CENTRE NATIONAL D'ÉTUDES SPATIALES

EUCASS

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R&T, demonstrators, systems studies: a logic for future European launchers

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Director of launchers

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1. Present situation
2. Evolution of launcher family in Europe
3. Orientation for future launch systems
4. Strategy to prepare the future
5. Research and technologies
6. Technology and system demonstrators
7. Prospective / Younger generation
8. Conclusion

Today's European Launchers: a global offer

VEGA SOYOUZ in French Guiana ARIANE 5 GS ARIANE 5 ES / ATV ARIANE 5 ECA

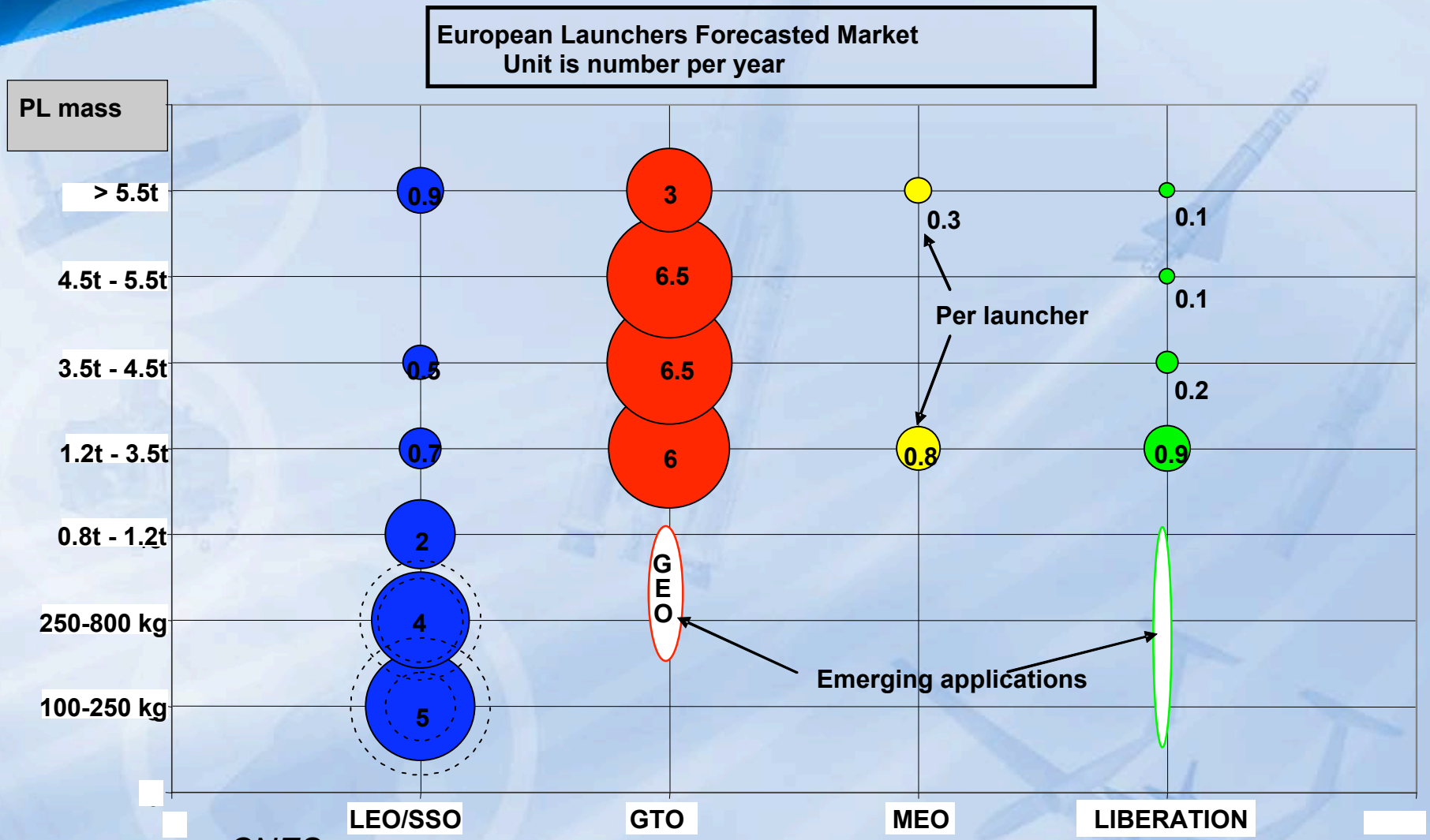
