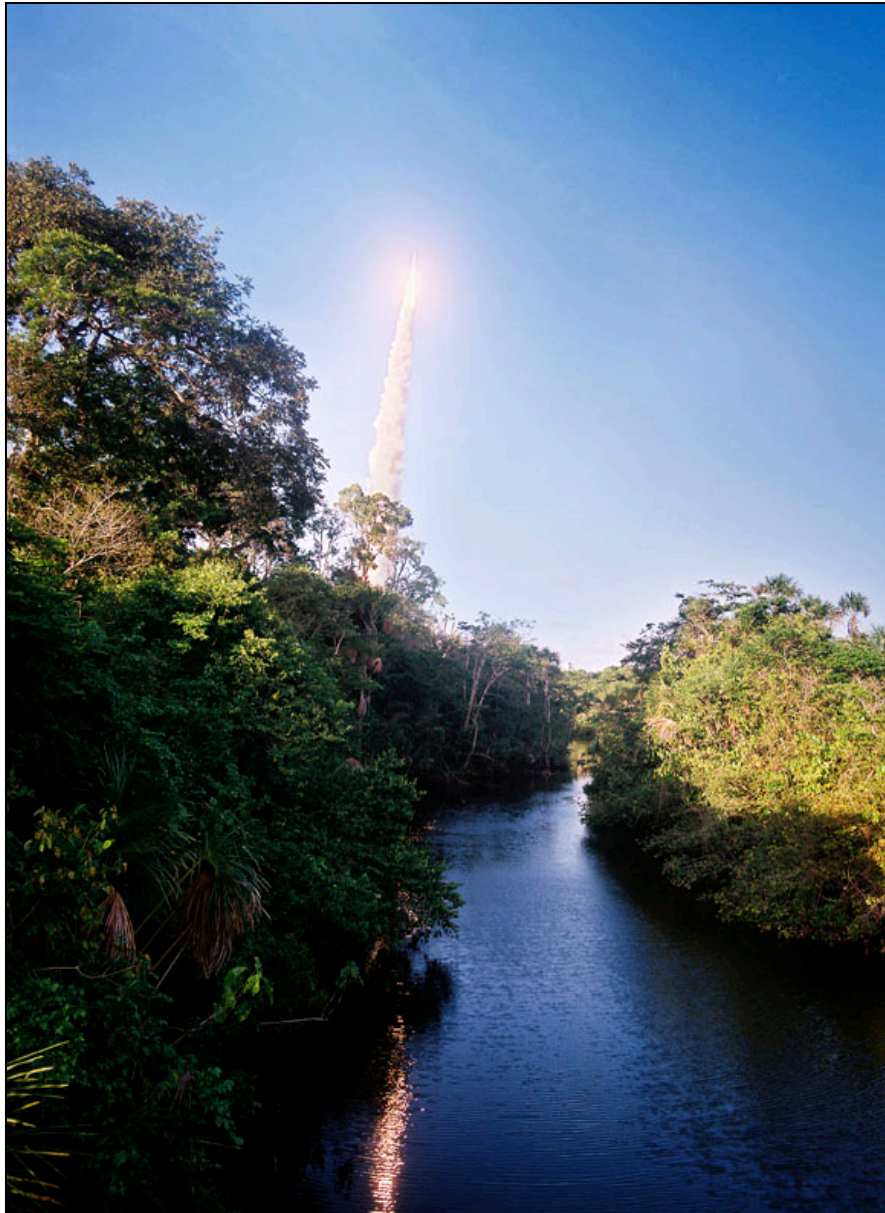
ESA Launcher Directorate

Ariane 5 Launch Log





Ariane 5 ECA Lift-off



Marc Toussaint – ESA HQ-D



ESA Launcher Directorate

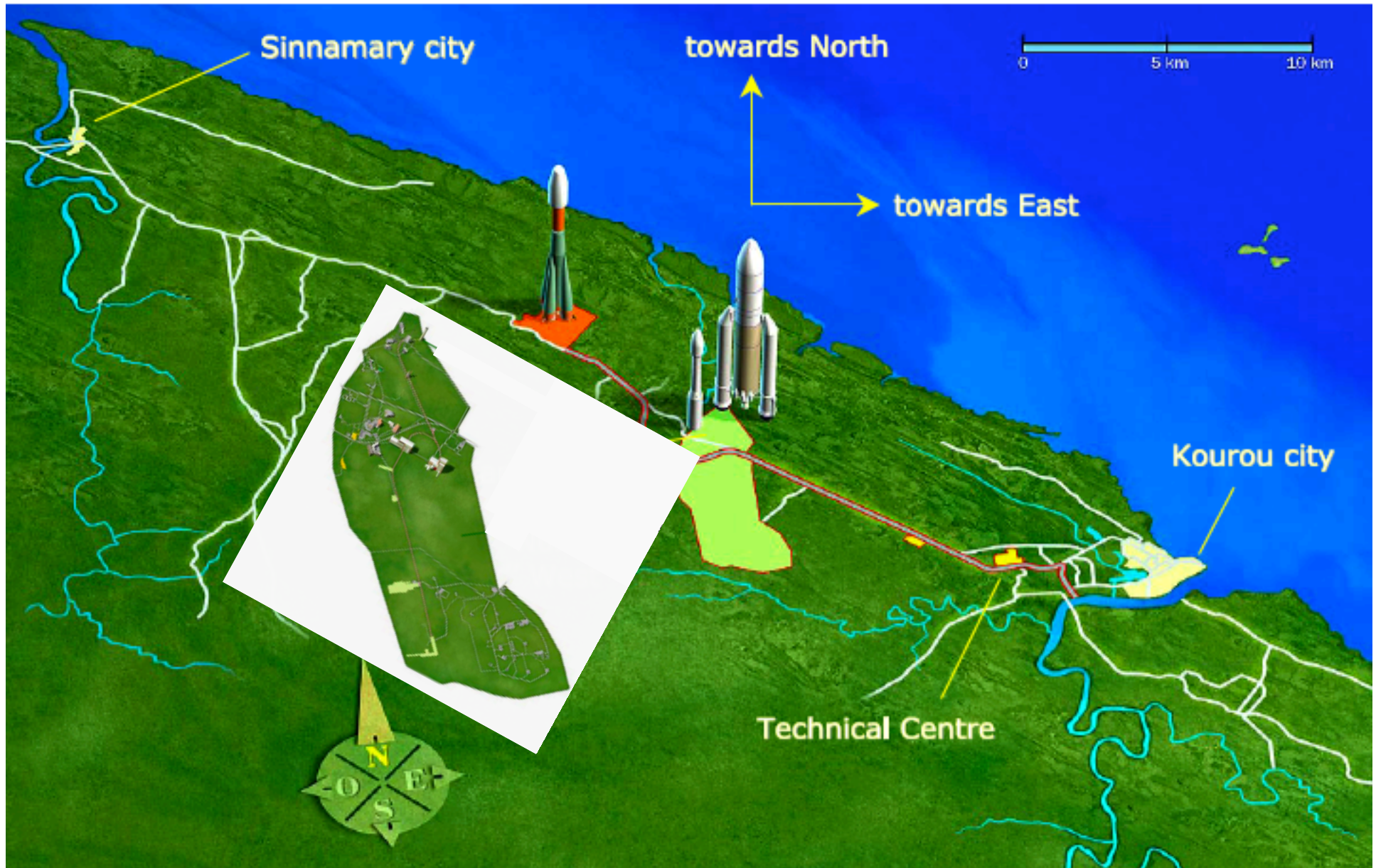
Ariane 5 ECA on its way to GTO



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European Family of Launchers in Guyana





European Family of Launchers in Guyana

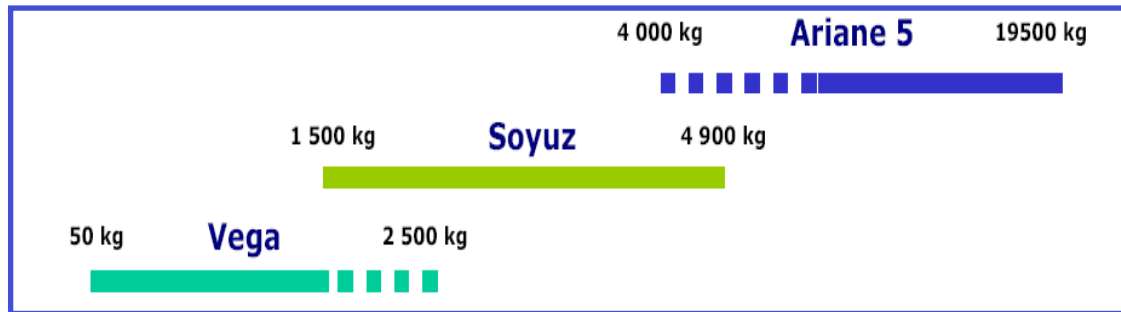


New European Launchers Family Members



New ESA - Vega Launcher

VEGA targets small payload in low Earth orbit complementing the European launchers family.



