Hellenic Technological Capabilities

Upstream segment

Advanced Structures, Mechanisms, Materials for Spacecraft, Satellite, Launchers

Dr. Christos Kyriazoglou
CBDO, INASCO HELLAS

Ukraine - Greece: Join Interests in Space Area, 24.02.2021, Videoconference

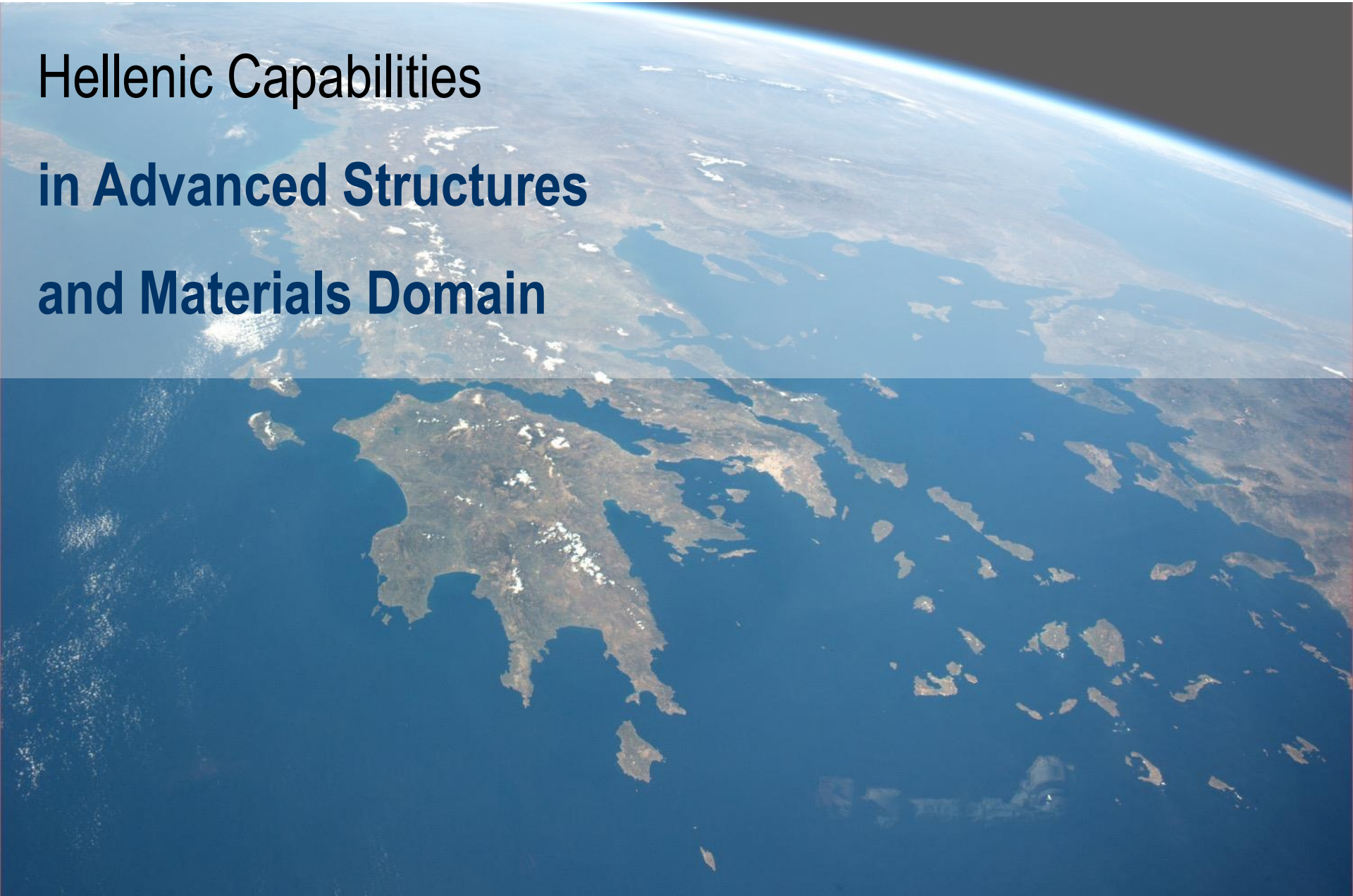
Contents

si·cluster
a corallia initiative

EBIAITE
Hellenic Association of Space Industry

Hellenic Capabilities

in Advanced Structures and Materials Domain



Upstream:

Materials & Structures

7 industrial **SME** + **3** academic labs

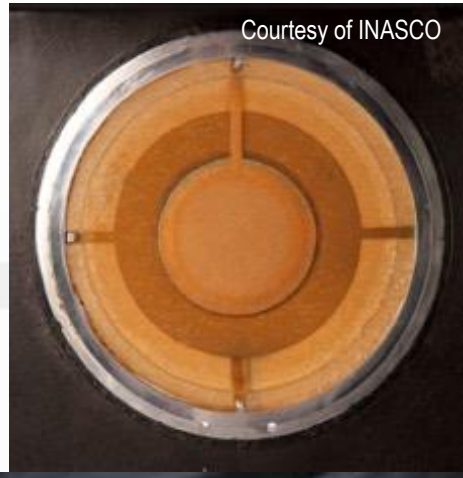
Technologies offered for S/C and Launcher Applications