Future Launcher Studies

Improvement

Evolution

Revolution

Market considerations



sources : CNES

Evolution of launcher family in Europe

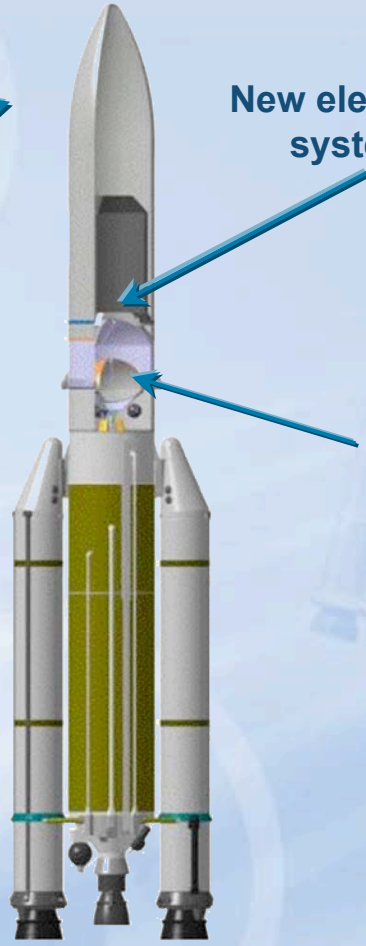
Potential evolution of ARIANE 5

ARIANE 5 ME

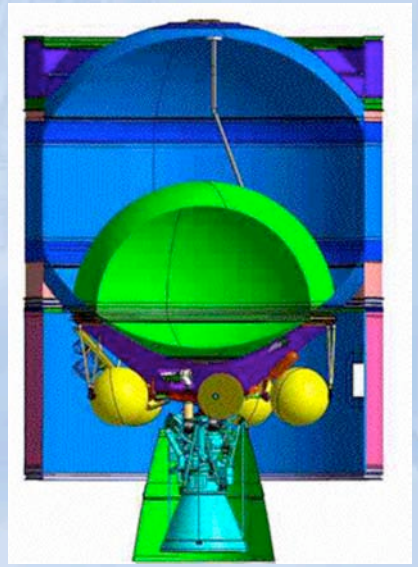
Performance (11,5T GTO) and versatility

Long fairing
H: 20m

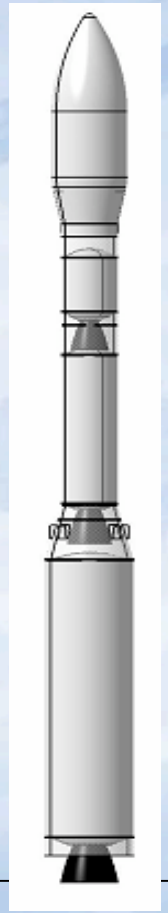
New electrical system



New cryogenic upper stage
ESC B / Vinci



Potential evolution of VEGA

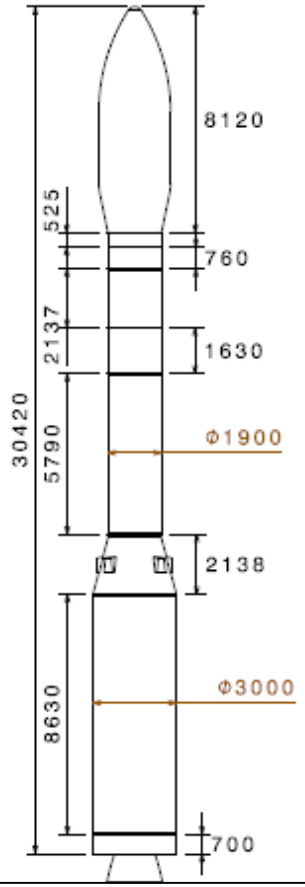


Z9

Z23

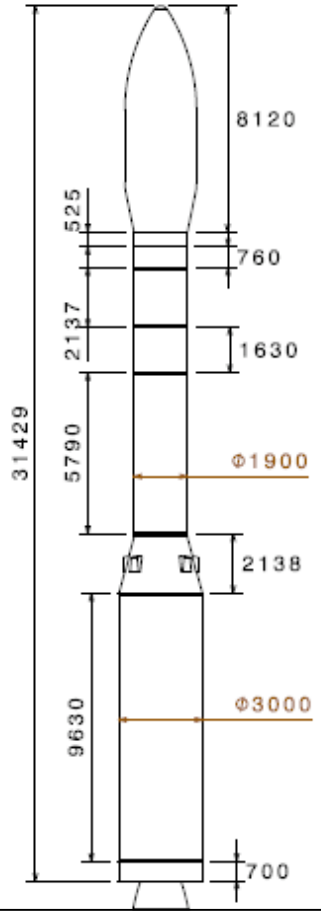
P80

VEGA Reference



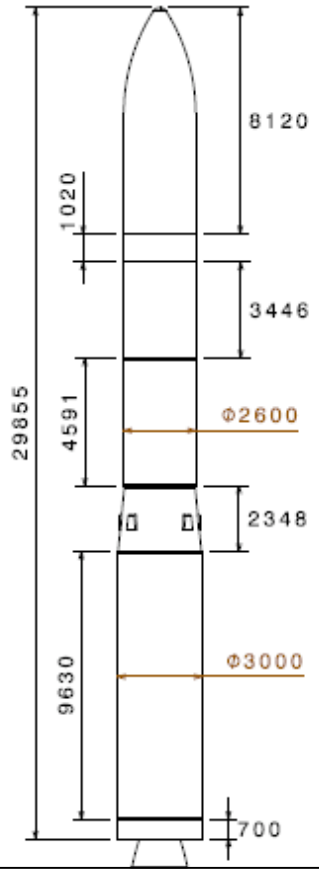
Référence

VEGA Reference +P100



P100-Z23-Z9-Avum

VEGA +



P100-Z40-L7
(Aestus 2)

