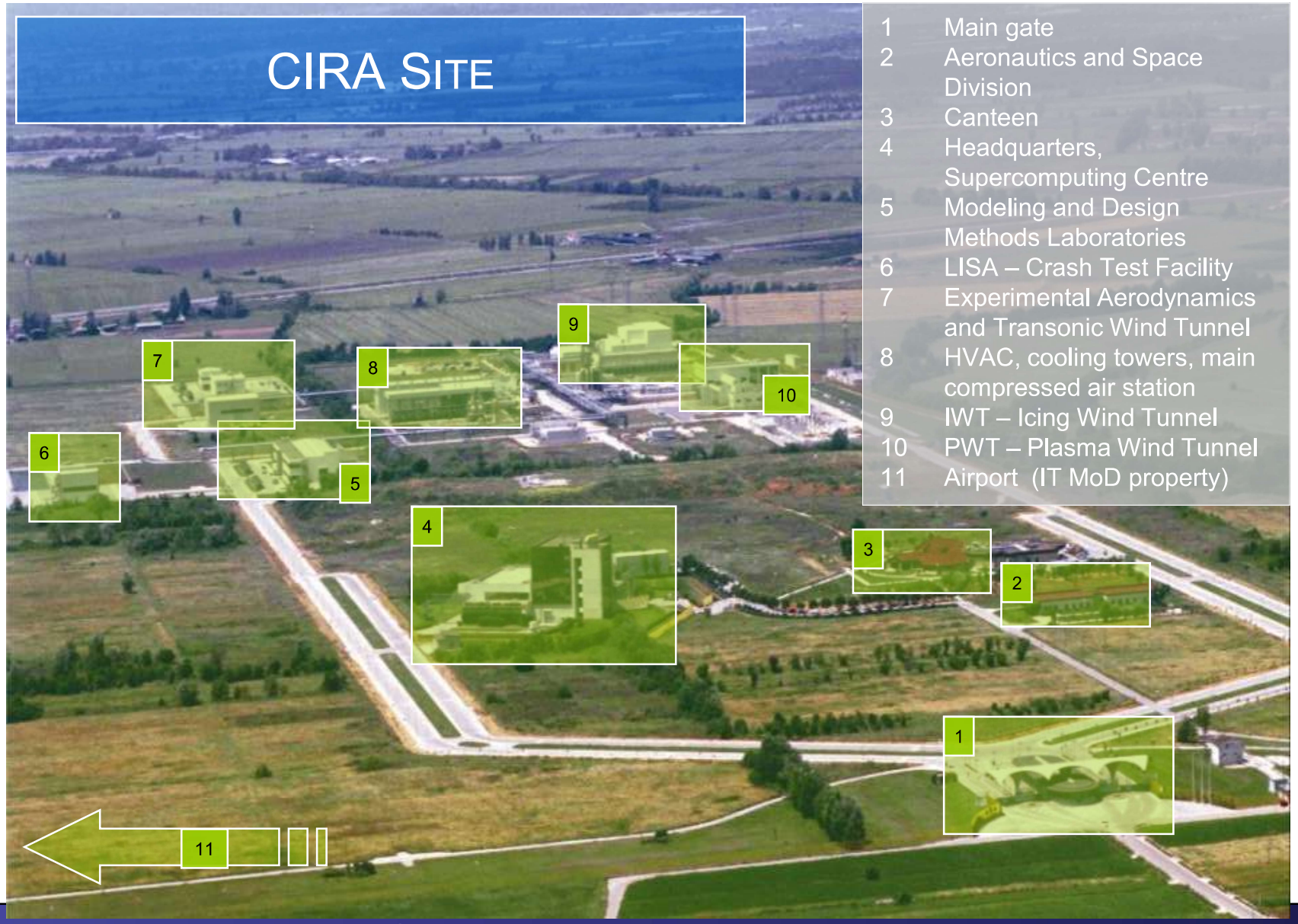
dal Concept al Prototipo in Composito: Sviluppi Tecnologici del Laboratorio di Prototipi in Materiale Composito del CIRA

Felice De Nicola

CIRA SITE



1 Main gate
2 Aeronautics and Space Division
3 Canteen
4 Headquarters, Supercomputing Centre
5 Modeling and Design Methods Laboratories
6 LISA – Crash Test Facility
7 Experimental Aerodynamics and Transonic Wind Tunnel
8 HVAC, cooling towers, main compressed air station
9 IWT – Icing Wind Tunnel
10 PWT – Plasma Wind Tunnel
11 Airport (IT MoD property)

IWT – Icing Wind Tunnel

Operational since 2003, is world unique for size, test envelope. Capable to simulate clouds within current and foreseen certification envelopes to improve flight safety in icing condition.

PWT – Plasma Wind Tunnel

Operational since 2002, is world unique for power and size. Capable to simulate high speed orbital and super-orbital re-entry to test safety critical thermal protection systems of space vehicles.

LISA – Crash Test Facility

Operational since 2003, is world unique for testing envelope. Capable to simulate landing scenario in case of accidental ground impact to improve passenger and payload protection.

PT1 – Transonic Pilot Tunnel

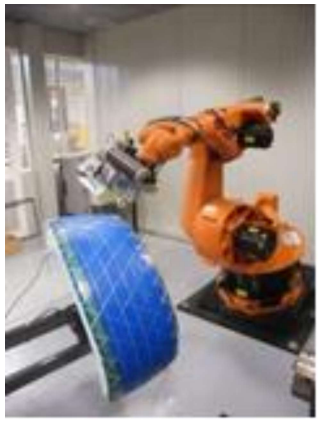
Operational since 1999, for transonic and supersonic aerodynamic simulation (M<0.4 cont. M<1.4 int.)