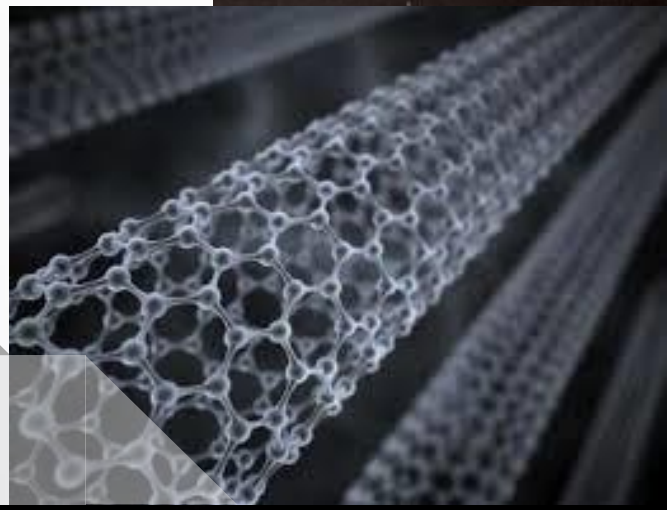
- Composites Materials & Structures
- Novel Materials and Processes
- Deployable Technologies
- High precision mechanisms
- MGSE and Harnessing
- Multiphysics and Material Modelling simulations
- Engineering Support and Technical Documentation
- Structural and thermal design & analysis

a Multifunctional Composites

Next Gen-Multifunctional Composites provide load bearing but also additional capabilities

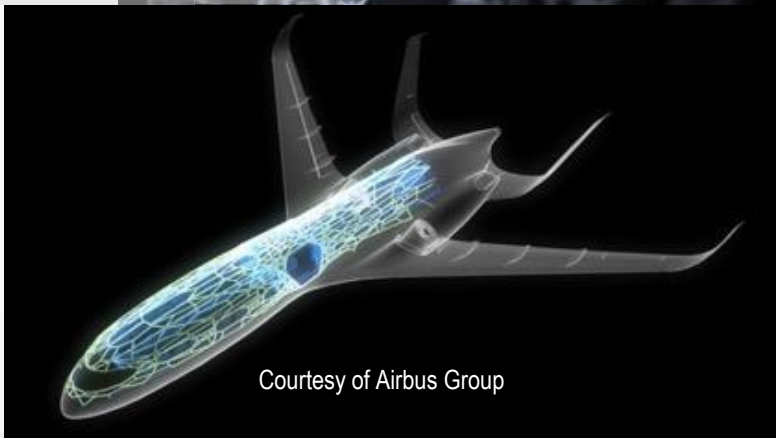
Targets:
acoustic damping,
embedding sensor networks-SHM
Increase electrical conductivity


Courtesy of INASCO



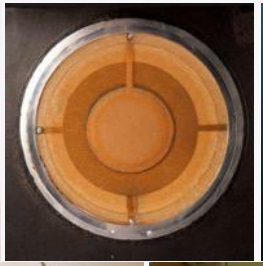
Significant challenges are presented, like:

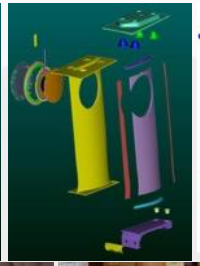
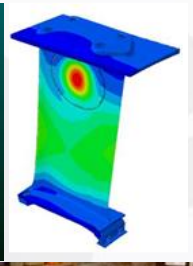
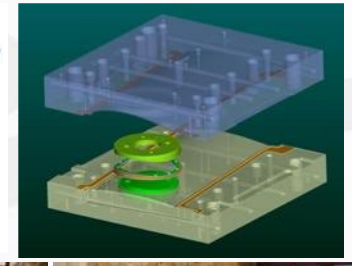
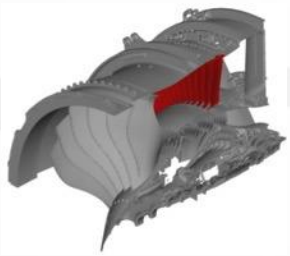
- *increase in the complexity of the manufacturability*
- *functionalization*


Courtesy of Airbus Group

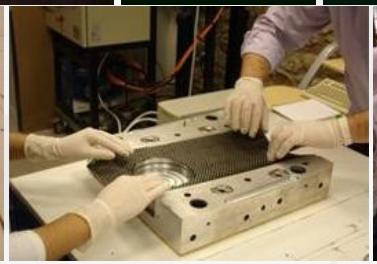
Aircraft Jet-Engine Outer Guide Vane

with integrated active damping elements (CFM-56 engine)

CFP-56 engine cut-out

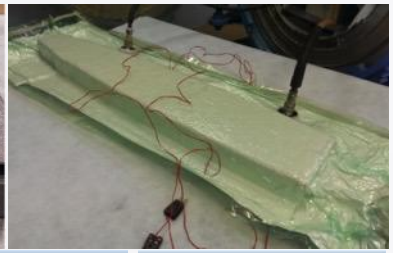
Features

- VARTM One-Shot manufacturing (OoA)
- CFRP Aerospace grade, High Temp
- Process Monitoring HW/SW for QA
- Critical Process Parameter Selection

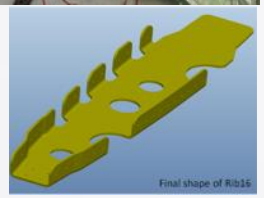
Regional Aircraft Wing Box Rib

with integrated Fiber Optic Sensors for SHM

Design, MAIT performed by INASCO HELLAS





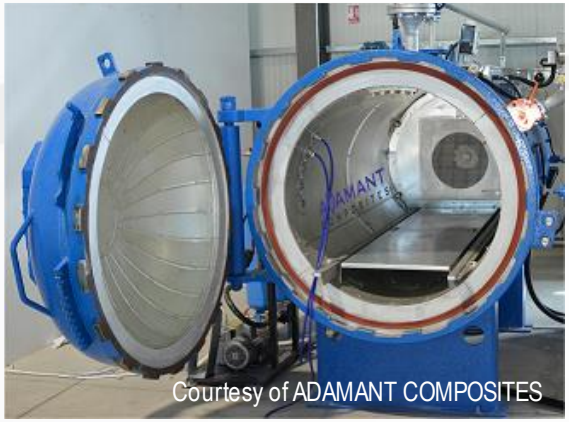
Features

- Autoclave manufacturing
- CFRP Aerospace grade, High Temp
- Integrated network of FBGs for Structural Health Monitoring