VEGA guarantees European independent access to Space for small institutional satellites performing a wide range of missions (science, earth observation, exploration, technology demonstration, re-entry ...).

VEGA Reference lift capability:

1 500 kg at 700 km in circular polar orbit

Flexibility: a wide mission range

From equatorial to polar & SSO orbit (5.2°/102°)

From 300 km to 1 500 km altitude

From 300 kg to 2 500 kg

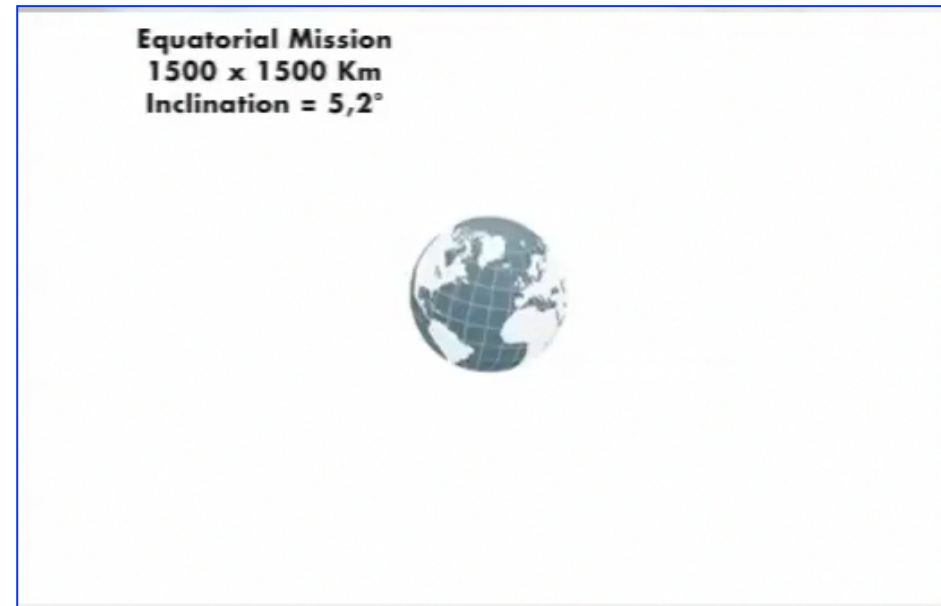
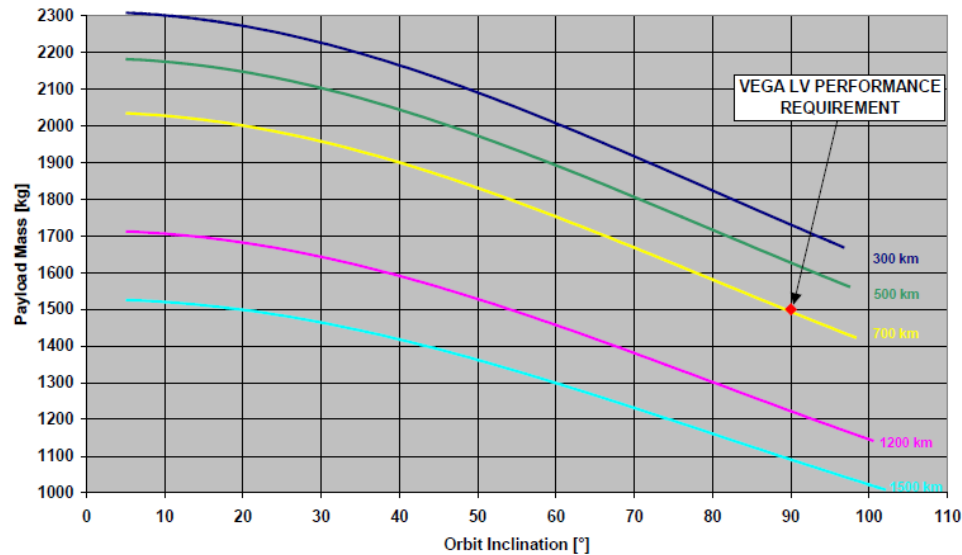
Design Reliability: 0.98



Vega Missions & Characteristics

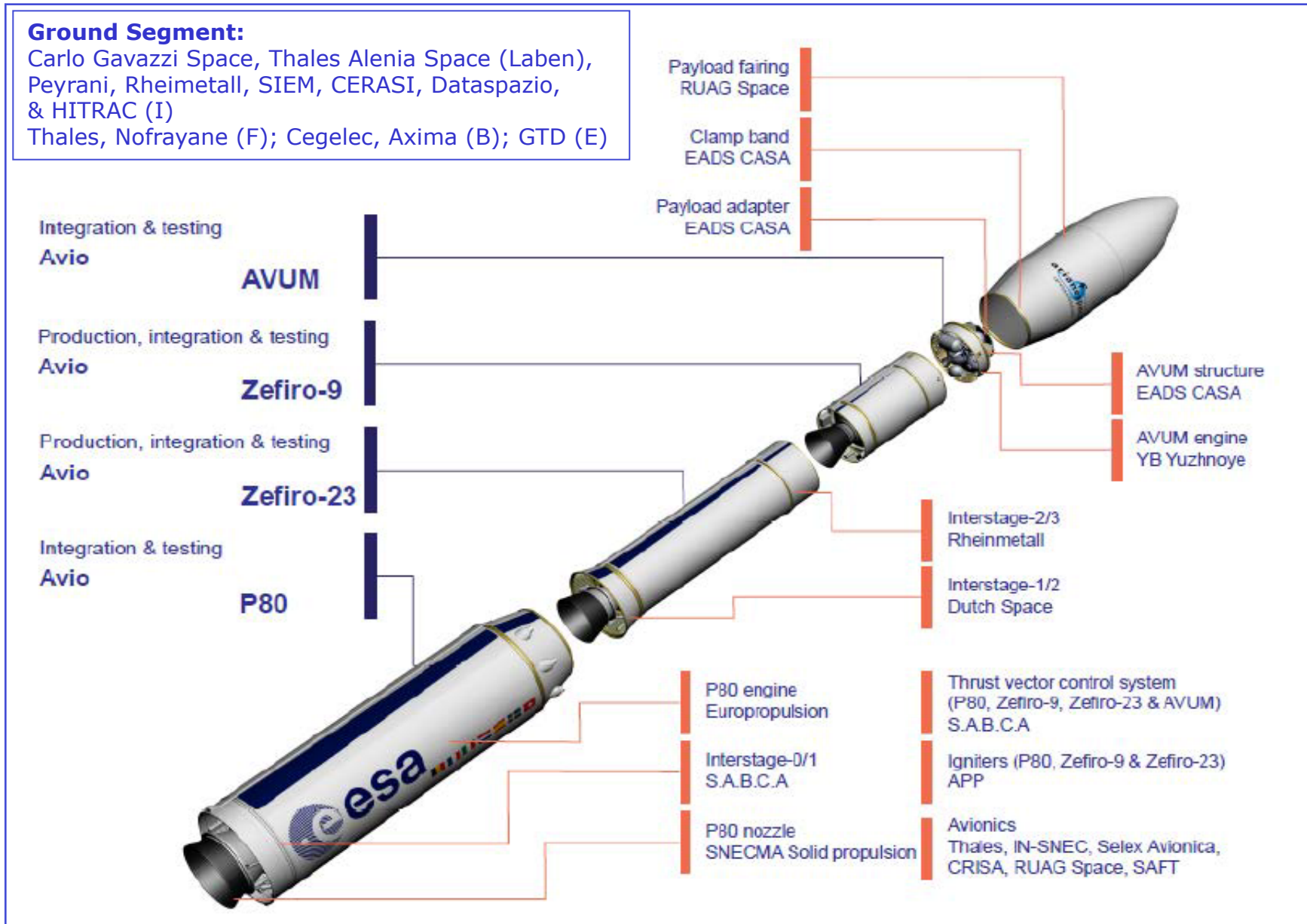


	P80	Z23	Z9
Overall length (mm)	10 791	7585	3953
Outer diameter (mm)	3003	1904	1907
Propellant mass (kg)	87 733	23 823	10 570
Inert mass (kg)	7030	1951	915
Burn time (s)	110	77	118
Vacuum specific impulse (s)	280	288	296
Nozzle expansion ratio	16	27	72.5