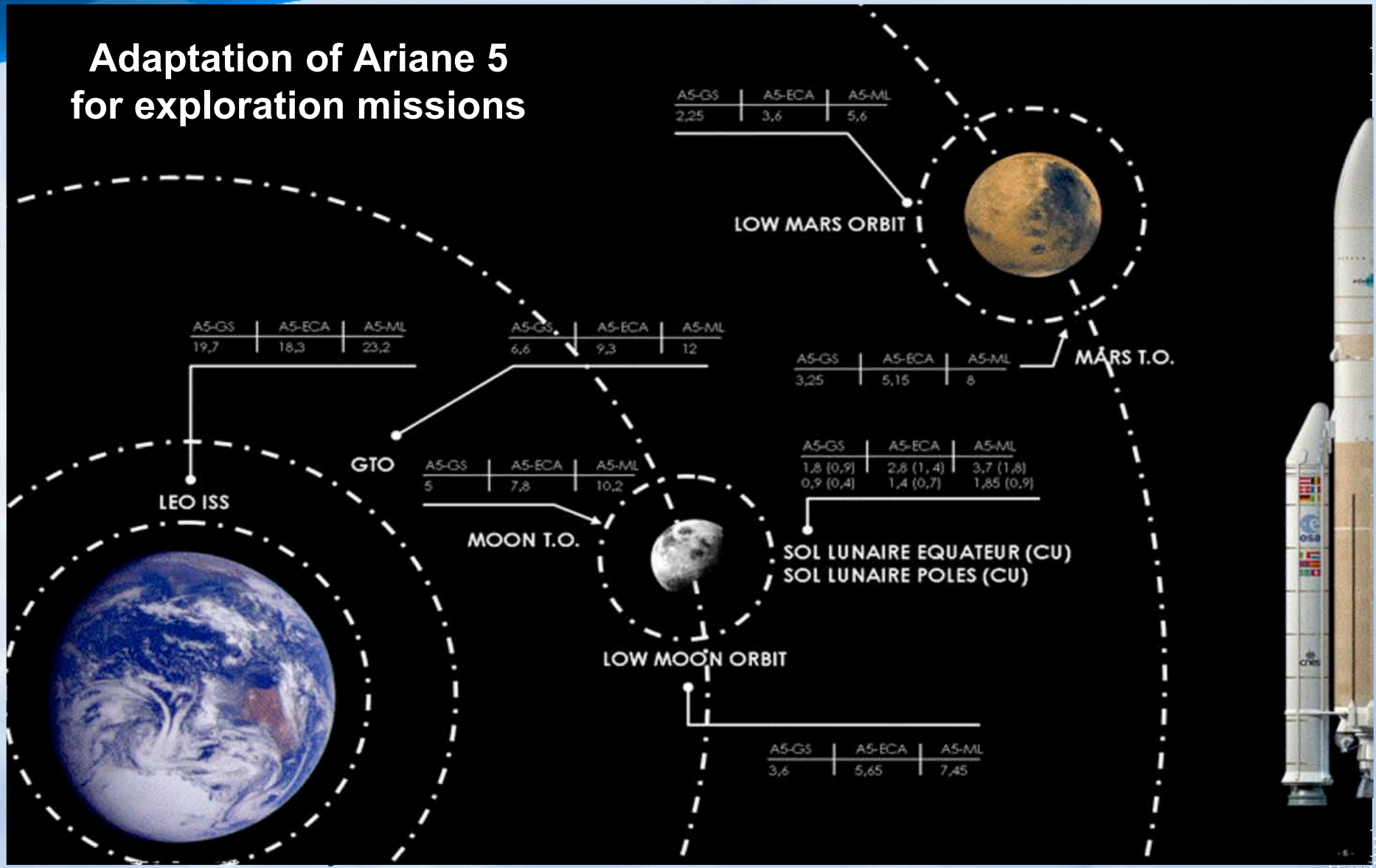
L7

Z40

P100

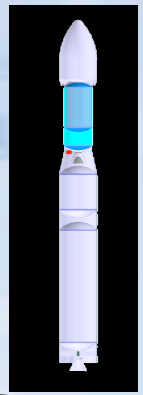
New Missions

Adaptation of Ariane 5 for exploration missions



Orientation for future launch systems

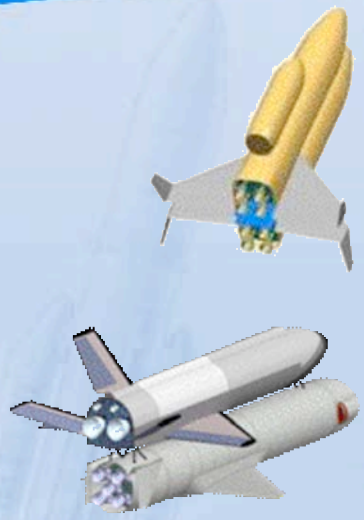
Future launch systems



Ariane 6

Expandable launchers

Semi reusable launchers



Reusable launchers

INTER OPERABILITY

Inovative systems

DUAL USE AND REACTIVE SYSTEMS
(Civil / Defense)