Space Qualification Laboratory

Standard ESA, ECSS-E-10-03C, MIL-STD-810G

Qualification capabilities for:

- Physical properties measurements
- Acceleration test
- Pyro-shock test
- Combined vibration, humidity, temperature and altitude test
- Environmental stress screening
- Thermal shock test
- Thermal vacuum test

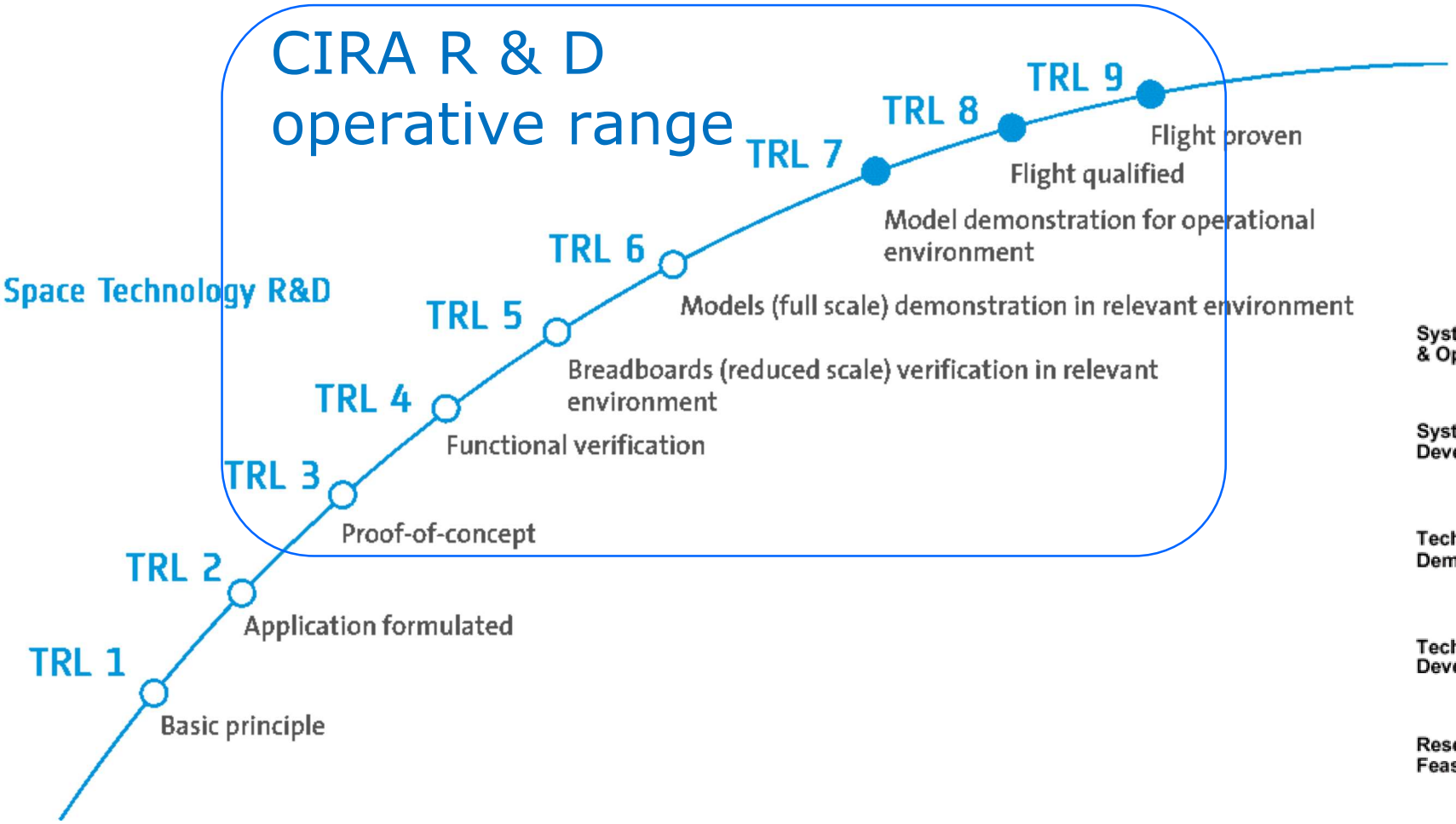


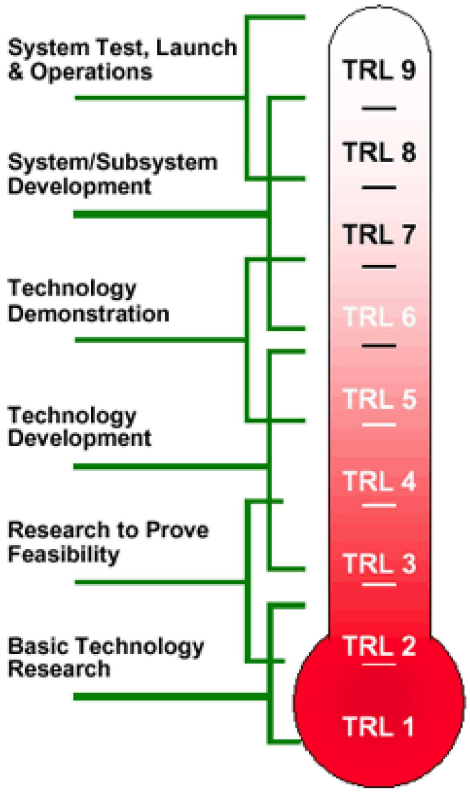
Structures and Materials Technological Laboratories

Composite Materials
Filament winding, Robotic winding, Thermoplastic Fiber Placement
Autoclave, RTM equipment,
Thermo-physics & Mechanical characterisation