Ground Segment:

Carlo Gavazzi Space, Thales Alenia Space (Laben),
Peyrani, Rheimetall, SIEM, CERASI, Dataspazio,
& HITRAC (I)
Thales, Nofrayane (F); Cegelec, Axima (B); GTD (E)



VEGA 1st Stage: P-80



Development firing test: 30 November 2006
 Qualification firing test: 04 December 2007
 Stage qualification: June 2010

Mass: 95.8 T (88.4T propellant)
 Dimensions: 3 m Ø * 11.2 m length
 Thrust: 2261 KN at sea level
 Specific Impulse: 280 sec in vacuum
 Burn Time: 106.8 sec

VEGA 2nd Stage: ZEFIRO-23



Development firing test: 26 June 2006
 Qualification firing test: 23 March 2008
 Stage qualification: December 2008

Mass:	25.7 T (23.9 T propellant)
Dimensions:	1.9 m Ø * 8.4 m length
Thrust:	1196 KN at sea level
Specific Impulse:	289 sec in vacuum
Burn Time:	71.7 sec

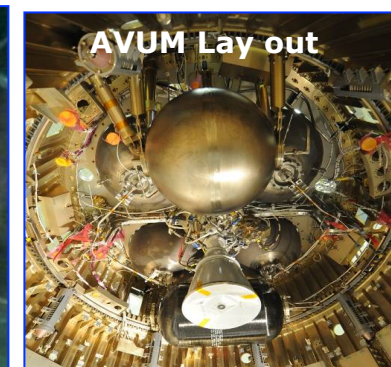
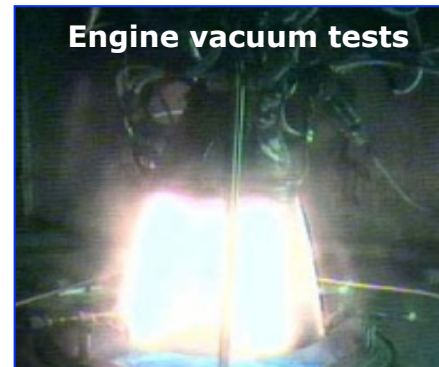
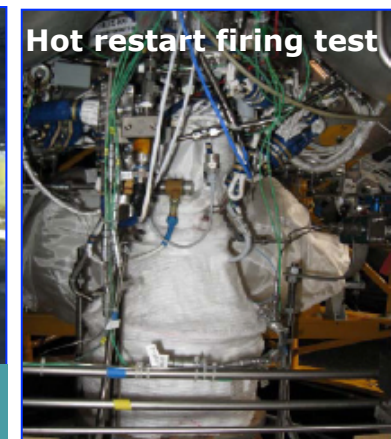
VEGA 3rd Stage: ZEFIRO-9A



Z9 Development firing test: 19 December 2005
 Z9 Qualification firing test: 27 March 2007
 (Nozzle failure)
 Z9A Qualif. firing test 1: 23 October 2008
 Z9A Qualif. firing test 2: 28 April 2009
 Z9A VERTA firing test: May 2010
 Stage qualification: November 2010

Mass: 10.95 T (10.12 T propellant)
 Dimensions: 1.9 m Ø * 4.1 m length
 Thrust: 225 KN in vacuum
 Specific Impulse: 295 sec in vacuum
 Burn Time: 109.6 sec

