Space transportation challenges

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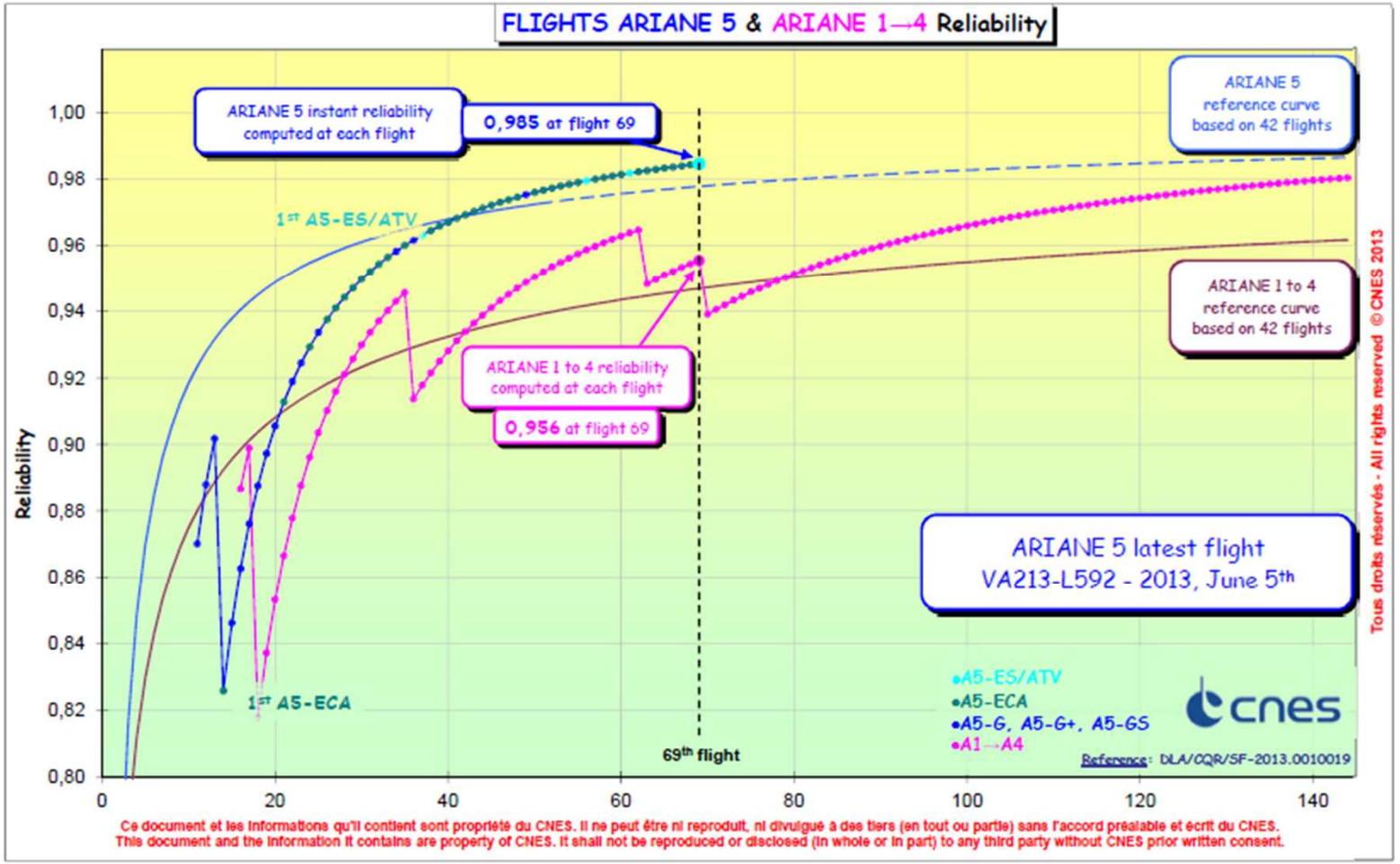
ARIANE, SOYOUZ and VEGA

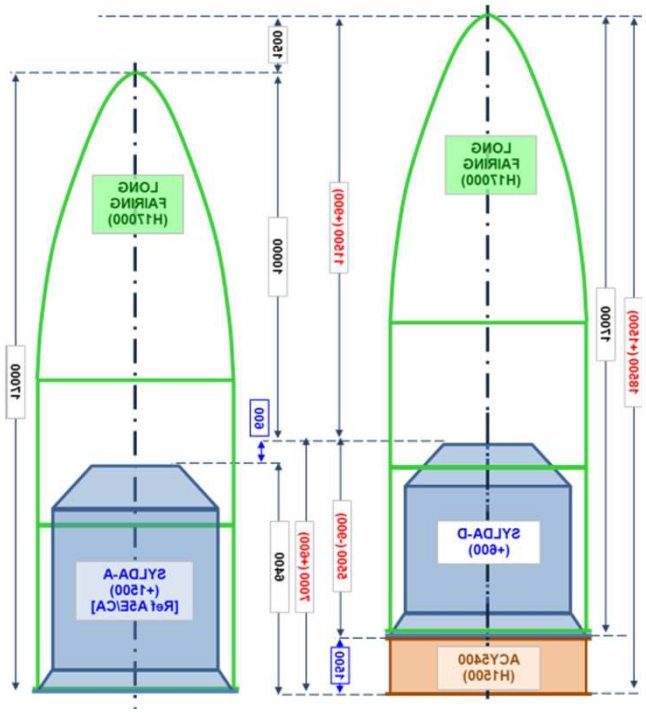
- European family of launchers Ariane, Soyouz and Vega is operational a wide range of orbits and performances achievable