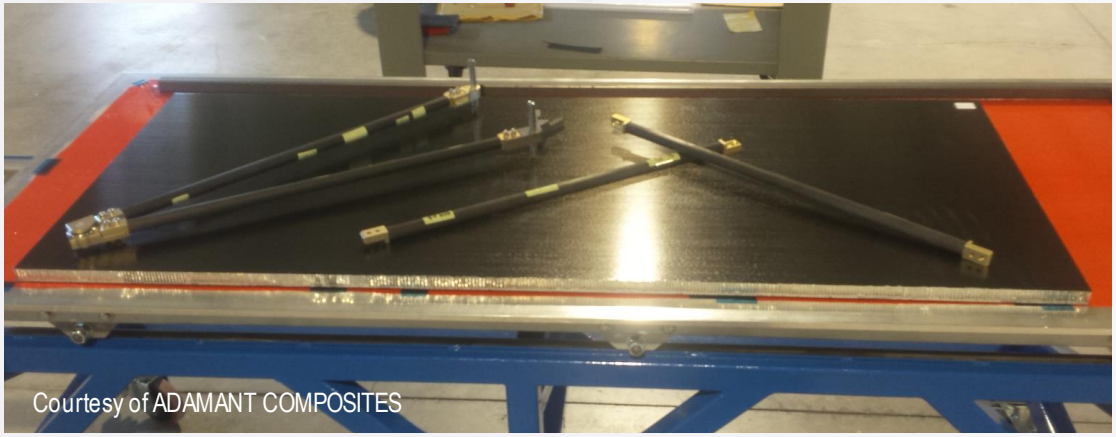
b.1 Composites Manufacturing

Autoclave Manufacturing

- Design and Development of Composites Structures
- MAIT of raw sandwich panels
- MAIT of CFRP/Al struts
- Enclosures
- Monolithic parts brackets and joints
- Composites Material Scientific and Engineering Support



Features:
Cyanate Ester CFRP
M-series (High Modulus) Fibres processing
Bonding and Assembly processes (film & liquid adhesives)



b.2 Composites Manufacturing

Out of Autoclave Manufacturing

Out-of-Autoclave manufacturing of large size composites space structures is gaining momentum due to:

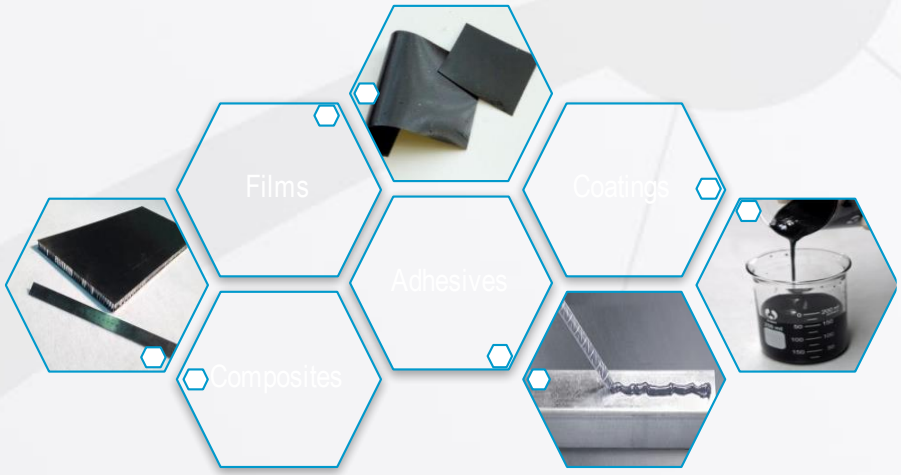
Lower capital expenditure and operational costs necessary for acquiring and operating the production infrastructure

Increased design flexibility vs partial in-flexibility inherent to an autoclave vessel sizes and geometry

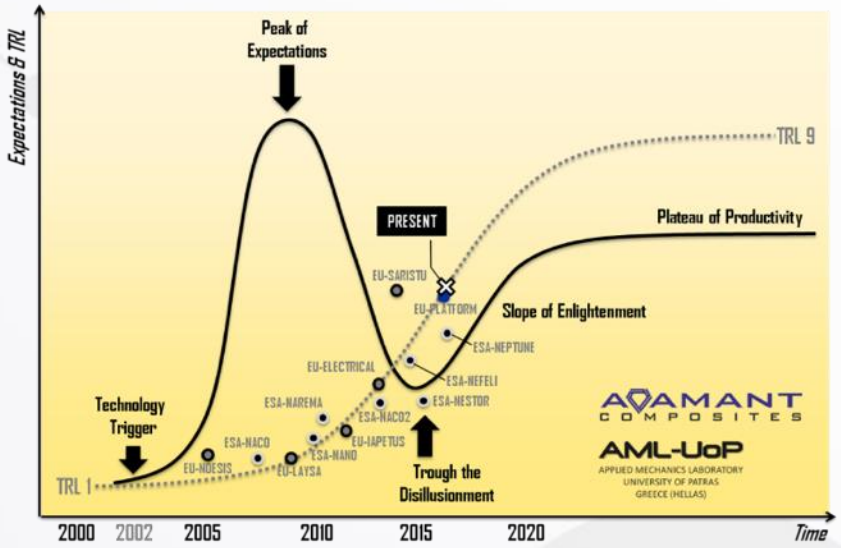
OoA is a sustainable and attractive manufacturing option for niche SME that are now entering the composites manufacturing sector of the Space Market, especially for applications like launchers, small-medium-large satellites

c Nano-enabled Materials

For multi-functional components…



A critical review of nanotechnologies for composite aerospace structures. Kostopoulos et al. ,CEAS Space J. DOI 10.1007/s12567-016-0123-7. 08 July 2016