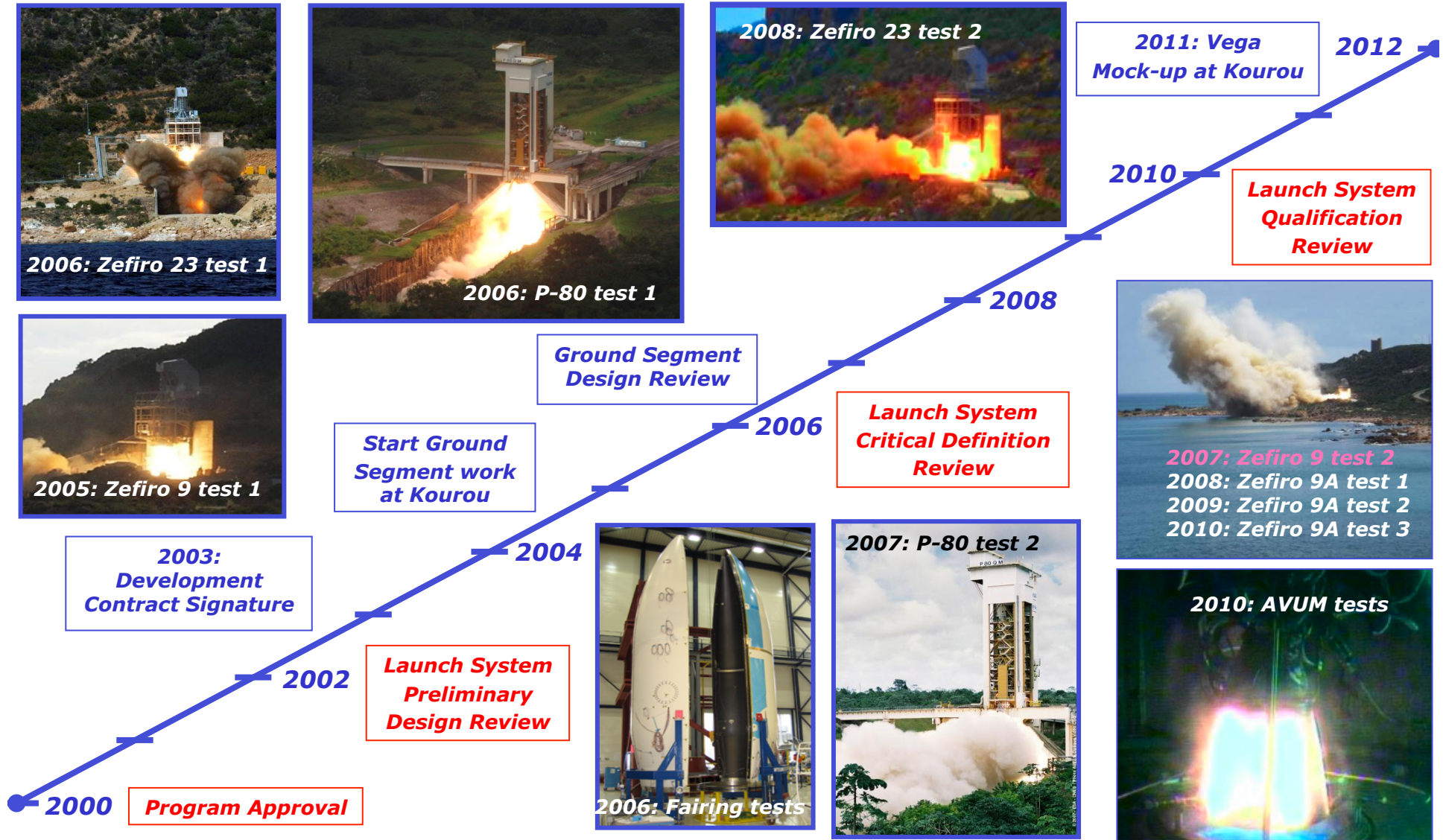
VEGA 4th Stage: AVUM



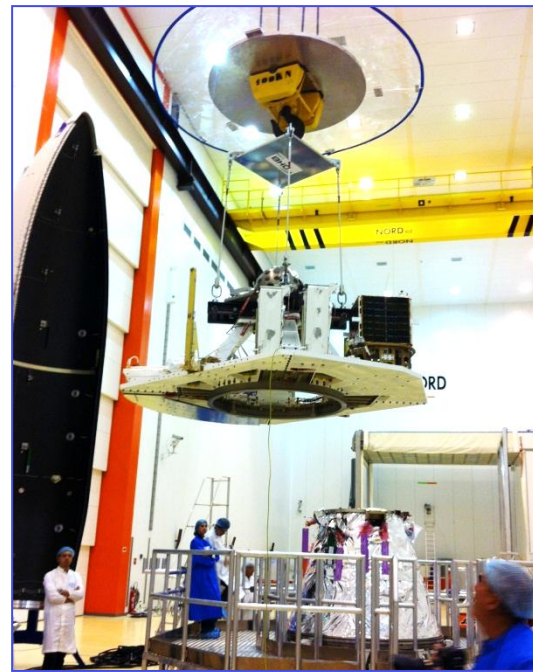
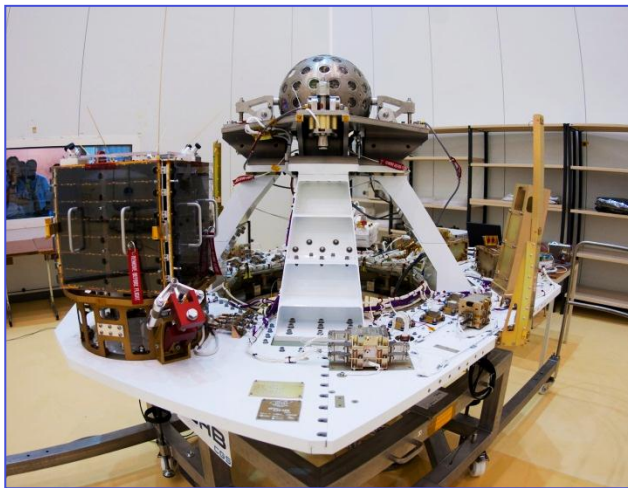
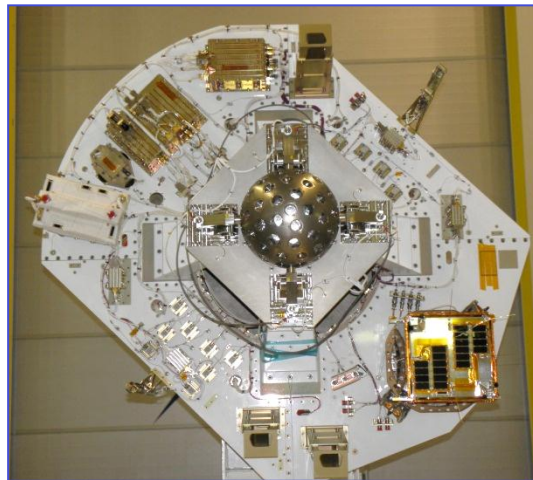
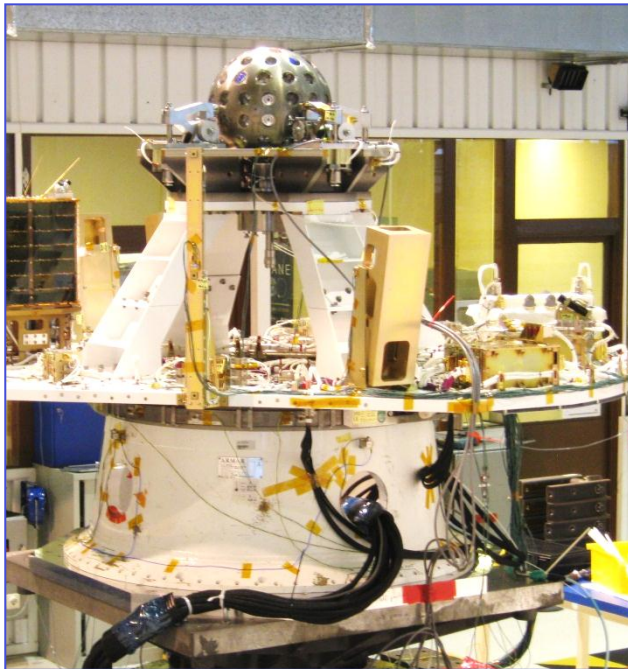
Three Qualification engines tested
6000 s cumulated firing time
More than 100 Ignition sequences
(vacuum cold & hot, restarts)
Stage firing test campaign
Qualification in February 2010
Robustness tests (bubble injection)

Mass:	968 Kg (550 Kg propellant)
Dimensions:	2.2 m Ø * 2 m length
Thrust:	2.45 KN in vacuum
Specific Impulse:	315.5 sec in vacuum
Burn Time:	317 sec / 3 re-ignitions

VEGA Development Chronology



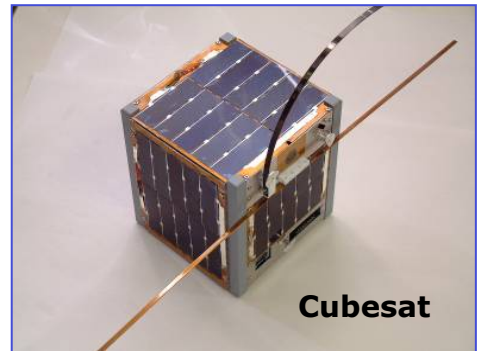
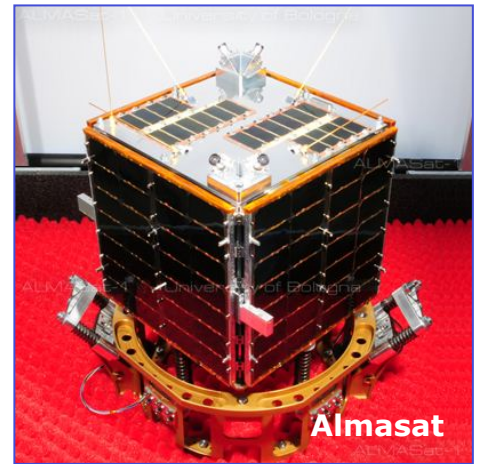
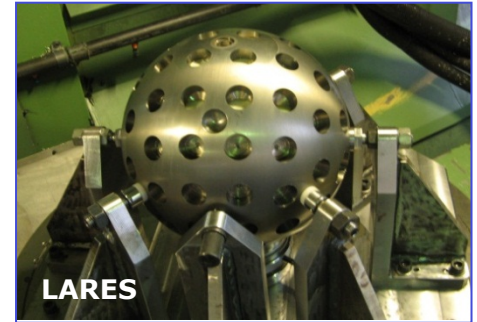
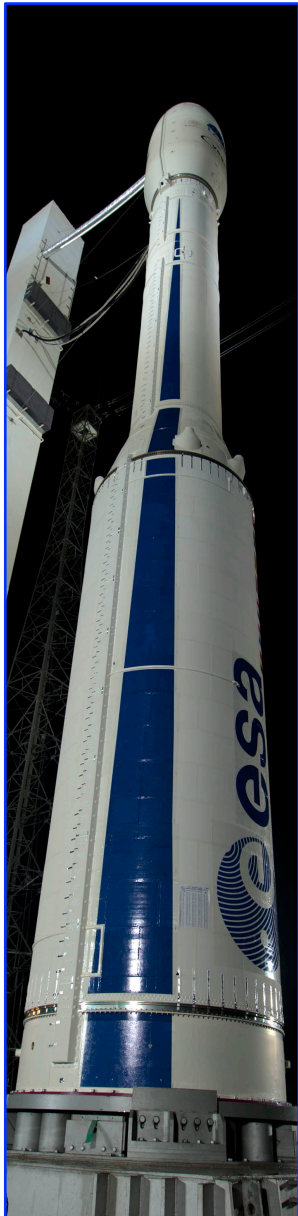
Payloads Preparation & Integration



A photograph of the Vega launcher assembly building at Europe's Spaceport. The building is a large, white, multi-story structure with several tall cranes attached to it. The ESA logo and the word "vega" are visible on the building. In the foreground, there is a paved area, a yellow building, and a large water tower. The sky is blue with some clouds.

VV01 VEGA qualification flight, launcher assembly
Europe's Spaceport : 7 november 2011 - 22 january 2012

VEGA Maiden Flight 13/02/2012



Orbits @ Inclination of 69.5°: 700 Kg Payload
LARES: 1450 km x 1450 km circular;
ALMASAT-1 & 7 Cubesats: 350 km x 1450 km