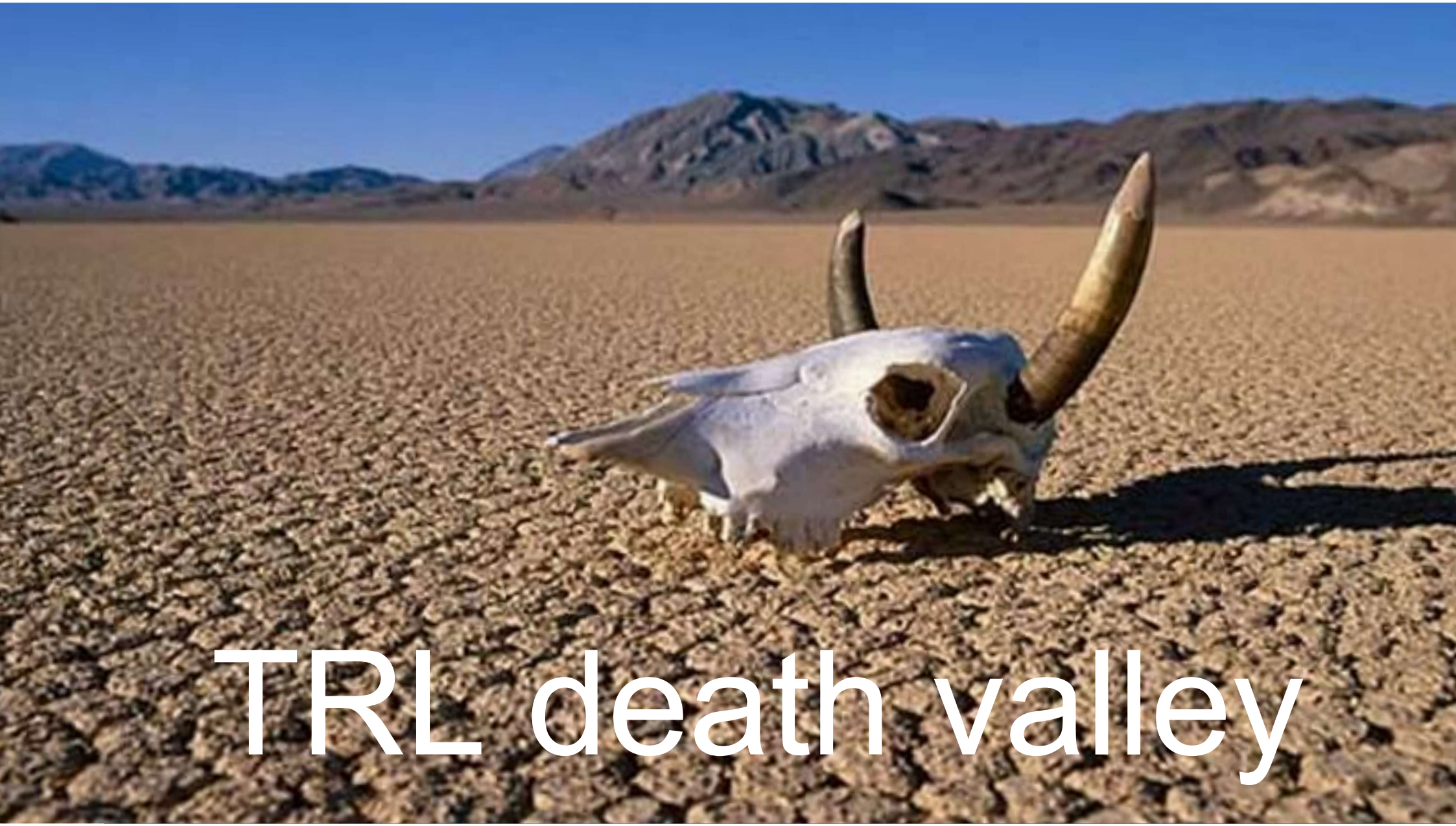
Metal alloys Additive Manufacturing
EBM Additive Layer Manufacturing