- Challenges for the short term are:
  - To gain maturity for the new systems
  - To keep quality and reliability
  - To gain flexibility in operations
  - To cope with satellites evolutions (mass, volume, missions)

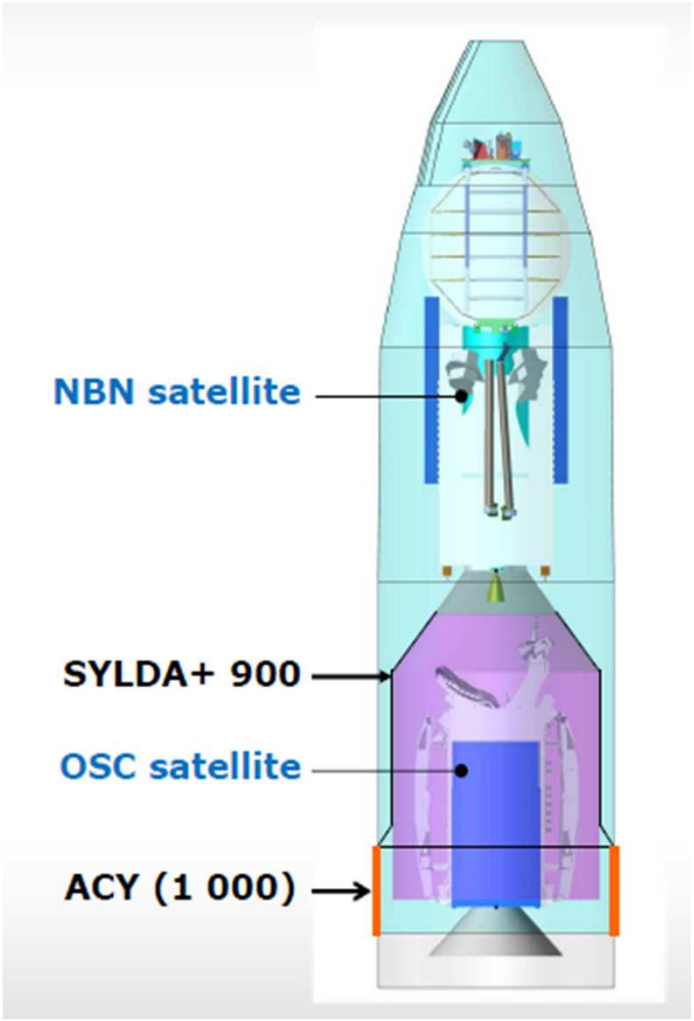
RELIABILITY



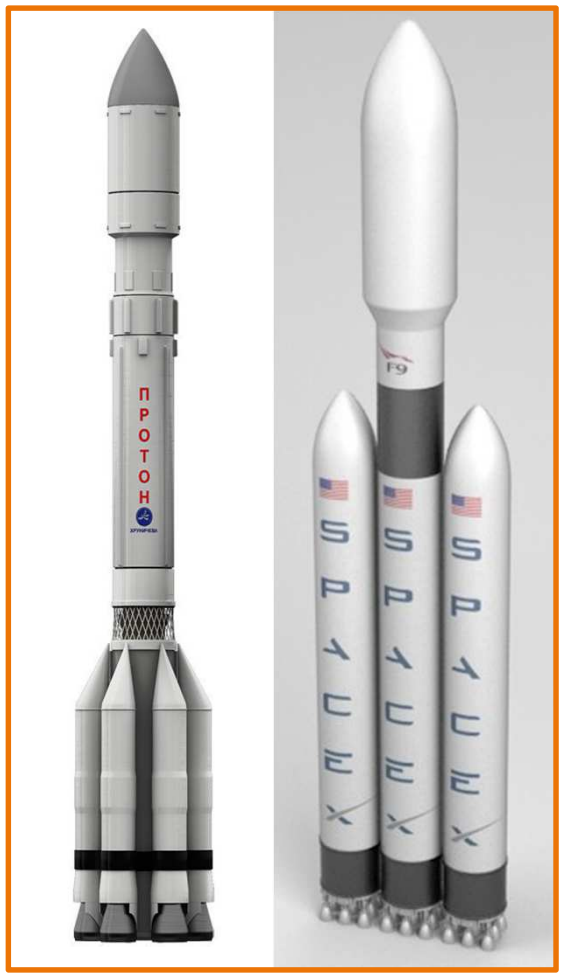
SATELLITES VOLUME EVOLUTION



A5 today A5ECA+



COMPETITIVE ENVIRONMENT IS CHANGING

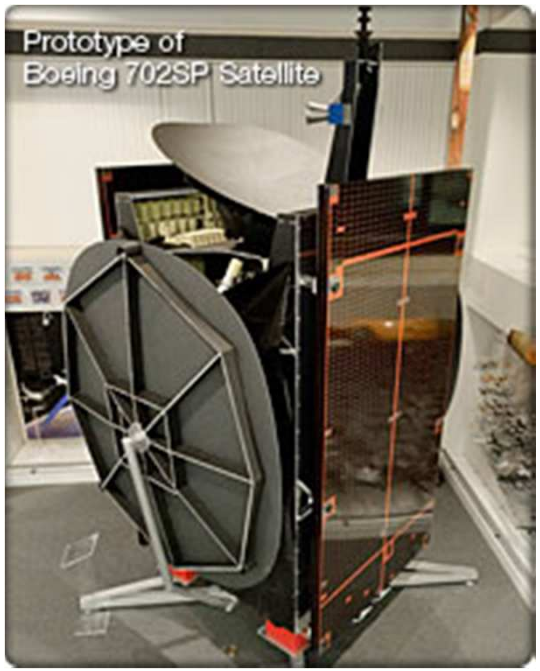