CUSTOMISATION

HYBRID SYSTEMS
(launcher + satellite)

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Ariane 6 potential configurations

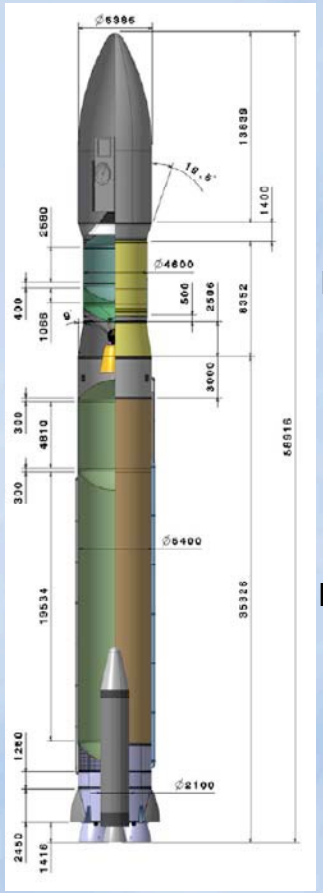
P : solid propellant
C : Oxygen / Hydrocarbon
H : Oxygen / Hydrogen

H 28

P 88

P 180

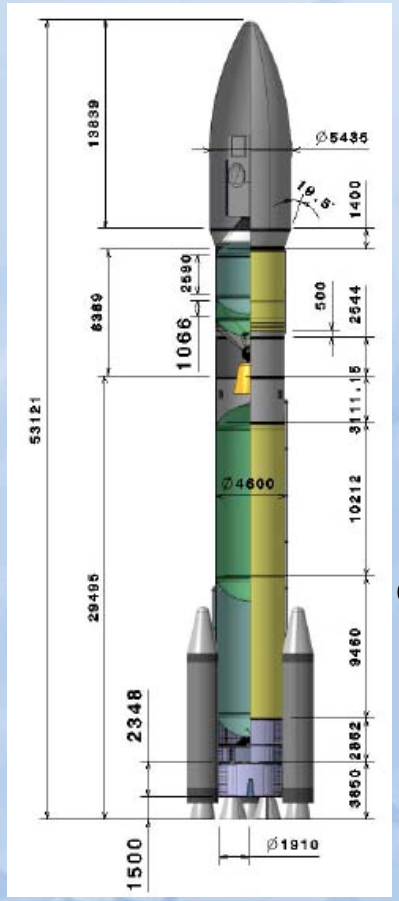
0 / 2 / 4 / 6
P40 solid boosters



H 30

H 205

0 / 2
P47 solid boosters



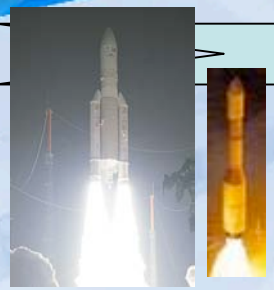
H 30

C 270

0 / 3
P40 solid boosters

Strategy to prepare the future

Innovative process to prepare the future



Existing Launchers exploitation & improvement

Reliability

Cost Reduction

Competences Preservation

Lessons learned

Techno Demonstrators

Feed back from Demonstration tests results

Focus R&T actions on demonstrators

Space applications

System studies

Consider results from R&T

R&T

Define R&T orientations

Development phase

New needs

NGL development preparation

Research & Technologies

R & T - Objectives

Objectives and activities

- **Five objectives:**
  - Reliability
  - Payloads comfort
  - Technology for future Launchers
  - Simulation
  - Free Studies
- **Six technical domains:**
  - Liquid propulsion
  - Solid propulsion
  - Mechanical Structures
  - Environmental behavior
  - Avionics and software
  - Guidance / navigation / control.

R & T

Research : Knowledge of the complex phenomenon which happen in Space Transportation Systems.

R & T

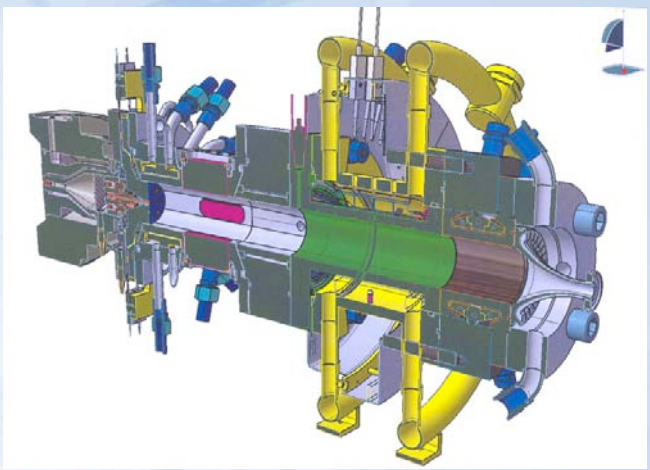
Technology : Maturation of Technologies necessary to improve existing systems or needed for new systems feasibility and development.