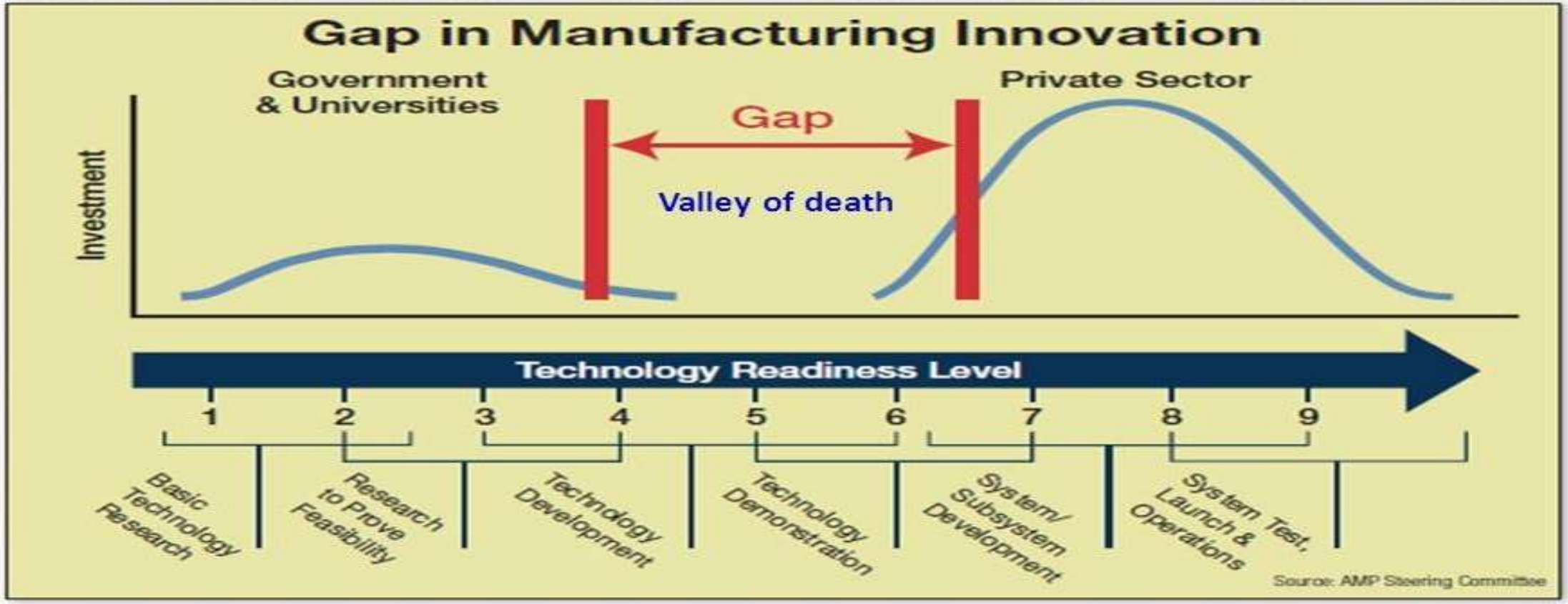
CIRA R & D operative range





Technology Readiness Level


TRL death valley



TRL 1-3
Discovery
Preliminary scientific evidence

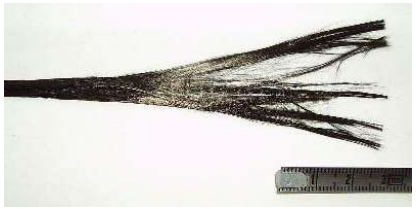
TRL 4-5
Feasibility
- Evidence for scalability
- Labscale validation

TRL 6
Practicality

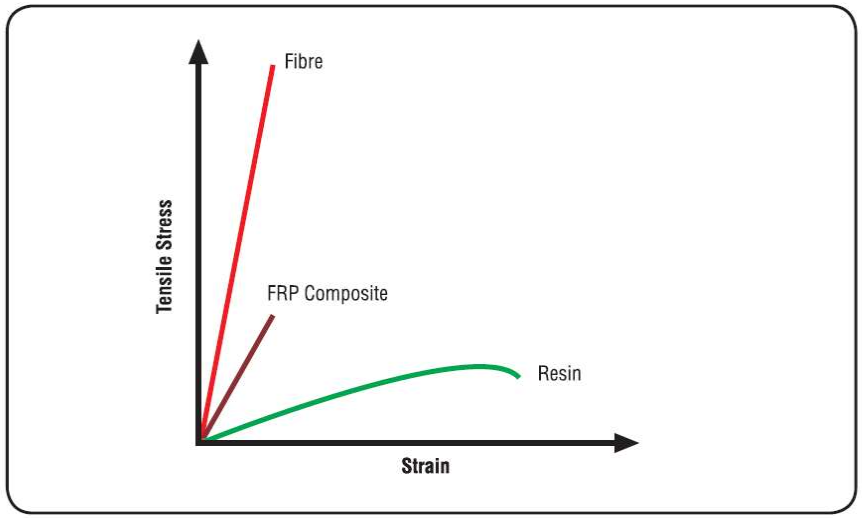
TRL 7-9
Applicability
Product performance Verified, scaled, adapted