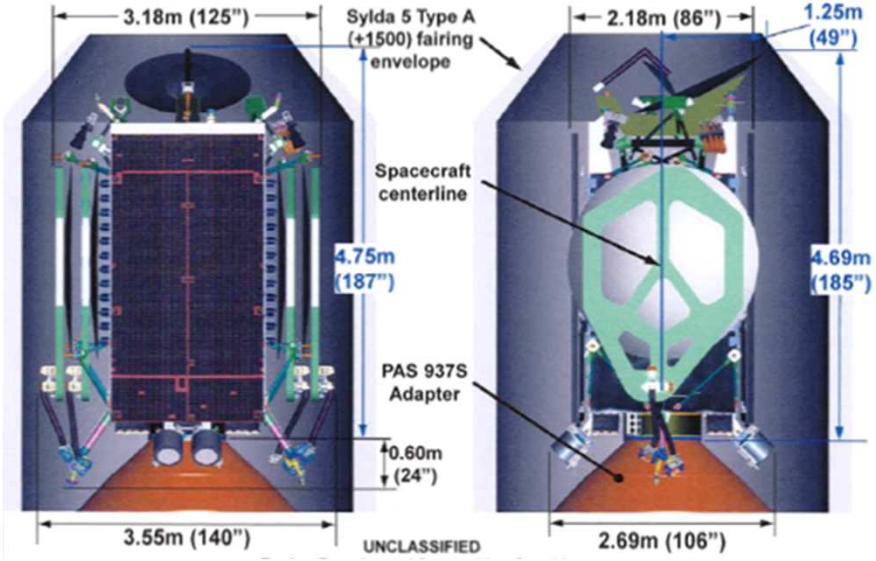
Proton Falcon

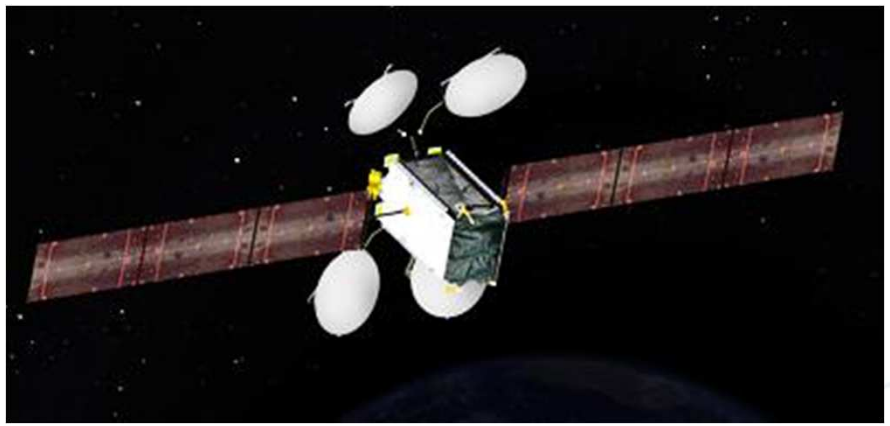
- To anticipate the impact of environment's evolution => Strong competition
  - Proton in the segment of heavy satellites (6T class)
  - "Falcon is coming" in the segment of small medium satellites (3/4 T class)

ELECTRIC PROPULSION

- A new type of satellites and missions are emerging (electric propulsion)