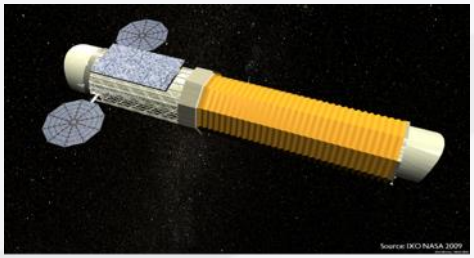


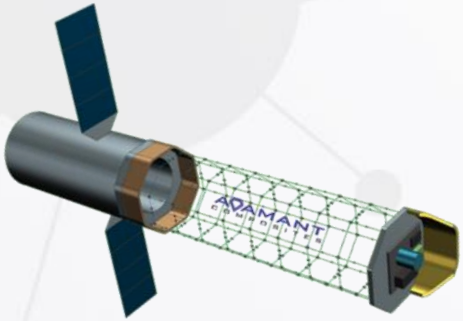
ESA Projects in the field

- ESA-NESTOR (ADAMANT COMPOSITES, AML-UOP)
- ESA-NEFELI (ADAMANT COMPOSITES, AML-UOP)
- ESA-NEPTUNE (ADAMANT COMPOSITES, AML-UOP)
- ESA-GOETHE (ADAMANT COMPOSITES, AML-UOP, PLEIONE ENERGY)
- ESA-GADGET (ADAMANT COMPOSITES, AML-UOP, PLEIONE ENERGY)
- ESA-NANOPREG (AML-UOP, INASCO)
- ESA-NANO (AML-UOP)

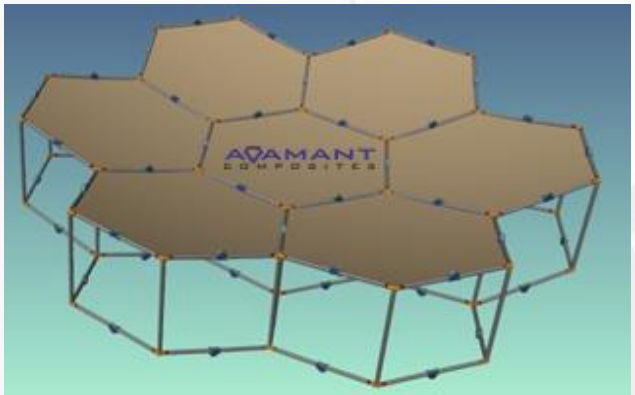
d Deployable Structures

..for future science telescopes..
.. for next generation telecom Antennas & EO SAR-radars



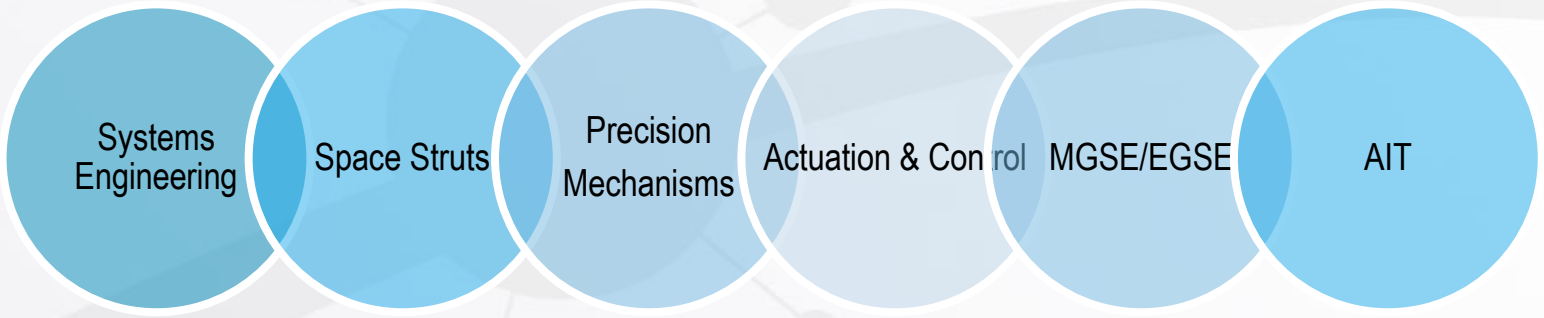


- Design and Development of Large Stable Deployable Structures for Future Science Missions
- Development program funded under ESA in collaboration with Greek Industry
- Assembly, Integration and Testing (AIT) Infrastructure including Gravity of Loading, Ultra high precision Metrology and Assembly Room already implemented in Greece.
- Development of a strong Industrial and Academic team.
- Parallel Technology Development and Heritage Build Up on CFRP/Ti Struts, Mechanisms, Motorization, High Precision Machining.
- Expansion in Deployable Antennas, EO SAR-radars.



Deployable Technologies Developments
ADAMANT COMPOSITES LTD

Parallel Technology Development and Heritage Build Up



e Robotics & Mechanisms

..for On Orbit Servicing..
..for deploying and positioning..

On Orbit Servicing (OOS) with Space Manipulators

- Active Debris Removal
- ORUs Replacement (capability of upgrade and servicing)
- Refueling
- Additional revenue due to the Extension of lifetime of current operational satellites for 5-10 years
- Necessary to all orbits, from LEO to GEO
- Many activities of ESA (like eDeorbit and Clean Space) focus on OOS capabilities
- USA, Japan are ahead on this field (e.g. Orbital Express, ETS-VII), Europe has to be self-sufficient

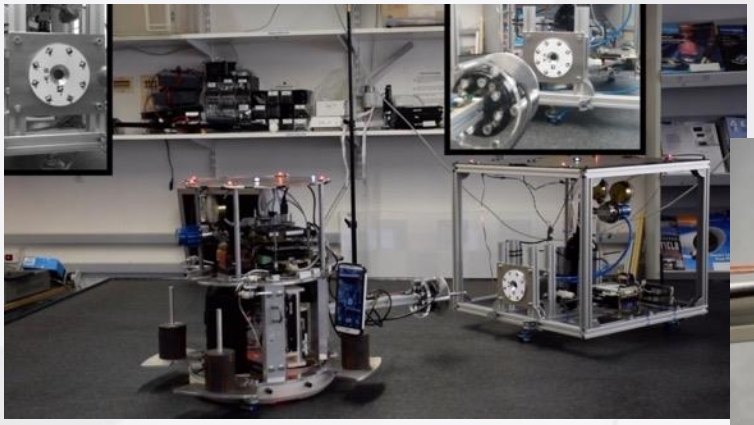
Deployment Mechanisms (DM)