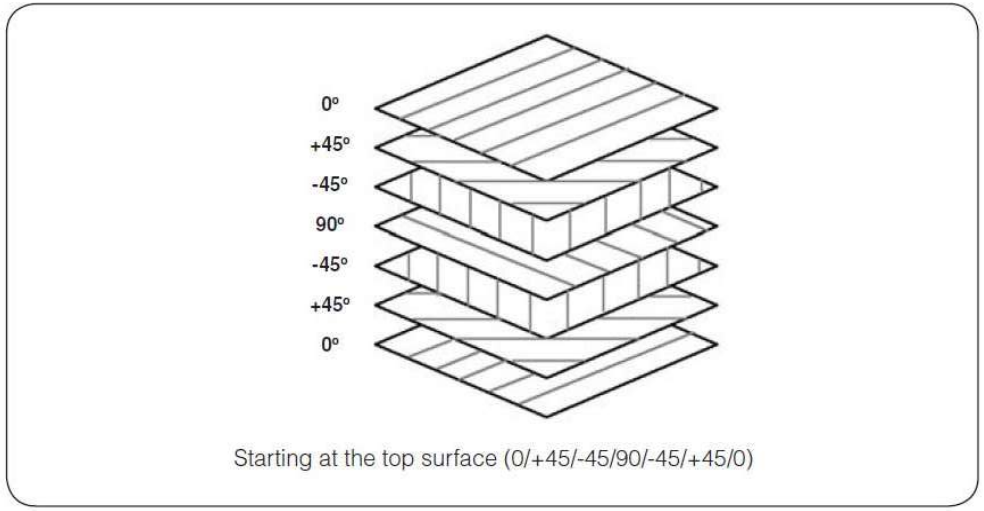
TRL 10
Production Ready

Valley of Death: Maximize Performance, Efficiency, reliability



CFRP

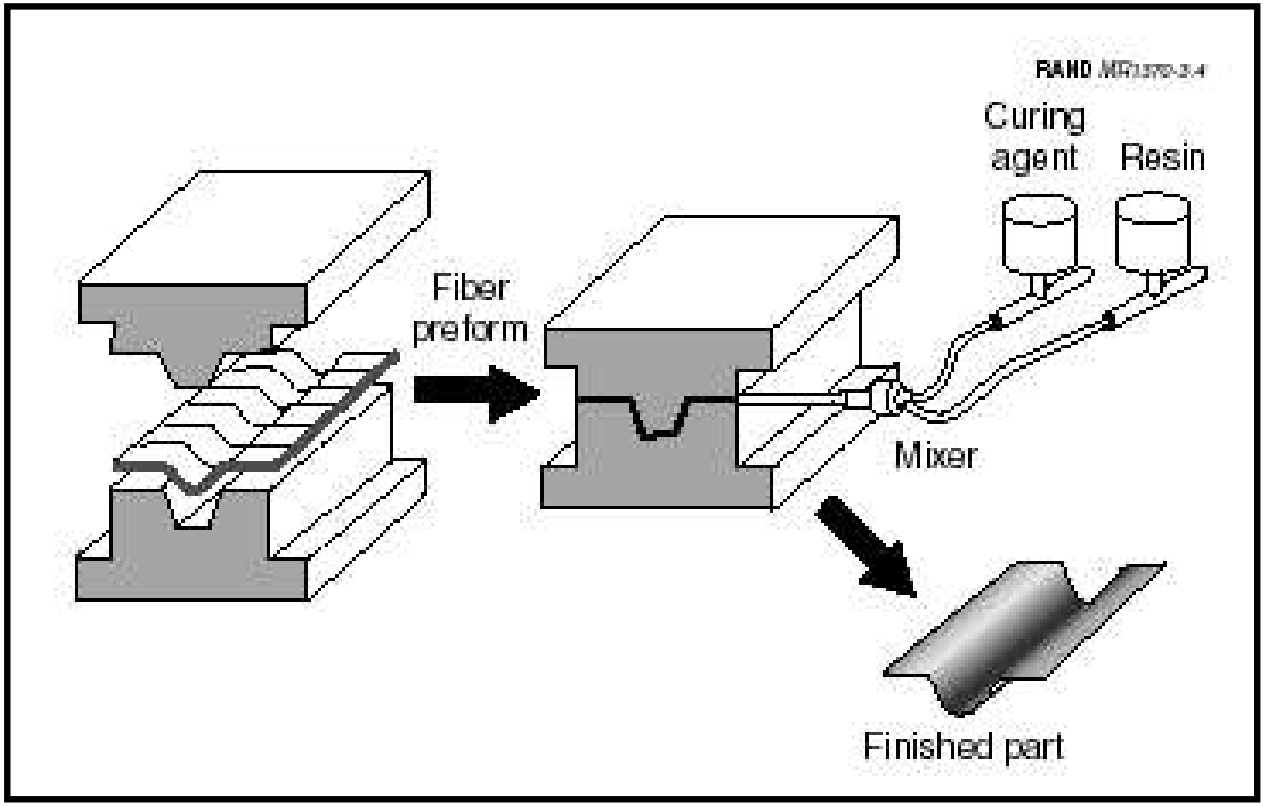




anisotropia

Autoclave

polimerizzazione



polimerizzazione

Aileron & Fin Panel

Piaggio Aeroindustries

Infusion and RTM technology

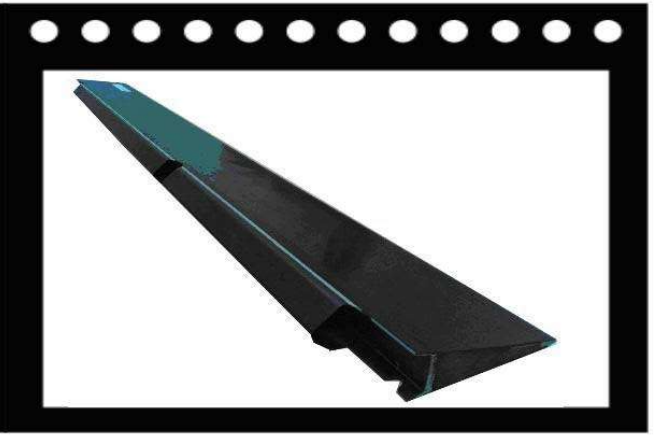
Trailing Edge Mould

Trailing Edge

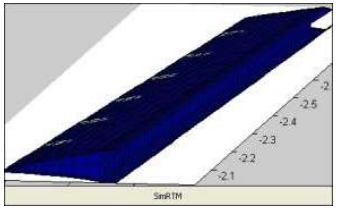
Leading Edge Mould

Leading Edge

Trailing and Leading Edge Bonded

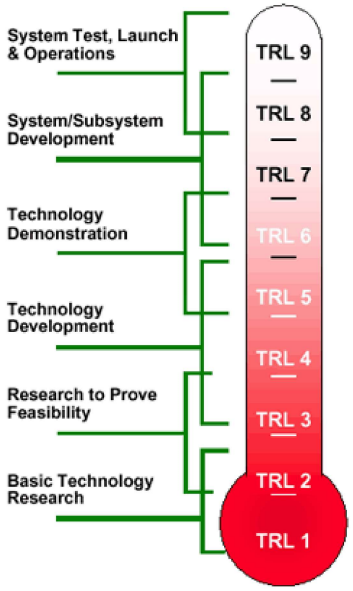


AILERON

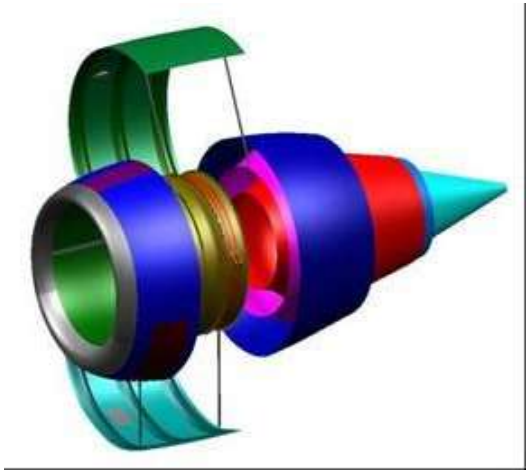


Piaggio Aeroindustries requirements

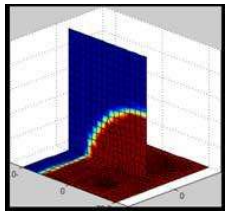
Riduzione del 20% del peso
Riduzione numero di parti.
Riduzione del costo di produzione del 20%