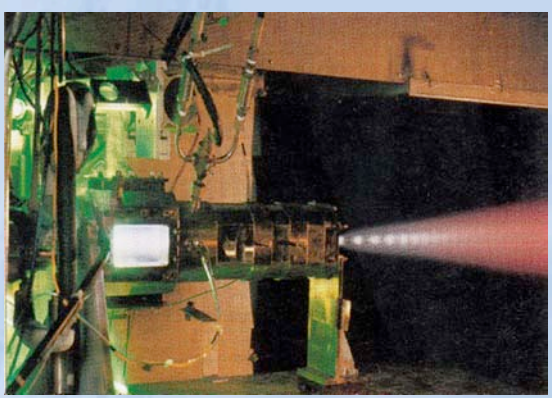
Research & Technology

Liquid Propulsion

Objectives:
* longer life time
* increased reliability
* cost reduction
* thrust modulation
* propellant management

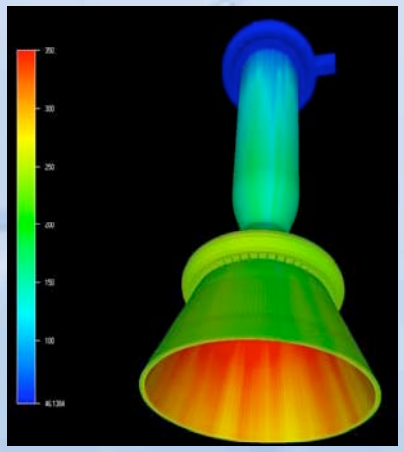
High mixture ratio combustion test facility



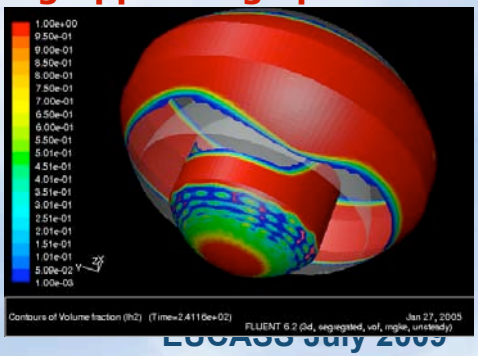


Mascotte combustion test facility

VINCI Engine combustion simulation

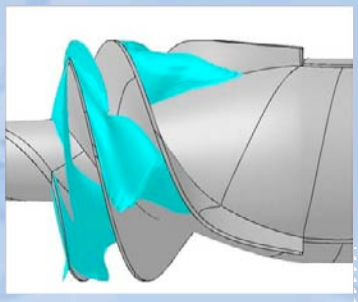


Cryogenic propellant behaviour during upper stage passivation



High frequency combustion unstability simulation device

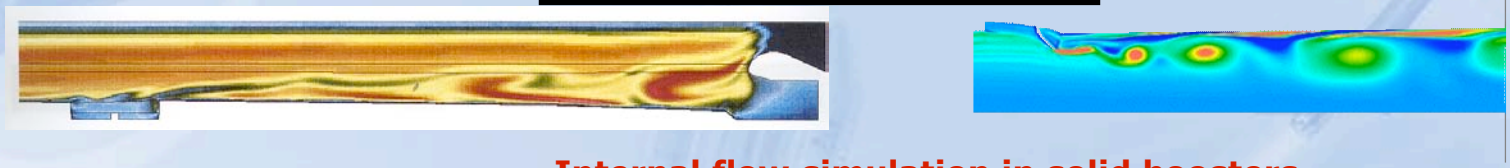
Cavitation in cryogenic hydrogen turbo pomp



Research & Technology

Solid Propulsion

Objectives: * safety
* increased reliability
* cost reduction
* environment
* dynamic behaviour



Internal flow simulation in solid boosters

Advanced processes tests

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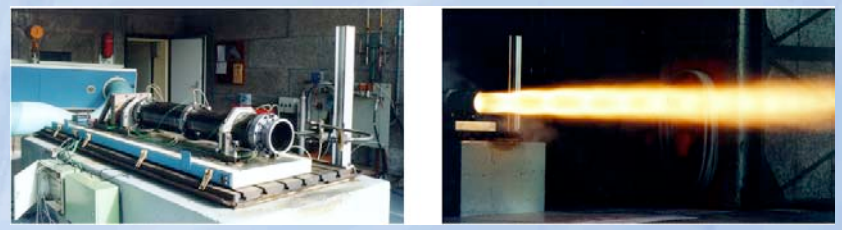