- Lightweight & ultra stable trusses
- Articulated deployable booms
- Precision Motorization Systems

Robotic refueling of Satellites -ESA ASSIST Project

CSL , Control Systems Lab, NTUA

CSL developed the dynamically equivalent satellite mockups and tested the breadboard developed by the consortium



Capabilities

Air Table Space Emulator

Robotics and Automation in Space

Modeling, Dynamics and Control of Space Systems

Mechanical and Mechatronic System Design

ESA Projects in the field

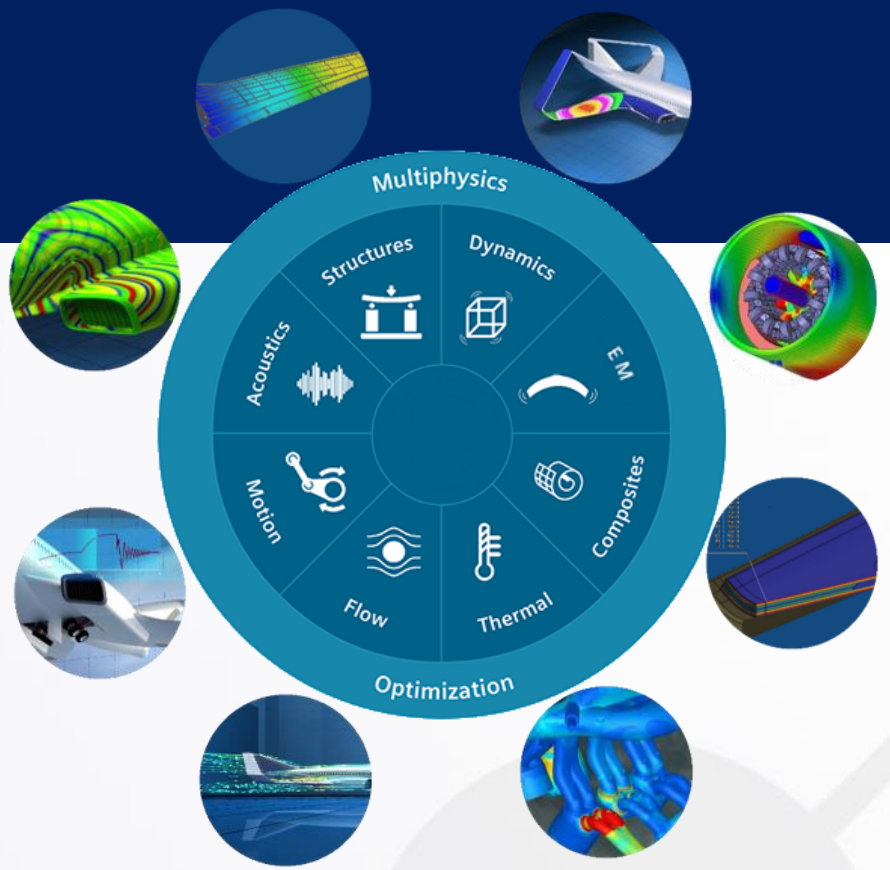
Pre-Development of a Launch Adapter Ring Gripper (ESA PREDATOR)

Control and Management of Robotics Active Debris Removal (ESA COMRADE)

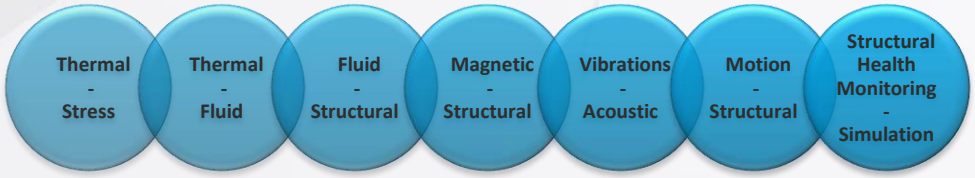
Adaptable Wheels for Exploration of Moon Poles (ESA AWE)

f Multi-Physics Analysis

Structures operating at space, experience a combination of loads whose impact affect their performance



Typically, effects from one physics domain also impact how a product behaves in another physics domain.



Understanding multi-physics behavior is therefore a major challenge to accurately predicting product performance

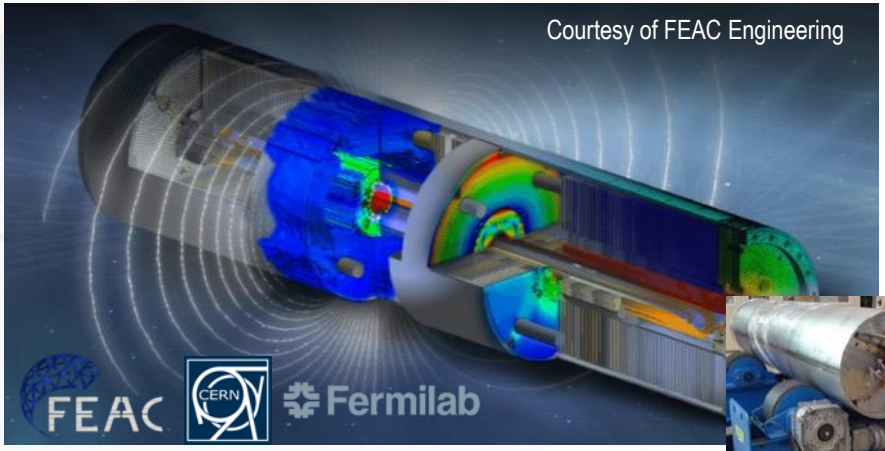
Simulating correctly the real-world behavior, in its digital twin, prior to construction of the product

Images Courtesy of
FEAC Engineering

(11T) high energy superconducting accelerator dipole magnet installed at LHC/CERN

-FEAC Engineering

Electromagnetic – Fluid – Thermal – Structural Interaction

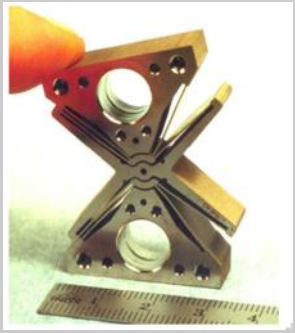


The 11T magnet will be the most powerful magnet ever installed in an particle accelerator. It will push the LHC towards its energy upgrade, on its quest to discover our solar system's origin. The test results performed at CERN confirmed the simulation results.