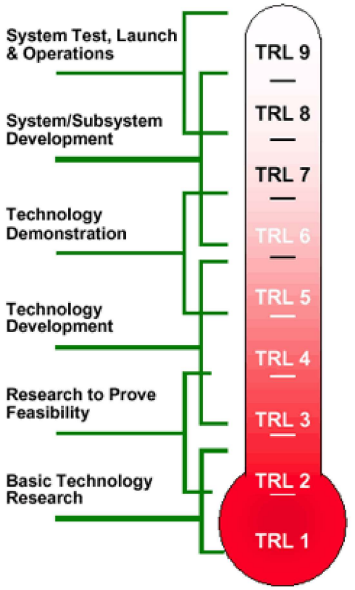


RTM- Strake

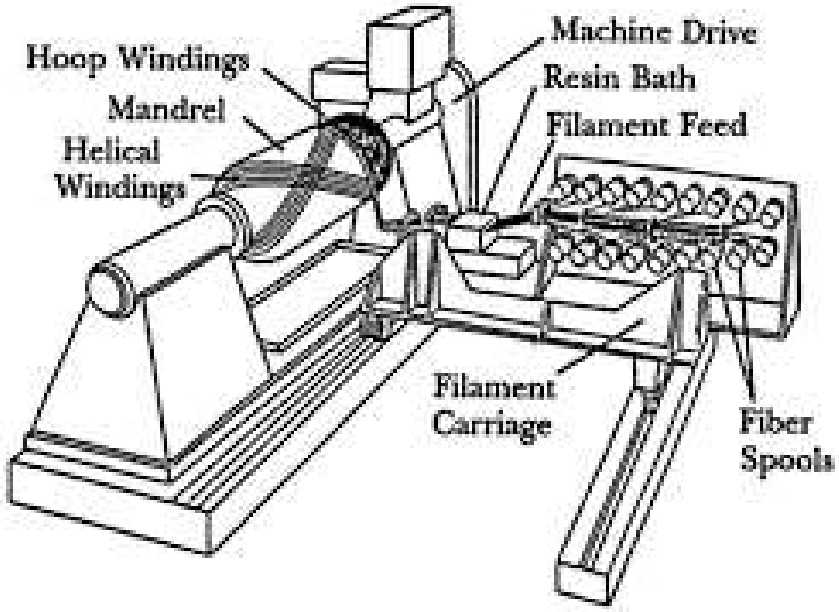


Aermacchi (Leonardo) requirements





hand layup



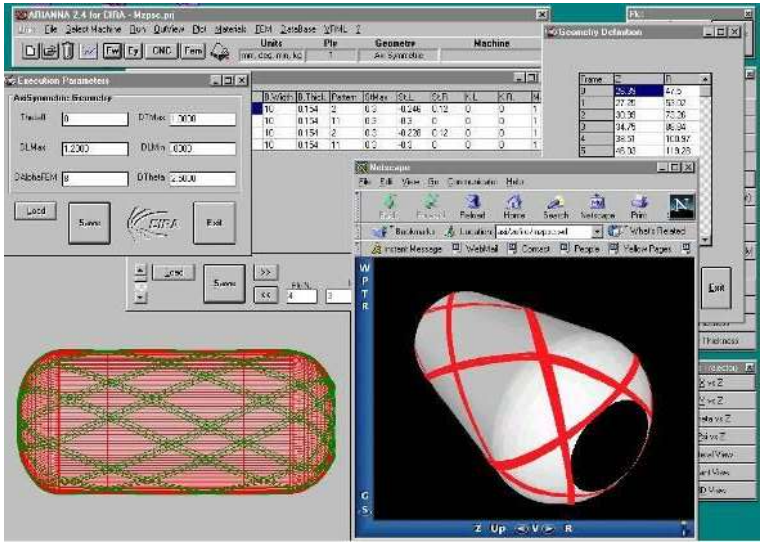
automated deposition

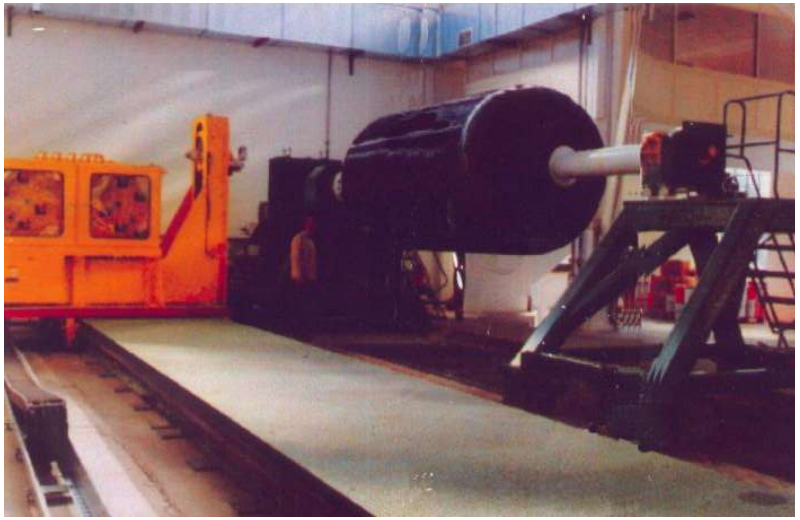
Filament Winding

6 dof, 1 infinite rotation

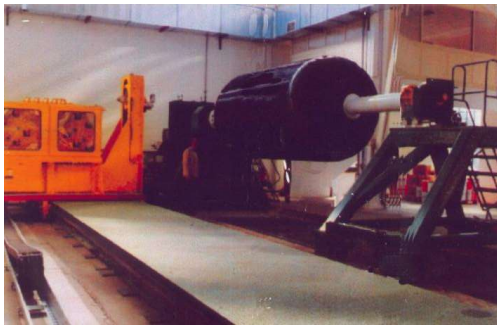
ARIANNA Winding software

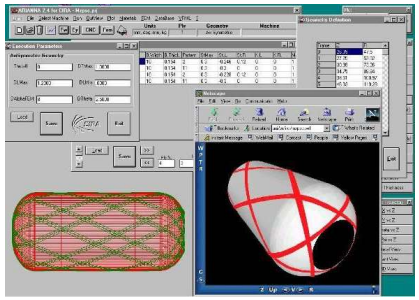
AVIO winding simulation for VEGA P80 booster