New propellants tests

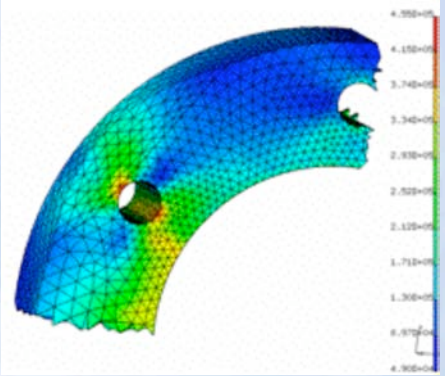
Combustion research

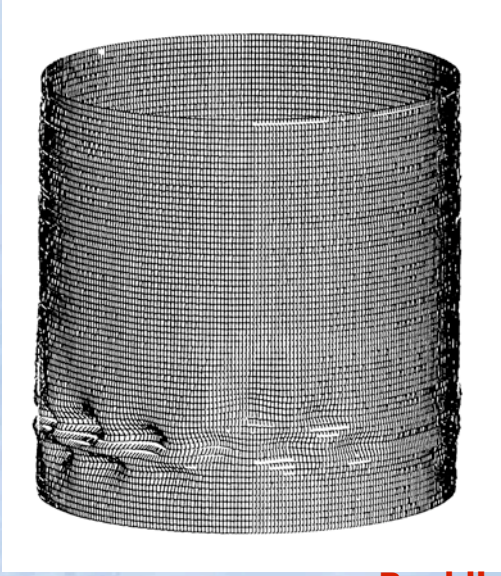
Research & Technology

Structures and materials

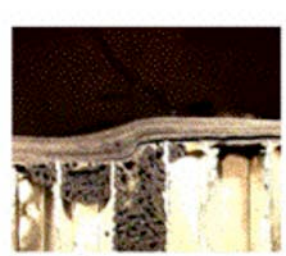
Objectives:
* performance
* damage tolerance
* cost reduction
* controlability

Non linear simulation

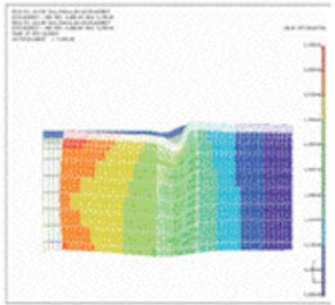




Buckling simulation and test



Prise en compte d'un défaut



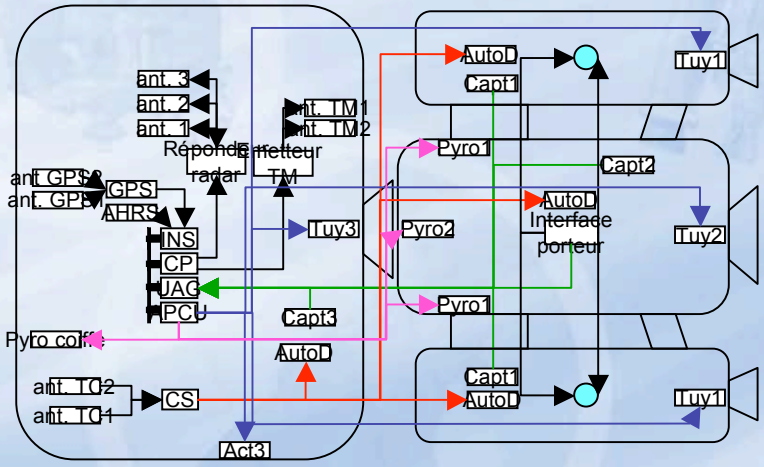
Modélisation fine du défaut

Composite materials tests
Failure modes evaluation

Avionics and components

Objectives: * cost reduction
* reliability
* overall control

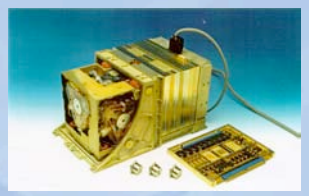
Advanced avionic architecture



Equipments and components

- electromagnetic compatibility
- radiations effects

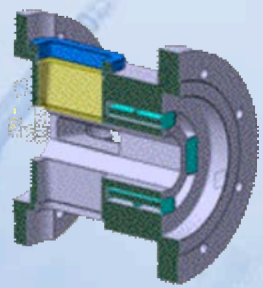




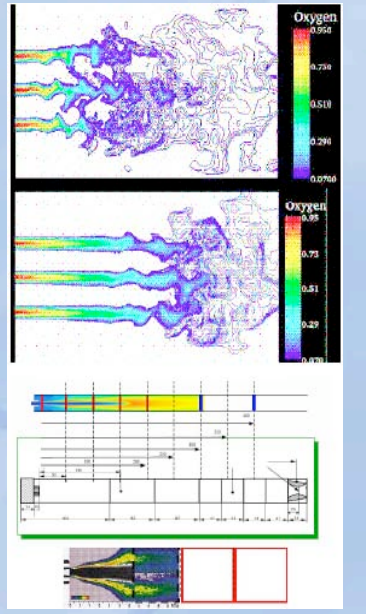

Research & Technology

European Research Groups for complex and sensitive topics (combustion, dynamics, shocks, aerodynamics,…)