VEGA Maiden Flight 13/02/2012

*P-80, Z-23, Z-9
& AVUM #1
Boosts*

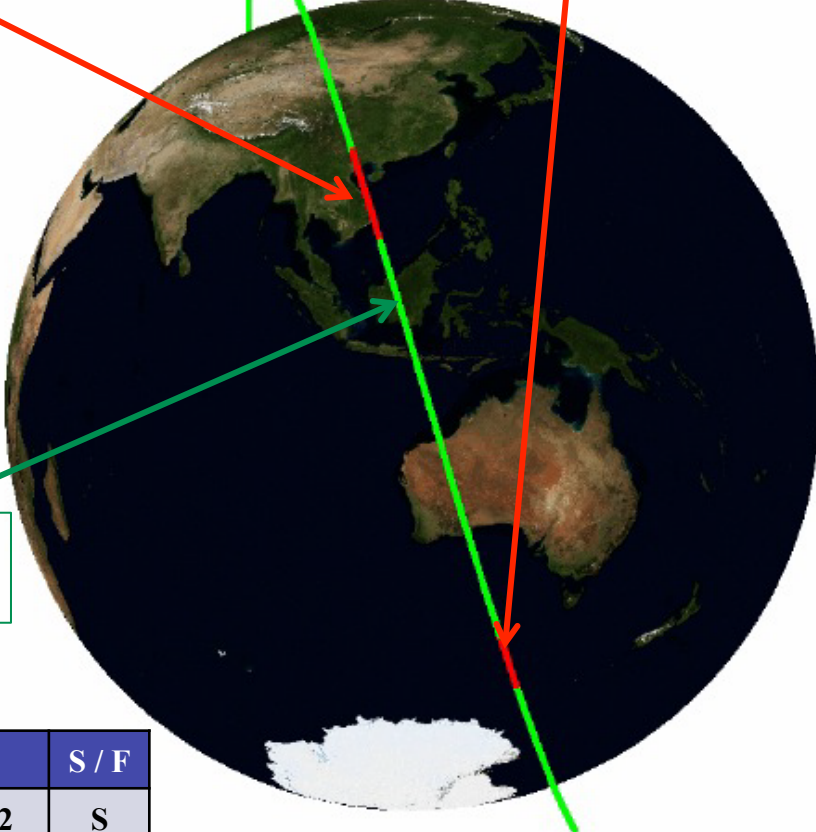
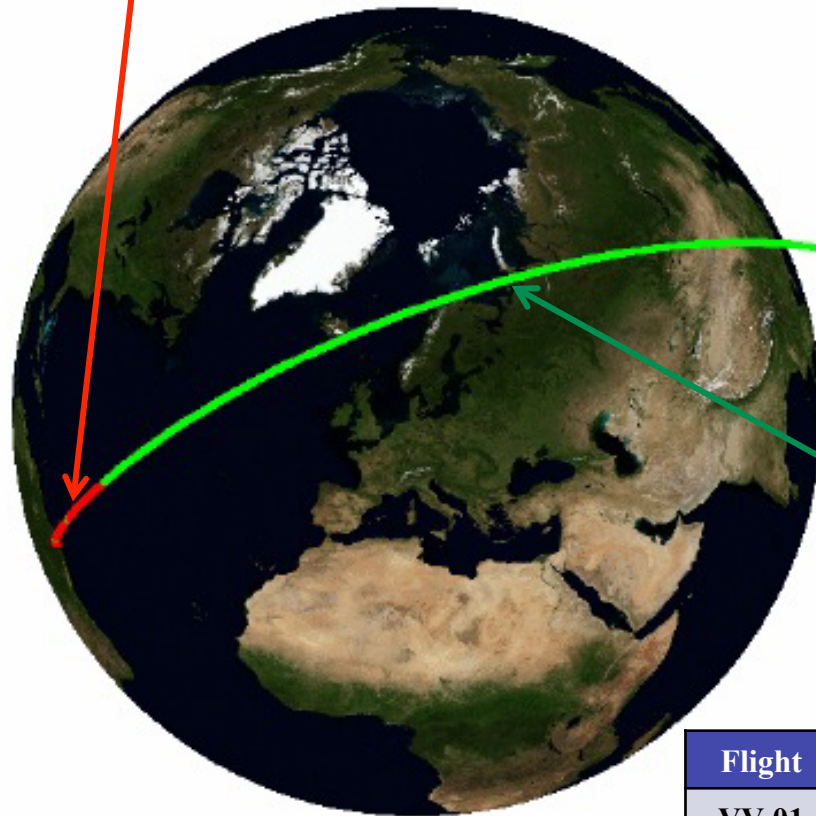
T0 + 8 min 45 sec

*AVUM #2 Boost,
Circularisation
& LARES Release*

T0 + 55 min 5.5 sec

*AVUM #3 Boost,
Perigee decrease
& 8 Small-sats Release*

T0 + 70 min 35 sec



*Coasting
Phases*

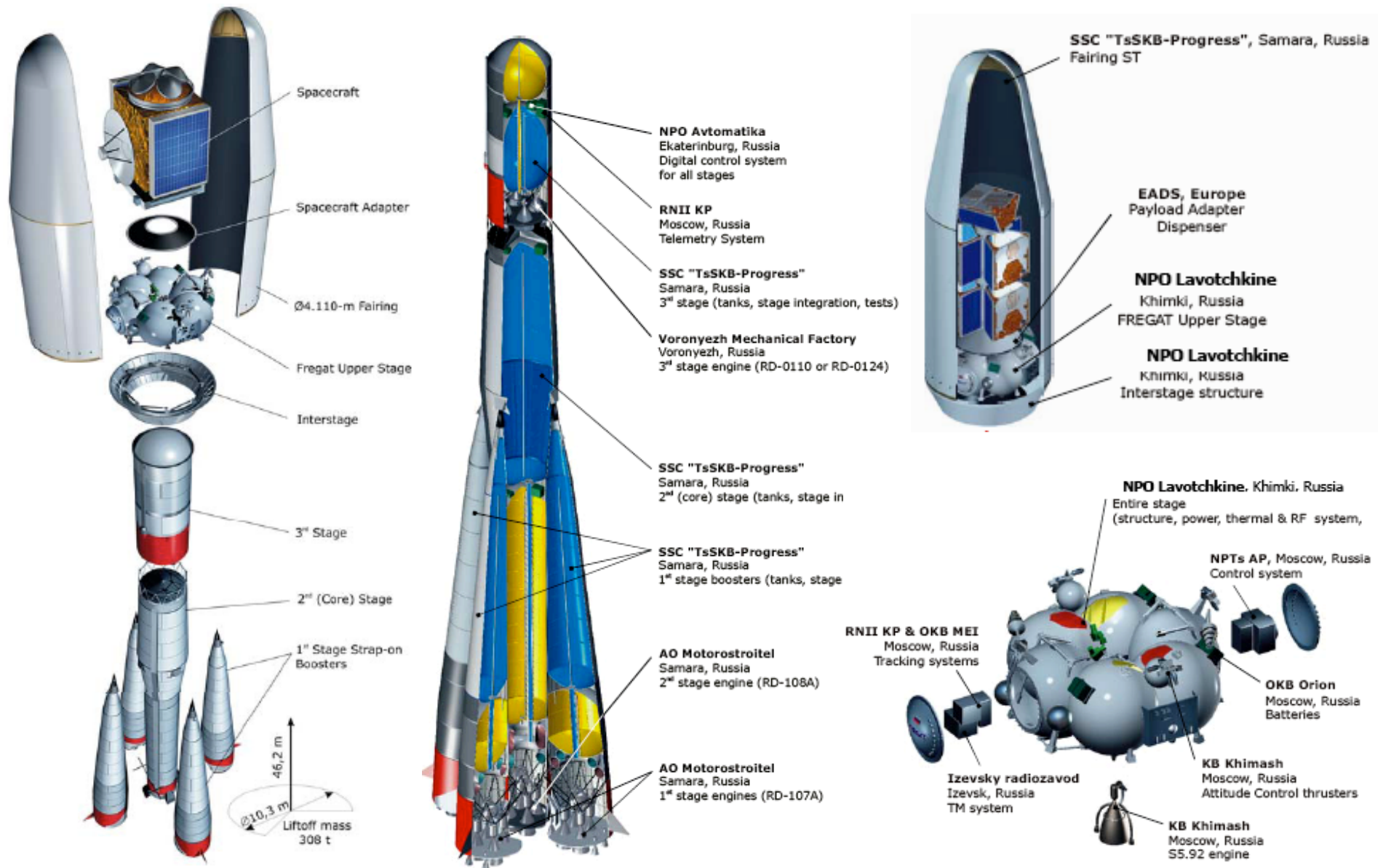
Flight	Date	S / F
VV-01	13/02/2012	S
VV-02	06/05/2013	S
VV-03	? /2014	