Large Angle Flexible Pivot for Science Application-ESA CTP project LAFP

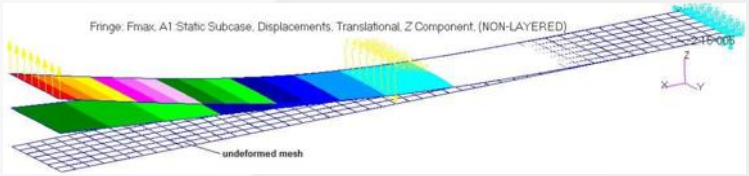
-Heron Engineering

- Non Linear Geometric (factors, verification)
- Thermo – Mechanical (Non Linear)
- Dynamic (sine & random)
- Fatigue and Damage Tolerance



Courtesy of CSEM

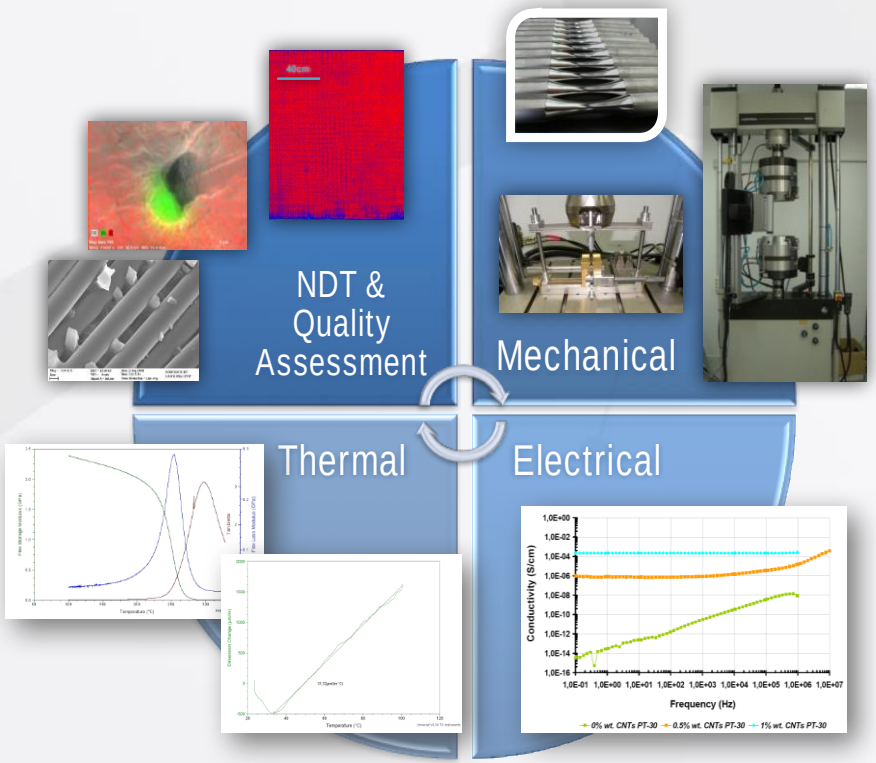
Simulation of delamination in composite structures under cycling / fatigue loads

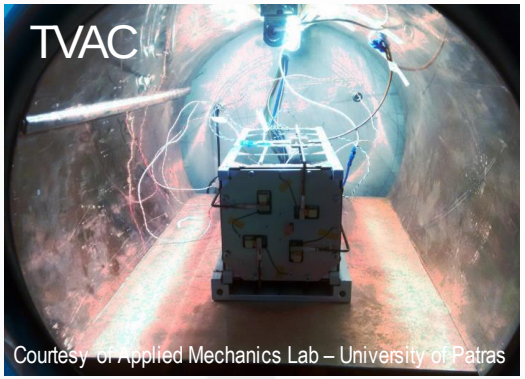


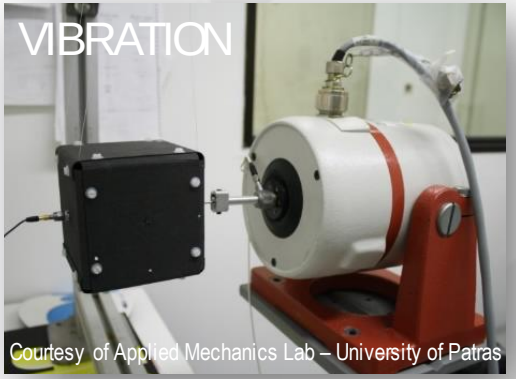
Courtesy of Heron Engineering

g Materials & Components Testing

From Material Characterization…
…. To component testing







UNIVERSITY OF PATRAS
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ

si·cluster
a corallia initiative

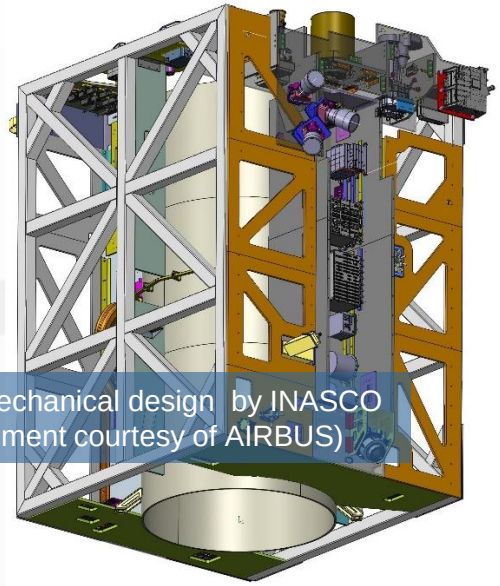
ΕΒΙΔΙΤΕ
Hellenic Association of Space Industry