ATAC



REST



LES Simulation – MASCOTTE Campaign HF4

OURAL research program

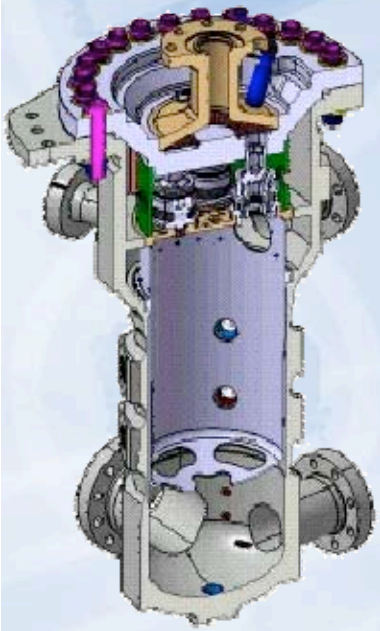
- **Cooperation between CNES & ROSKOSMOS initiated in 2005**
- **Objective: to commonly study the concepts & technolgies for new generation launchers (2025-2030)**
- **Main results [2005-2008]:**
  - System studies
  - LOX/ Methane engine test (KVD-1)
  - Resusable Cryogenic tank design
  - Flight demonstrators
- **Decision to focus on a small scale flight demonstator**

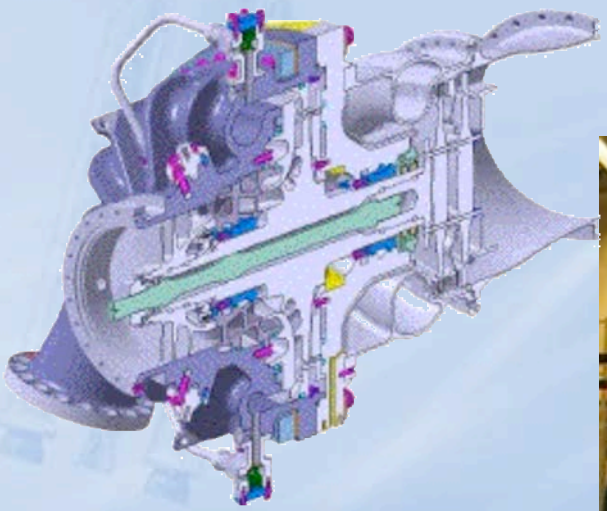
Technology and system demonstrators

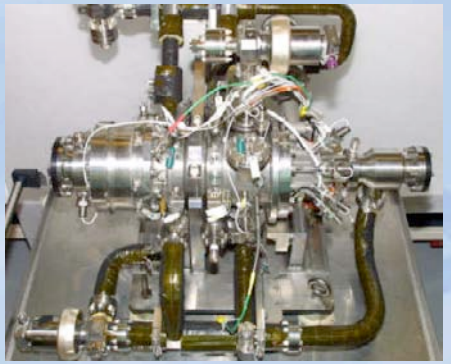
TECHNOLOGY DEMONSTRATORS

VULCAIN X

Advanced cryogenic propulsion (tests in 2009 / 2010)





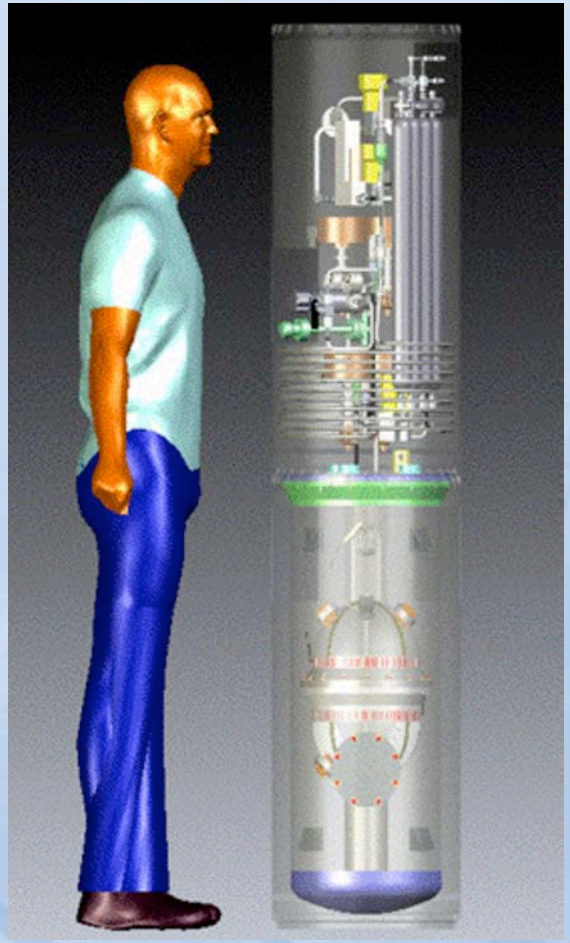


TECHNOLOGY DEMONSTRATORS

H X

Advanced cryogenic upper stage

(tests in 2009 / 2011)



« on ground» demonstration

« in flight» demonstration

SYSTEM DEMONSTRATOR

ALDEBARAN

Flight test bed to mature technologies and prepare concepts for future launchers

(potential tests in 2016 /2017)

A : « classical ELV »

« Reference » ELV

Possible stage configurations :

C-C, H-H, C-H, P-C, P-H, P-P-C, etc.