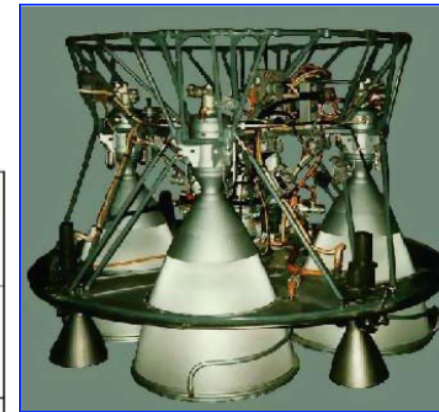
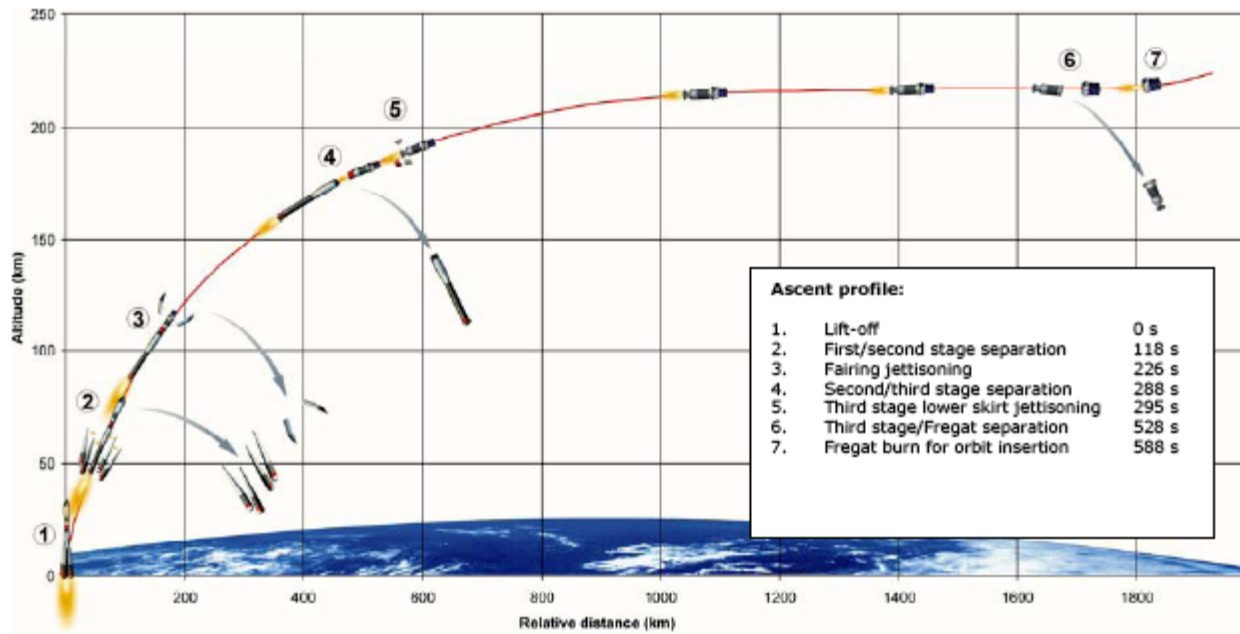
Soyuz Launcher at CSG

**ESA – Roskosmos
CNES – Arianespace**



Soyuz Launcher at CSG





ST 2-1A
RD-0110

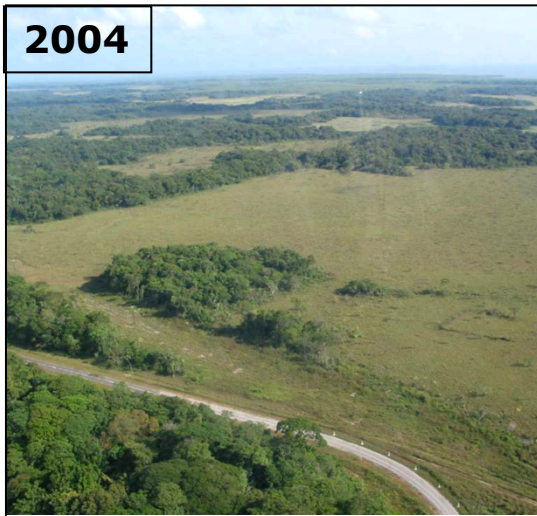


ST 2-1B
RD-0124



Orbit specifications	SOYUZ/ST (2-1A)	SOYUZ/ST (2-1B)
GTO ($\Delta V= 1500$ m/s)	2730 kg	3060 kg
Sub GTO ($\Delta V= 1905$ m/s)	3230 kg	3610 kg
SSO Orbit (type 98,1°/660 km)	4450 kg	4900 kg
Medium Circular Orbit (56°/23616 km)	1180 kg	1570 kg
High Elliptical Orbit (63,4° / 39100 x 1200 km)	2200 kg	2470 kg