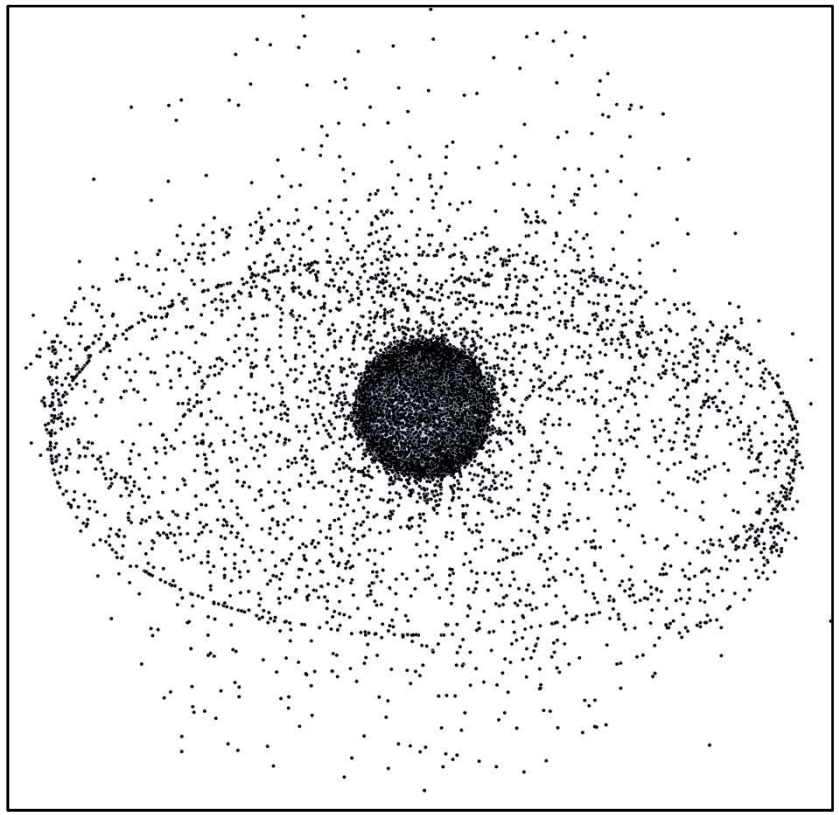


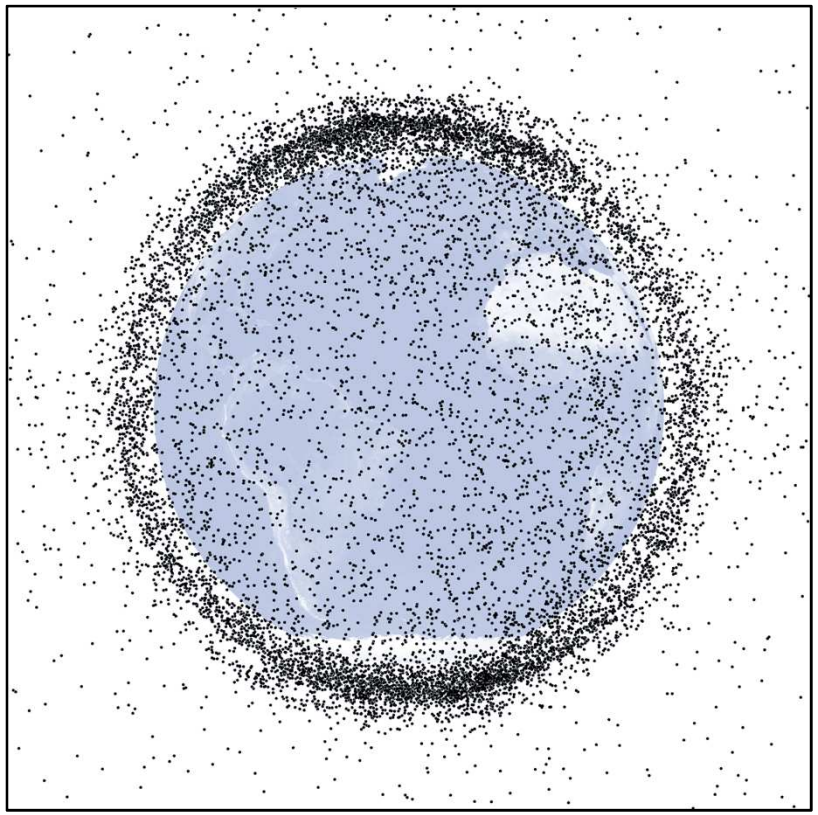




SPACE DEBRIS

- To cope with international and national regulations for space debris.





EUROPEAN LAUNCHER MAIN ORIENTATIONS

- Two main developments running in parallel:
  - A5ME with its re-ignitable upper stage (horizon 2018)
  - Ariane 6 based on a PPH configuration (horizon 2021) and commonalities on upper cryo stage with A5ME.

A5ME

A6 PPH

ARIANE 6 DESIGN DRIVERS

- **7 tons GTO performance**
- **7 years development and qualification**
- **70 M€ for the launch price**

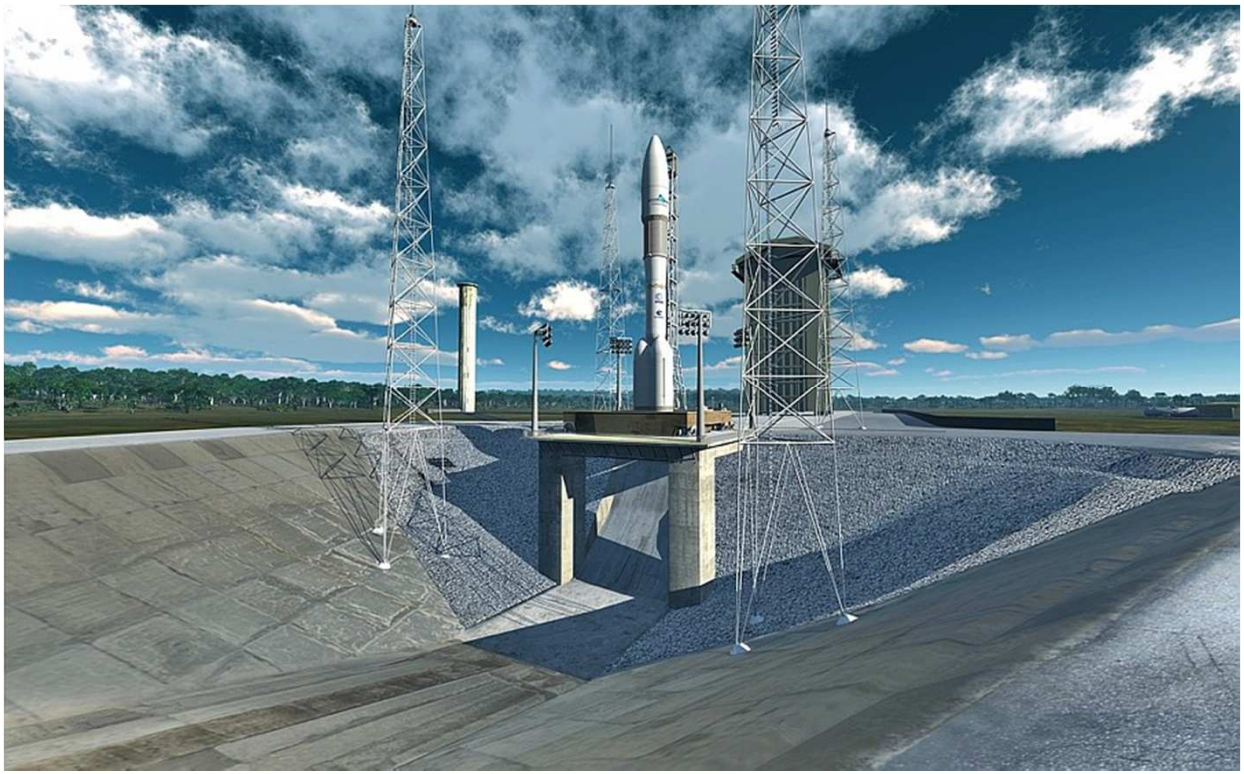
- High energy at lift off and high speed to cross atmosphere
  High level of reliability and availability, and low cost → Solid propulsion