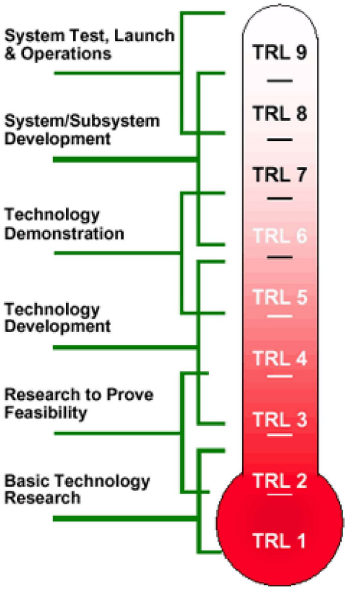




AVIO – VEGA P80 booster







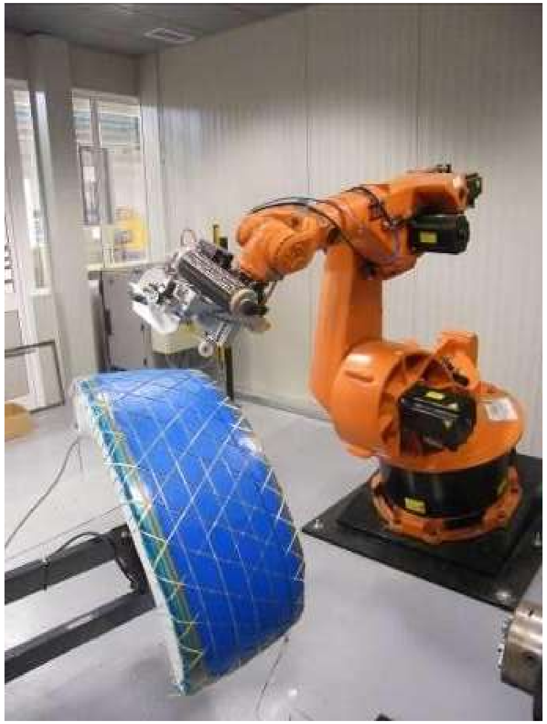
Robotic Winding

Filament Winding

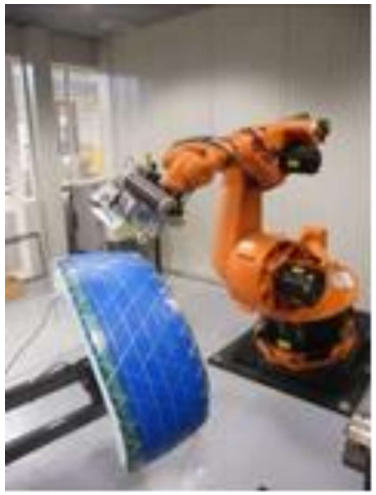
6 dof, 1 infinite rotation

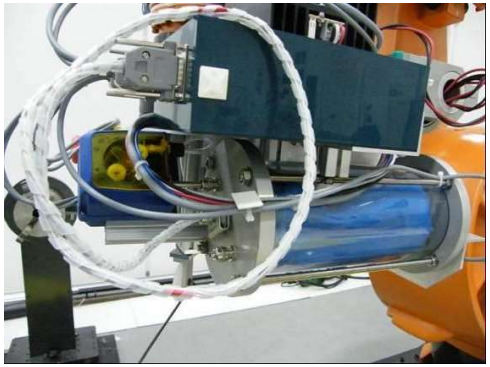
Robotic winding

8 dof , 2 infinite rotations



Robotic Winding



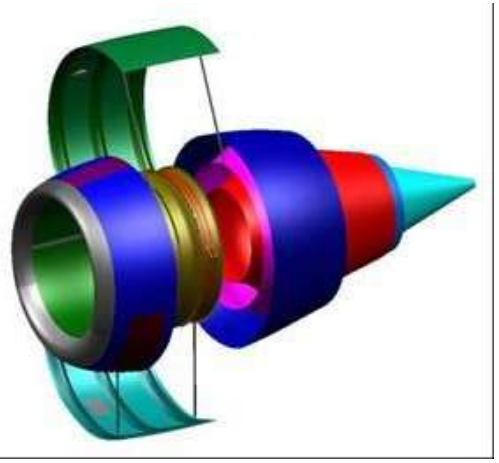


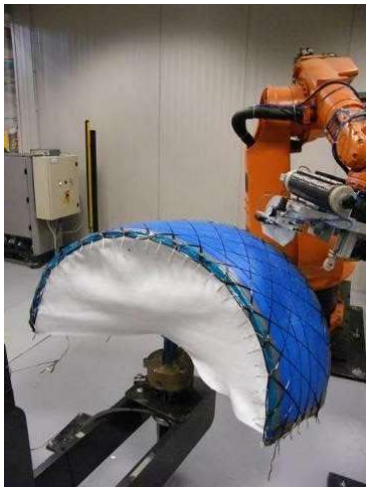
8 axes, 10 dof
2 infinite rotations