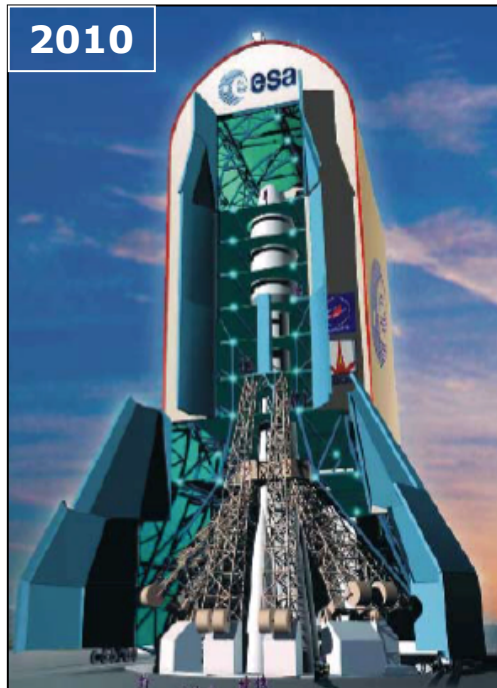
Soyuz Launch Pad Build-up



2009



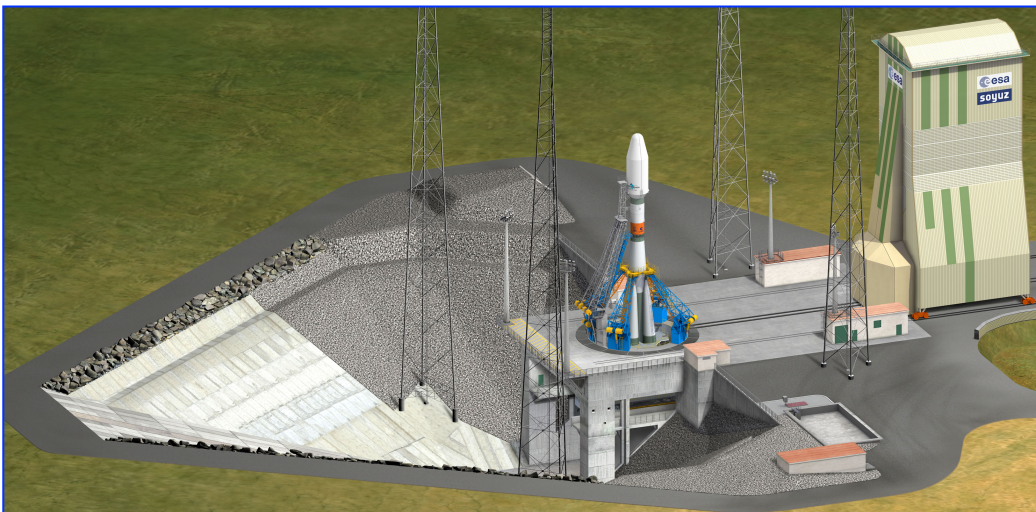
2010



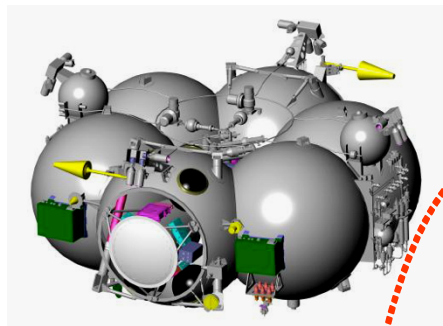
Marc Toussaint – ESA HQ-D

58/67

ESA Launcher Directorate



Marc Toussaint – ESA HQ-D



5119 Nm
15 days

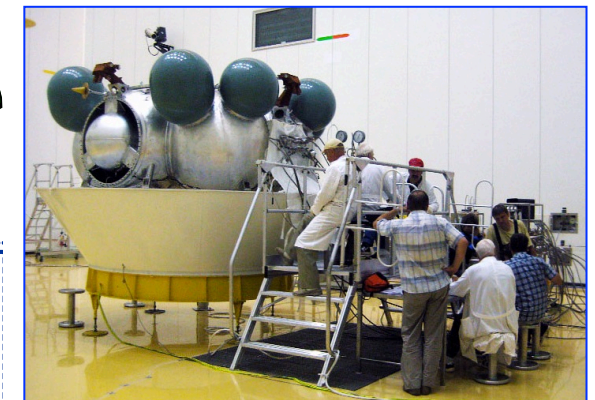


3810 Nm
11 days

Possibility of two launch vehicles plus associated propellants per trip



1490 Nm
5 days





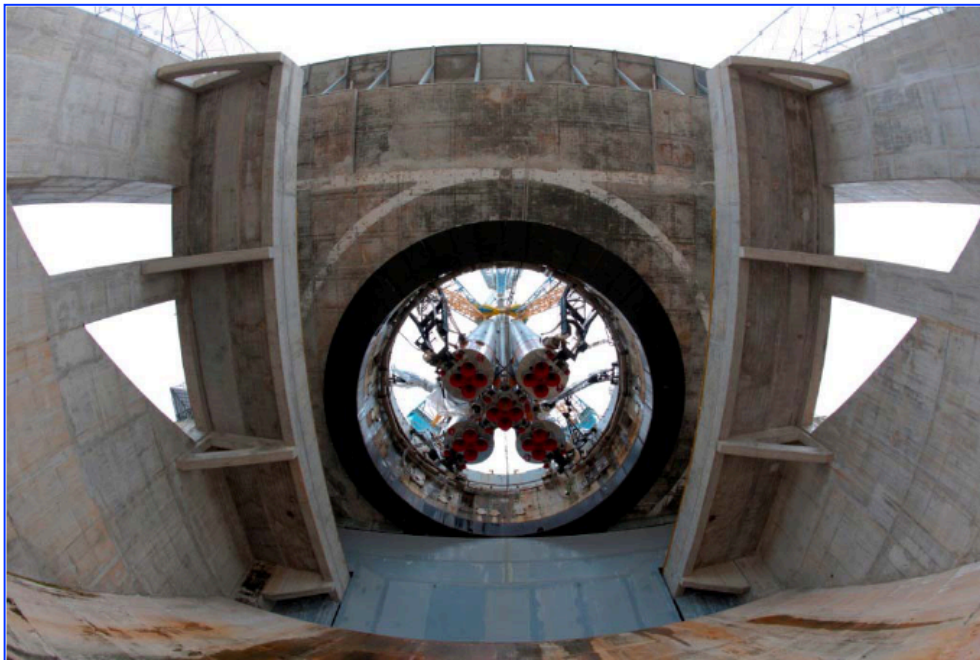
SOYUZ flight VS01 assembly

Europe's Spaceport 13-19 september 2011

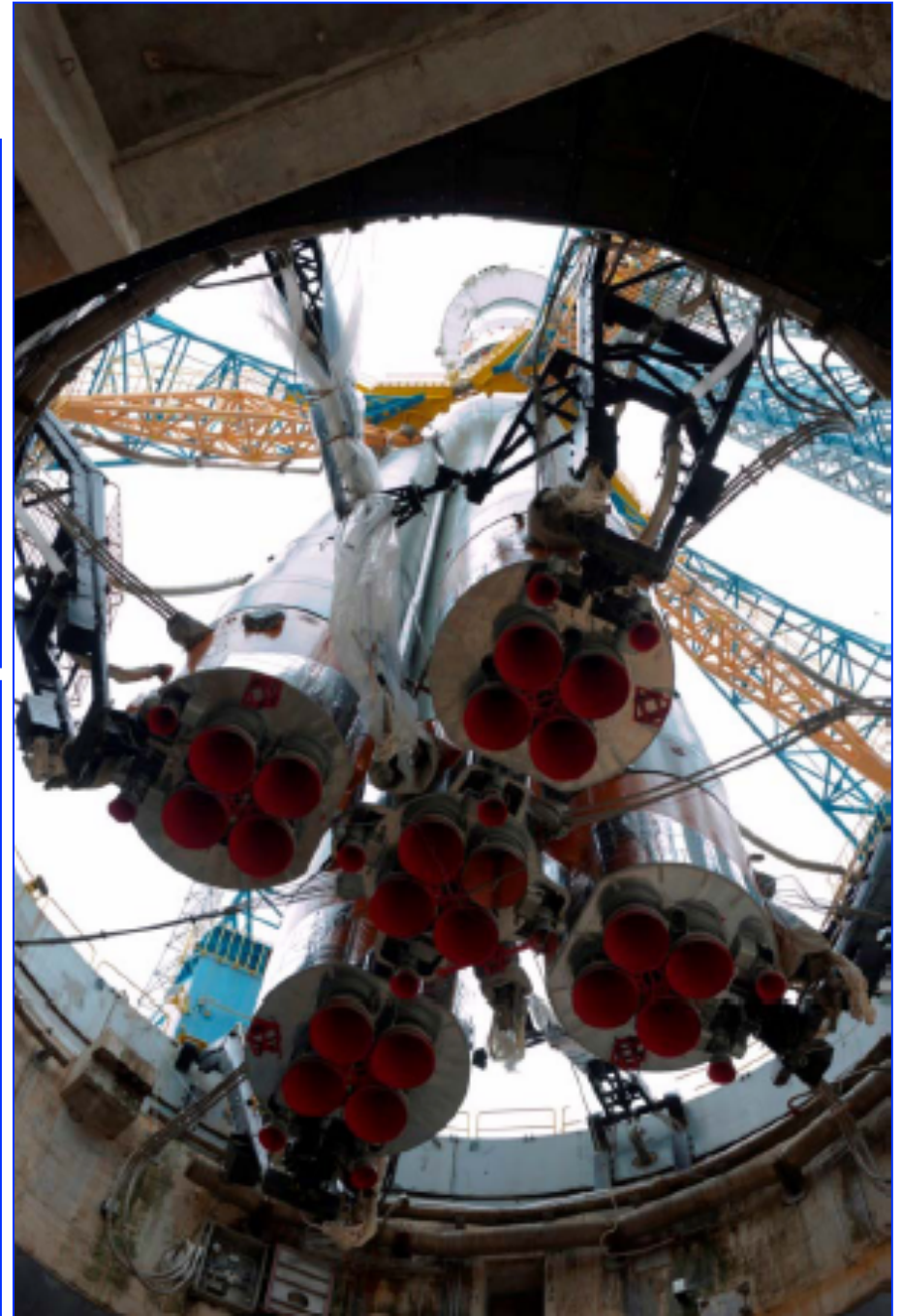
Soyuz VS01 with IOV-1 Launch campaign

Europe's Spaceport 14 to 21 october 2011

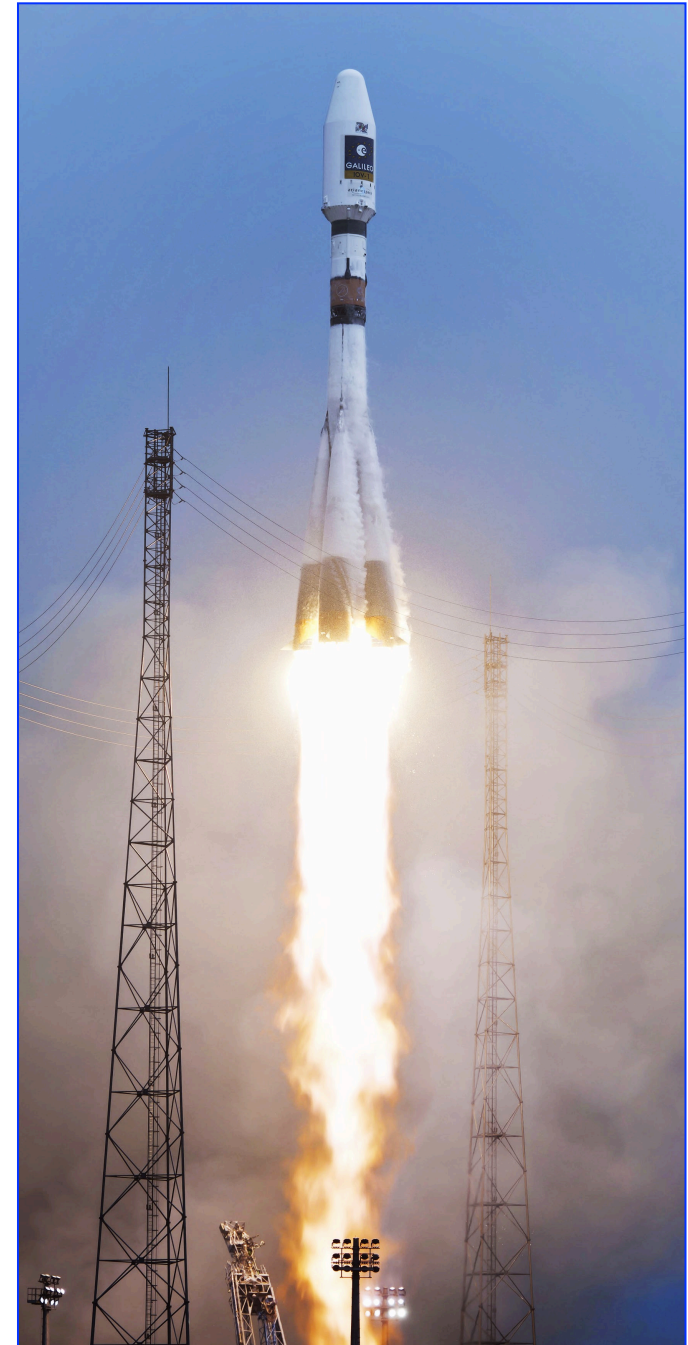
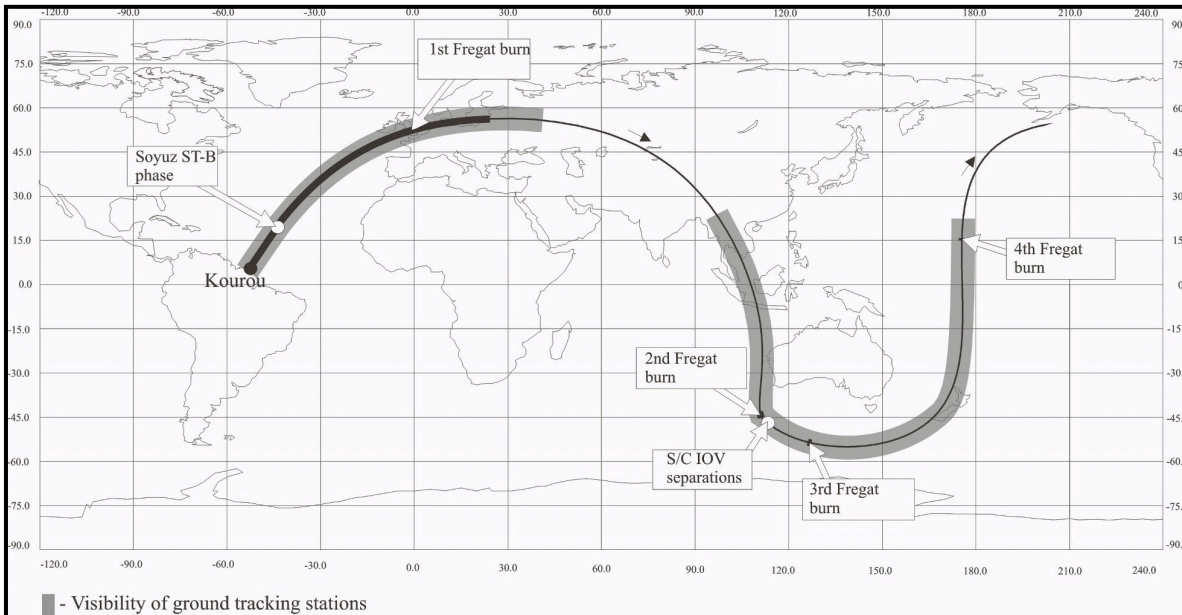




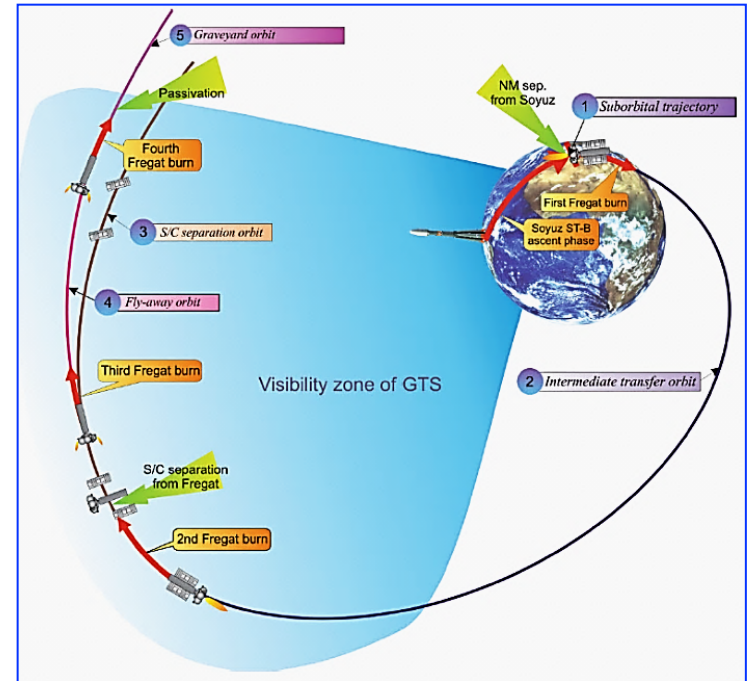
Marc Toussaint – ESA HQ-D



ESA Launcher Directorate

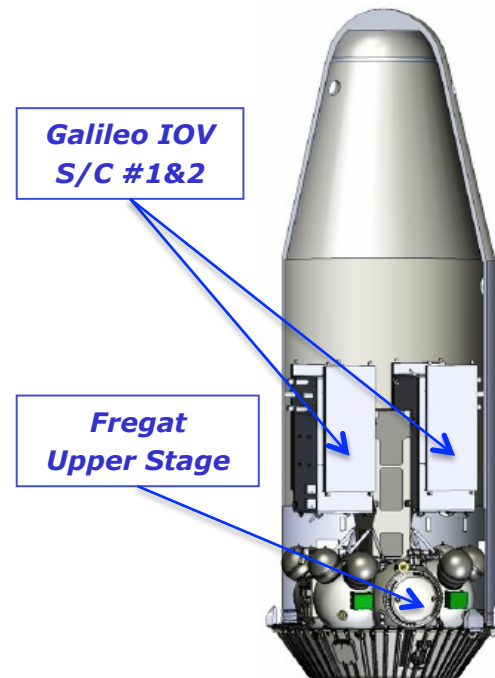


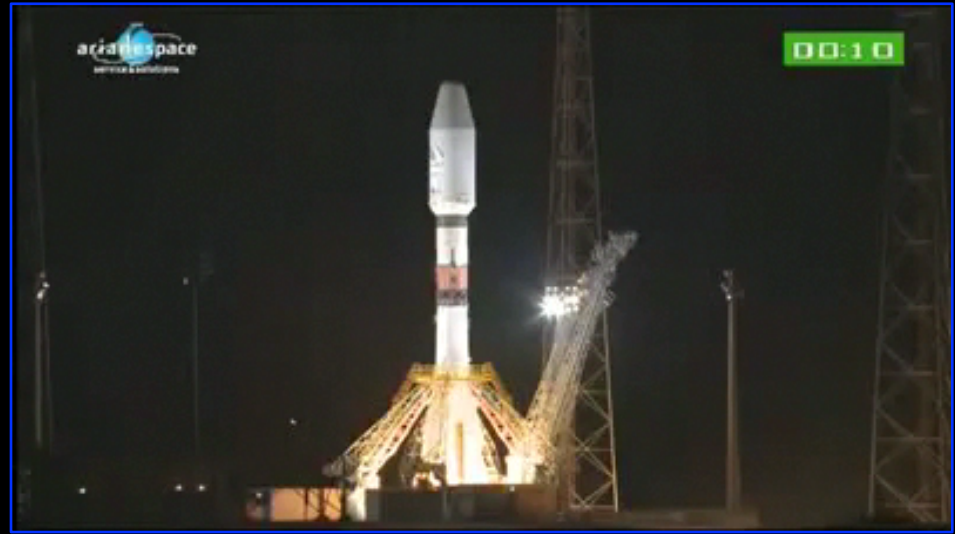
Flight	Date	S / F
VS-01	21/10/2011	S
VS-02	17/12/2011	S
VS-03	12/10/2012	S
VS-04	01/12/2012	S
VS-05	24/06/2013	
VS-06	? /08/2013	
VS-07	? /10/2013	



Выводимая масса головного блока	9100 кг	Nose Module injected mass	9100 kg
Наклонение	55,7812°	Inclination	55,7812°
Высота в точке выведения	175 км	Injection point altitude	175 km
Абсолютная скорость в точке выведения	7562,89м/с	Absolute velocity at injection point	7562,89 m/s

1 – Старт/Lift-off	0,00 s
2 – Конец вертикального участка/End of vertical flight	8,00 s
3 – Разделение I-II ступеней/ I-II stage separation	118,25 s
4 – Отделение головного обтекателя/Fairing separation	218,50 s
5 – Разделение II-III ступеней/ II-III stage separation	287,74 s
– Отделение хвостового отсека/Aft section separation	294,52 s
6 – Отделение головного блока/Nose Module separation	564,00 s







Space-Up in Paris
24-26/05/2013



*Thank you for
your attention*