Hellenic Flagship Activities

a ESA Space Missions

JUICE Spacecraft EM, PFM

Jupiter Icy Moons Explorer



SEMS mechanical design by INASCO
(equipment courtesy of AIRBUS)

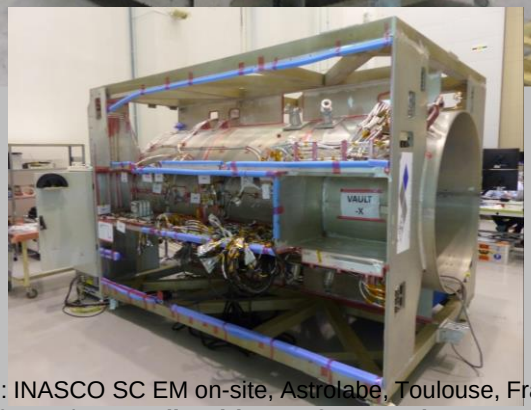
S/C EM Structure (SEMS), Transport Containers. MGSE

INASCO HELLAS

Prime: Design, Development, MAIT

FEAC ENGINEERING

Sub-co: Analysis



Images: INASCO SC EM on-site, Astrolabe, Toulouse, France
Ready for testing, ***Credit: Airbus Defence and Space***

S/C MGSE:

Stands & Trolleys

ADAMANT COMPOSITES (subco)

GRADEL

Responsible for:

- Structural Analysis & Verification of Design for MPT and VIS
- Magnetic Analysis
- Staging Design and MAIT

Lifting & Handling Devices

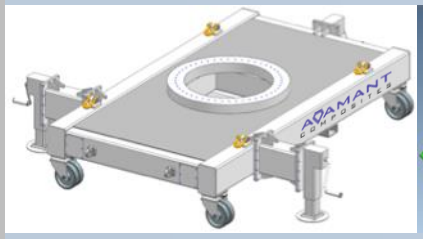
ADAMANT COMPOSITES (subco)

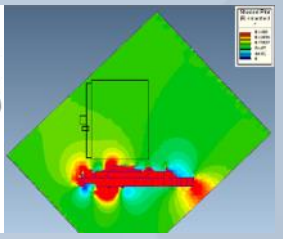
GRADEL

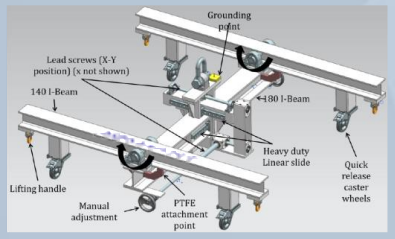
sonaca space

Responsible for:

- Structural Analysis and Verification of Design for SLD, SLLD, and HULD devices
- Magnetic Analysis







JUICE is the first large-class mission in ESA's Cosmic Vision 2015-2025 programme

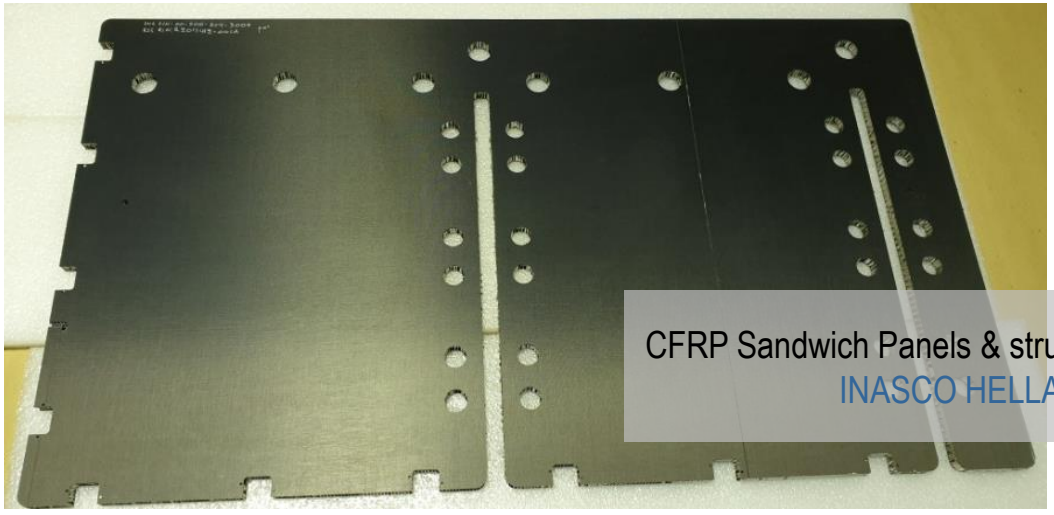
PLATO
PLAnetary Transits and Oscillations of stars

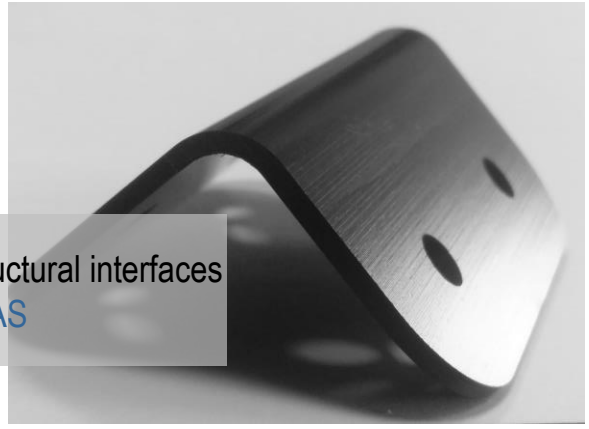
PLATO is the third medium-class mission in ESA's Cosmic Vision program 2015-2025; the PLATO OBA contract was carried under this program and is funded by the European Space Agency (ESA). https://sci.esa.int/web/plato
https://www.cosmos.esa.int/web/plato


Image: Artist's impression of the PLATO satellite (source: OHB System AG)