- High performance and accuracy to reach the orbit
  - Customization of the mission
  - De-orbiting after the mission

  → Cryogenic propulsion

HOW TO REACH THEM?

- Simple design
- Limited number of interfaces and subsystems
- Cadence effect on both launch system and subsystems
- Mastery of the design by industrial primes



- Creation of industrial clusters around coherent skills, technologies and processes
- “Plug and play” approach for operations

AND ALSO …

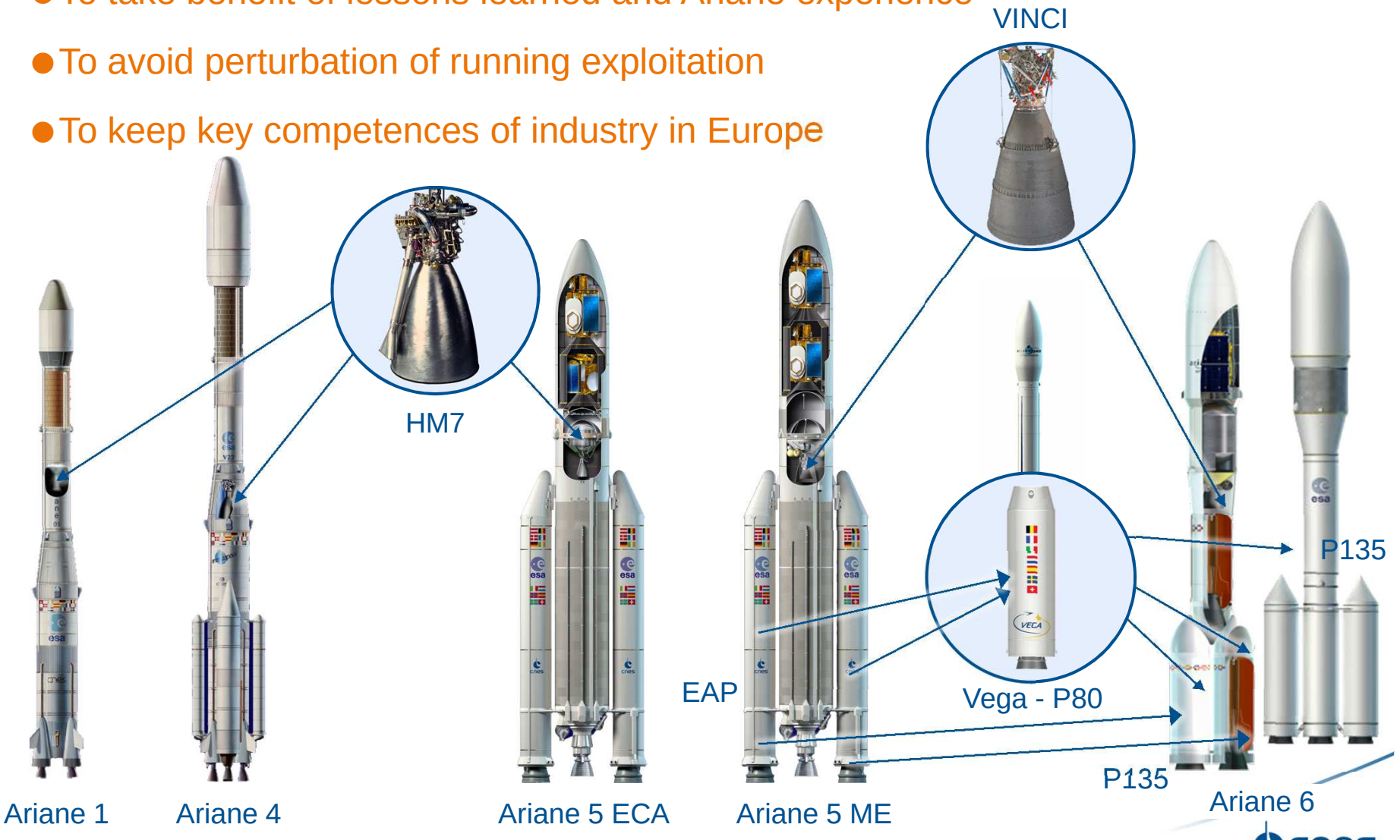
- To maximize the use of proven technologies, past investments on subsystems (Vinci engine) and production facilities (casting pits…)