P : solid propellant;
C : hydrocarbon;
H : Hydrogen

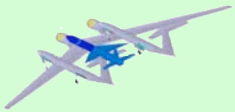
B : « airborne ELV »

B1 : under fighter (linear)

P-C, P-P-C, (P-H)

B2 : under fighter (multi body)

P-P-C, (P-P-H)



B3 : under drones or specific carrier

P-C, P-H, P-P-C, C-C, C-H …

B4 : inside carrier

P-C, P-P-C, P-P-H, C-C

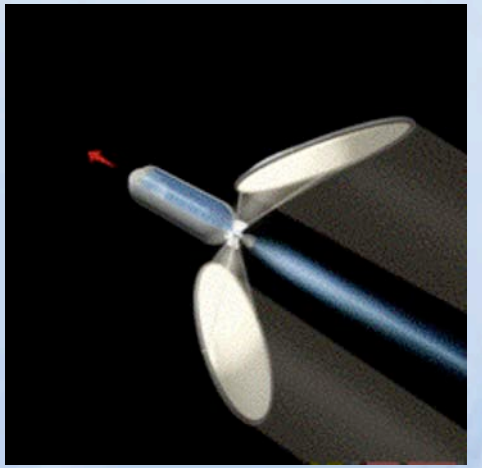
Non exhaustive …

Prospective

Younger generation

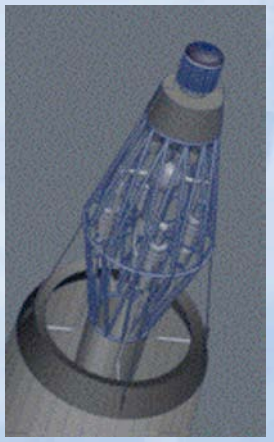
Prospective

Combined propulsion



Low thrust transfer stage

Nucleo electric tranfer stages



Laser energy transfer

Tether

PERSEUS

A projet of nano lauch system to innovate and motivate a new generation of engineers

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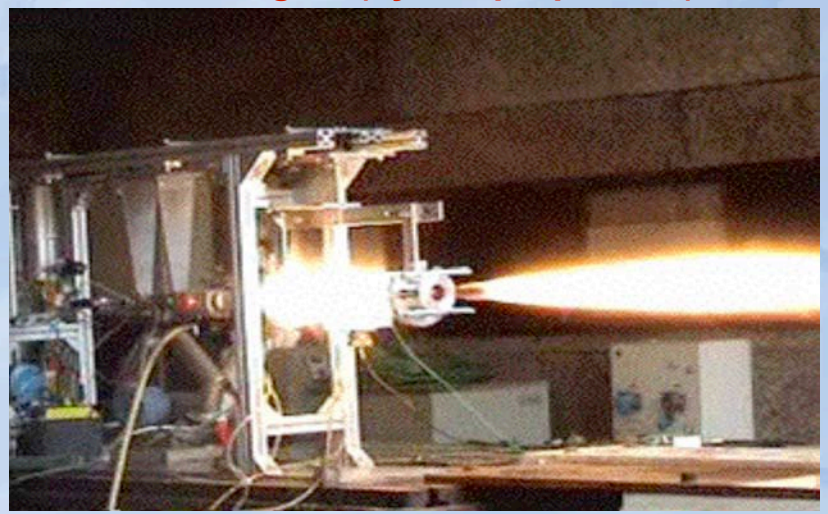
FUSEX engine (hybrid propulsion)



CONCLUSIONS

- **Preparation of future launch systems need to develop:**
  - Scientific approach of complex phenomena for system and propulsion.
  - Simulation capability including muti disciplinary approach
  - Demonstrations of key technologies by tests at system and sub system levels.
  - System approach including launcher, launch facilities and operations.
  - Strong management of the loop “R&T / Demonstrators / System studies”
  - “design to” approach focused on challenging objectives (design to cost, design to environme design to safety and reliability, design to operability…)
  - “lessons learned” approach from operational phase and past developments
  - Reinforced cooperation between R&D programmes in Europe (EU, ESA, States, regions…)
  - International cooperation for new missions like exploration

- **Decisions for Ariane 5 ME development programme and Ariane 6 preparatory programme will lay upon:**
  - Evolution of institutional and commercial needs
  - Emergence of new space applications
  - Evolution of competitive environment
  - Maturation status of key technologies
  - Preliminary definition status of launch systems
  - Commitment of industry