Manufacturing
CFRP sandwich panels
& structural interfaces by
INASCO HELLAS

INASCO has successfully delivered the CFRP sandwich panels and cleats for the STM OBA of the PLATO S/C; *to RUAG SPACE responsible Structure CT Member in the PLATO program*





CFRP Sandwich Panels & structural interfaces
INASCO HELLAS

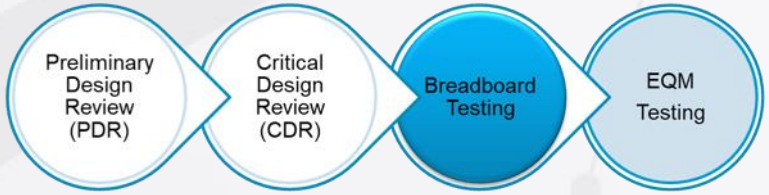
b ESA Technology Programs

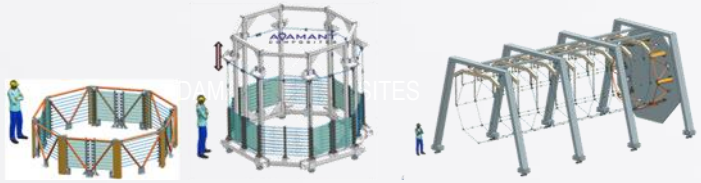
LAGARD: Large Stable Deployable Structures for Future Science Missions

Prime: ADAMANT COMPOSITES

Tasks Performed

- Deployable System Design, Analysis, Development, MAIT
- CFRP struts, precision mechanisms, motorization
- AIT of BB and EQM
- Gravity of Loading
- Ultra high precision Metrology





19 October 2017

BB Test Readiness Review @ Adamant Composites

Subcontractor: AML-UoPatras

Tasks Performed

- Multi-body dynamics simulation of deployable structures
- Development tests of breadboard elements
- Support in design, manufacturing and assembly of test equipment

Subcontractor: INASCO HELLAS

Tasks Performed

- Motorization Control System Implementation
- Selection and procurement of COTS components
- Software for Control

Vendor: IST

Tasks Performed

- MGSE Metallic Structures Manufacturing

c European Commission

SMILE - *SMall Innovative Launcher for Europe*

Features

Structural Design – FEA

Metal versus composites trade-off

Carbon composite honeycomb sandwich

Common stage and fairing separation systems (clamp band and plungers)

Engine thrust frames (conical and trusses)

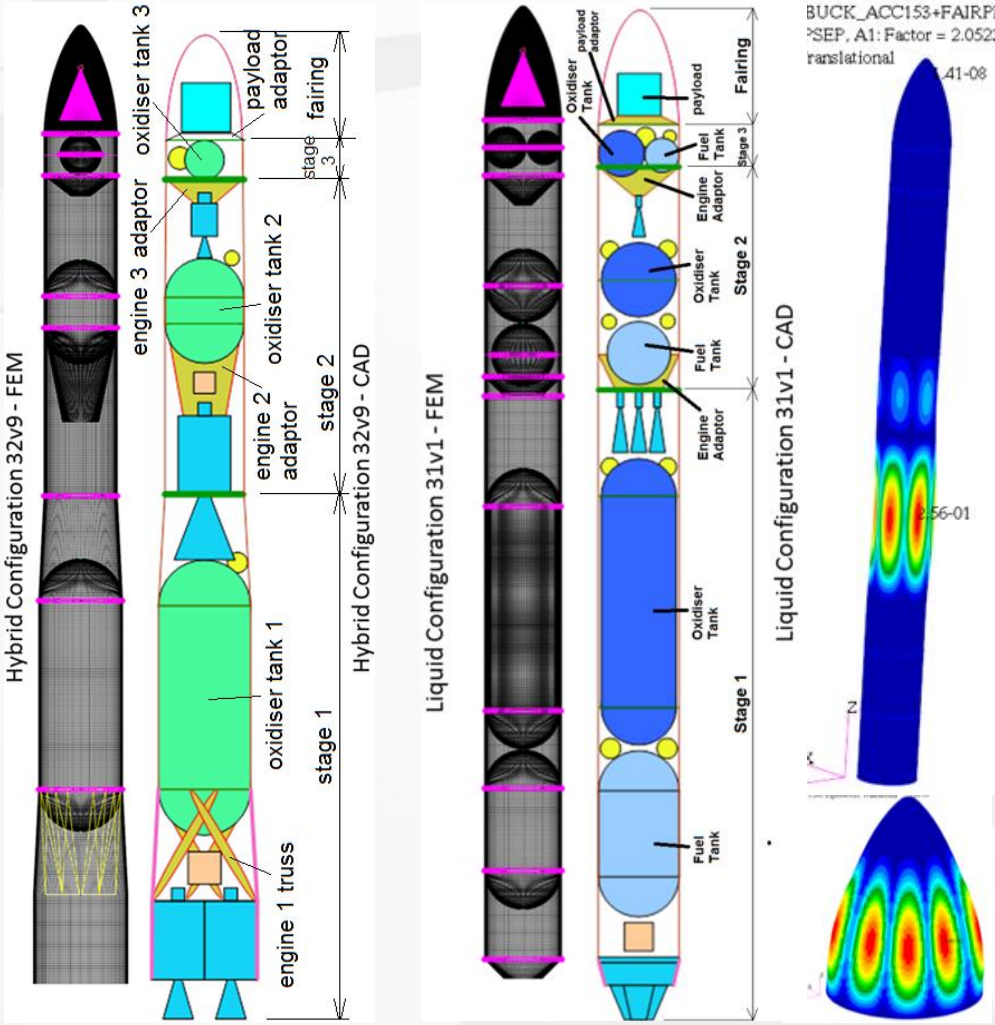
Tanks (separate and integrated)

EU Consortium

14 companies & institutes from 8 European countries

H2020–COMPET: Independent Access to Space

Design & Analysis performed by **Heron Engineering**



Images: Launcher CAD (hybrid-liquid configuration), Buckling Analysis: Launcher, Fairing

Thank you for your attention!