P80 – DM Loaded Motor Case

Vinci Engine test campaign 2013

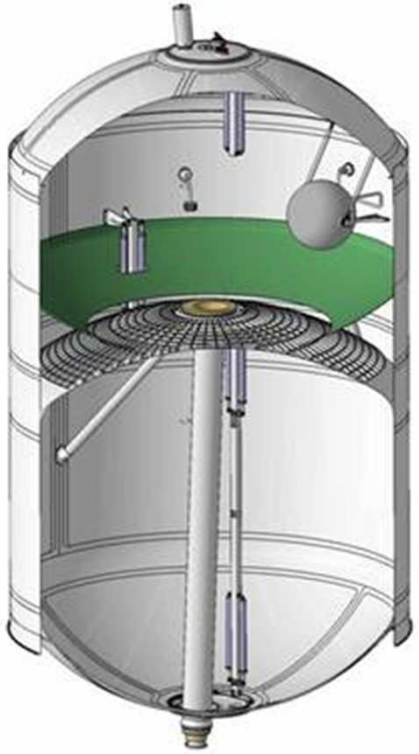
AND ALSO …

- To take benefit of lessons learned and Ariane experience
- To avoid perturbation of running exploitation
- To keep key competences of industry in Europe

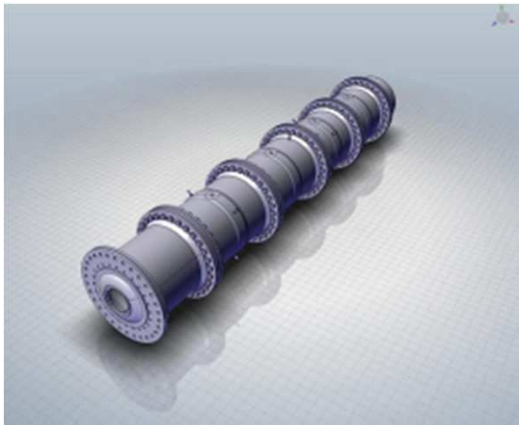


INNOVATION, SCIENCE AND RESEARCH

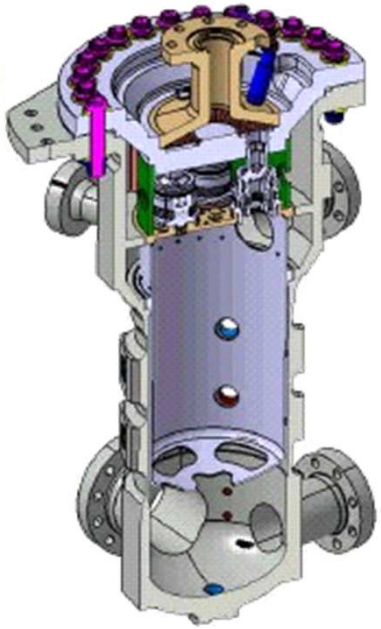
- Management of cryogenic propellant behavior during ballistic phases
- Mastery of thrust oscillations on solid propulsion
- Control of transient phases (system, engines,…)
- High frequency behavior of liquid propulsion engines
- Flight control and guidance
- Acoustic design of launch facilities



HX



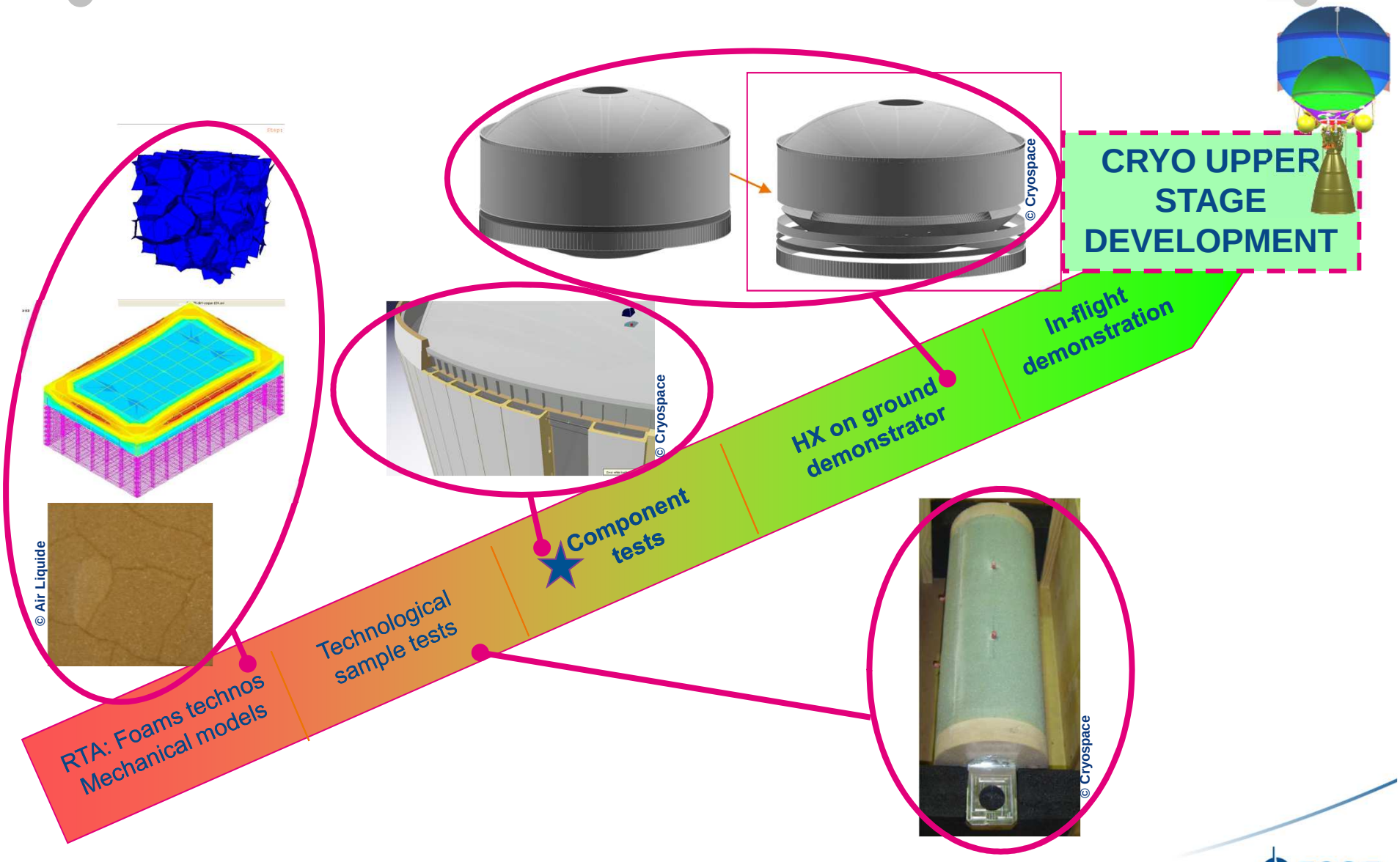
Demo POD-X



Vulcain X

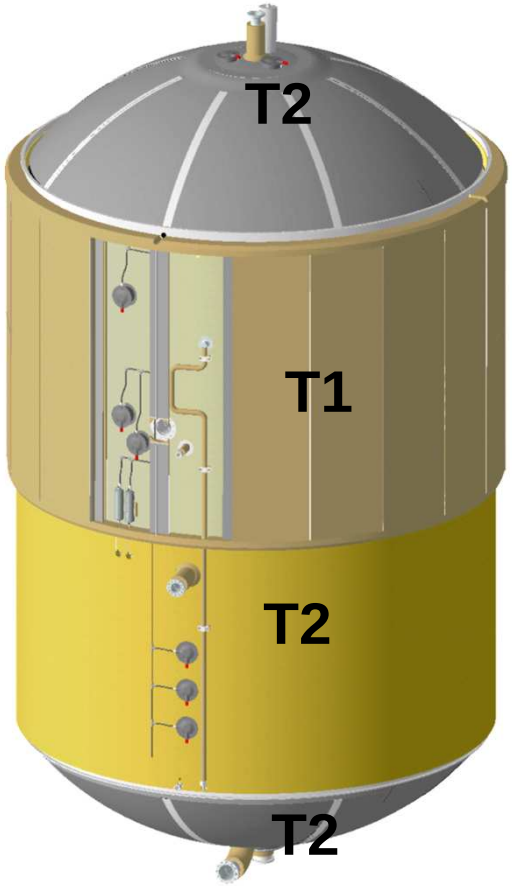
Research and Technology – for cryo stages

Example: COLD THERMAL PROTECTION MATURATION



Technological Demonstrators for A5 and A6: H-X

HXG-Technologies demonstration



TRL 6 achieved for

T1 : Foam-MLI-Foam (FMLIF)

T2 : Combined TP open cells

T3 : Insulation for ortho-grid Cl

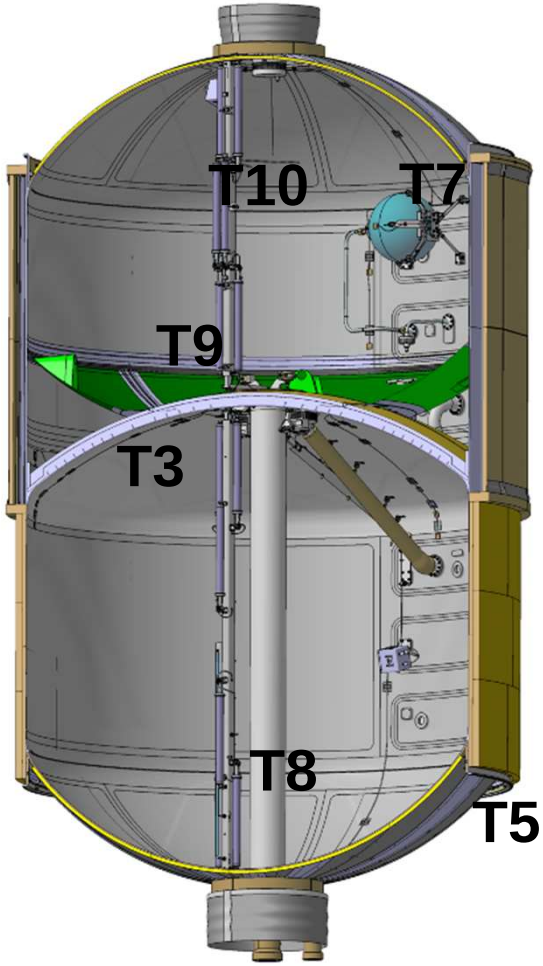
T5 : Vapour cooling

T7 : Pressurisation 20K

T8 : Internal line

T9 : Anti-wetting device

T10 : Level gauges + cameras



Technological Demonstrators for A6

SOLID PROPULSION : EXTRA LARGE CASING DEMO

SRM PROJECT : Insulated Case Demo.

→ **Program : design, manufacture and test mechanically a large and representative insulated case**

→ **Main objectives**

- Demonstrate a low cost manufacturing process of the whole insulated case
- Validate the capability to withstand high mechanical fluxes on skirts
- Validate the technology of the large mandrel for the insulated case

→ **Main 'Demo' characteristics**

- Scale one feasibility diameter : 3.7 m
- Nominal maximum pressure : 11 Mpa
- Nominal axial flux : 1500 N/mm

→ **Industrial Organization :**

- Astrium : case, skirts and tests
- Herakles : thermal insulation

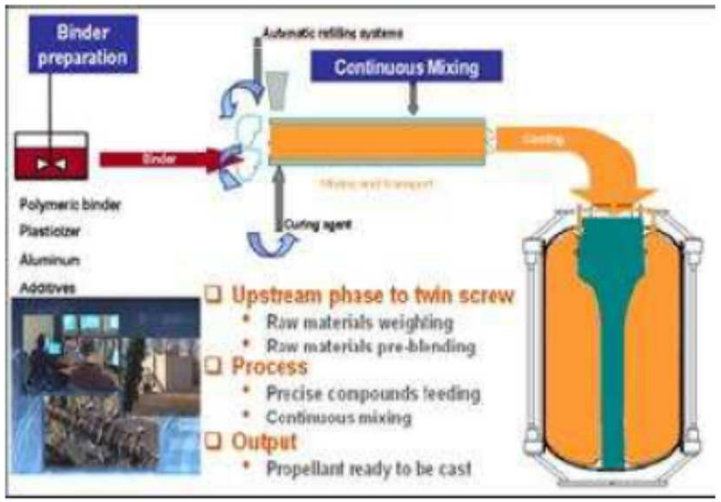
Technological Demonstrators for A6

SOLID PROPULSION : BI-SCREW NEW PROCESS

SRM : Continuous Mixing and Casting Demo.

From batch mixers
to
continuous twin screw

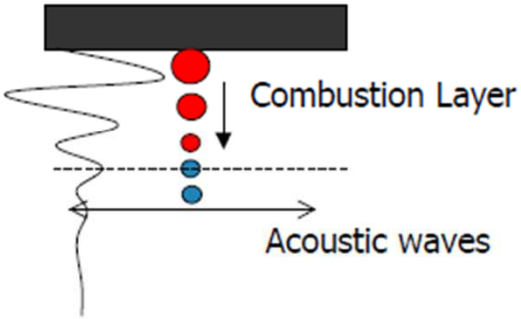
- **Objectives : reach TRL 5/6 for P180**
  - Low cost alternative to the “batch” mixing
  - Produce an ‘equivalent’ propellant
- **Program and activities :**
  - Test at pilot scale located at ESM
  - Validate process parameters influent on propellant behavior
  - Demonstrate the process robustness
  - Define scale 1 means and plant



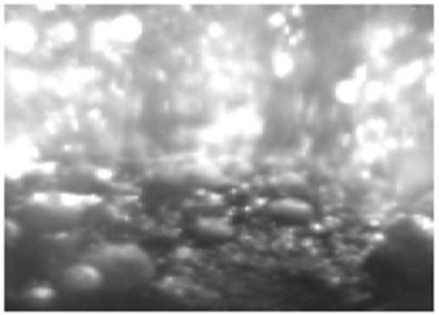
Technological Demonstrators for A6

SOLID PROPULSION : Combustion Instabilities Demo

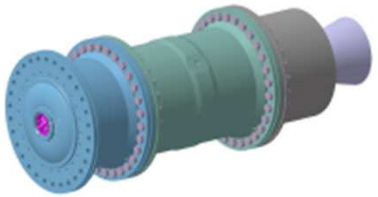
SRM PROJECT : Pressure Oscillation Demo.



Axial acoustic waves coupling with radial combustion layer can generates some pressure oscillation phenomenon's

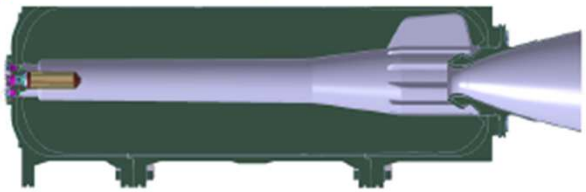


- **Program : select a propellant formulation and test it at subscale level**
  - Focusing on ITHAC pressure oscillation
  - Confirming that Vortex Shedding are not influent



- **Selected reduced scale**
  - Propellant mass 1.1 T
  - case length 2.2 m
  - Diameter 0,7 m

- **First planned firing test in 2014**



CONCLUSION

- Science and technology innovations are the key elements for an independent European access to space
- Optimization of industrial processes and operations are the key issues of A6 to reach low costs