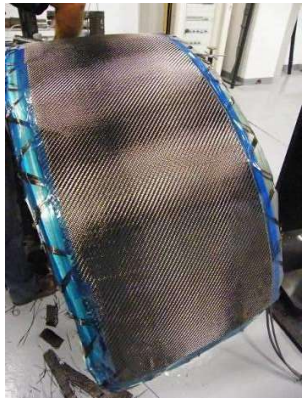
2.4 m lenght
0.8 m diameter

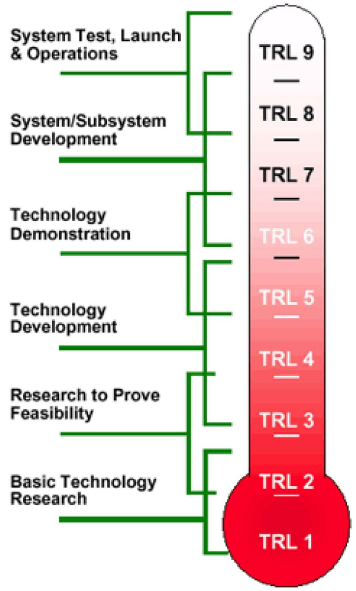
1 tow
tension control
(10-50 N)

wet/dry winding





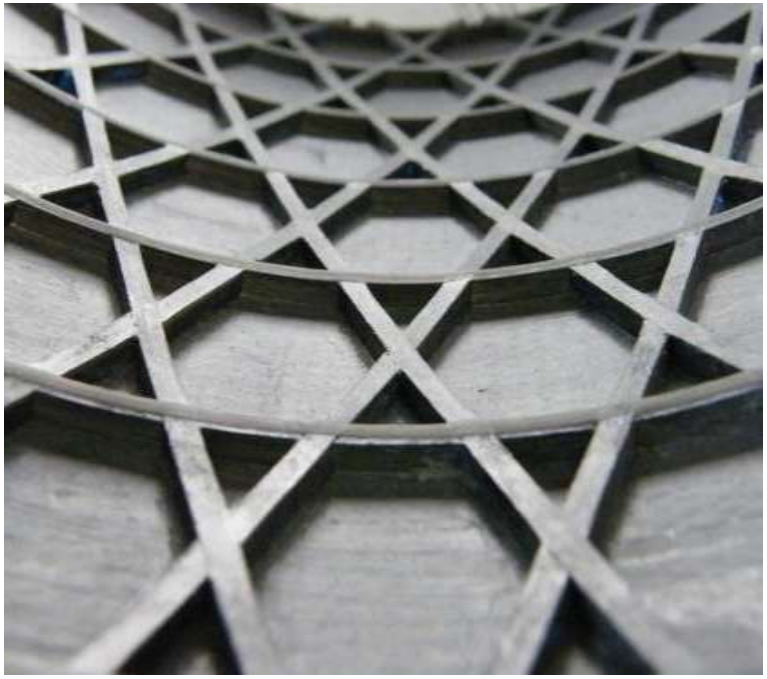




Anisogrid Technology Composite Nacelle Components

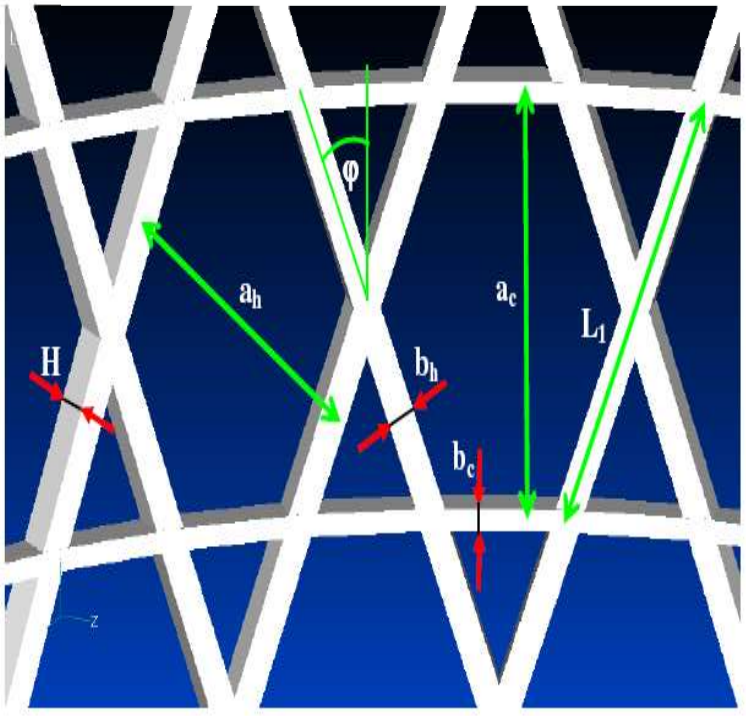
MIUR funded project partnership with AERMACCHI

Double curvature Panel: winding and infusion

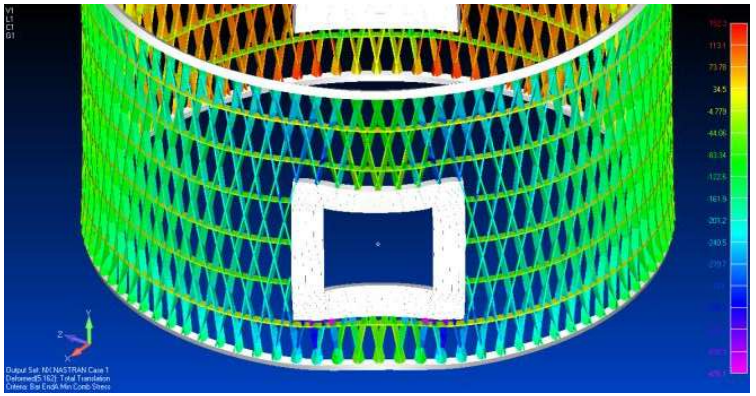


grid structures

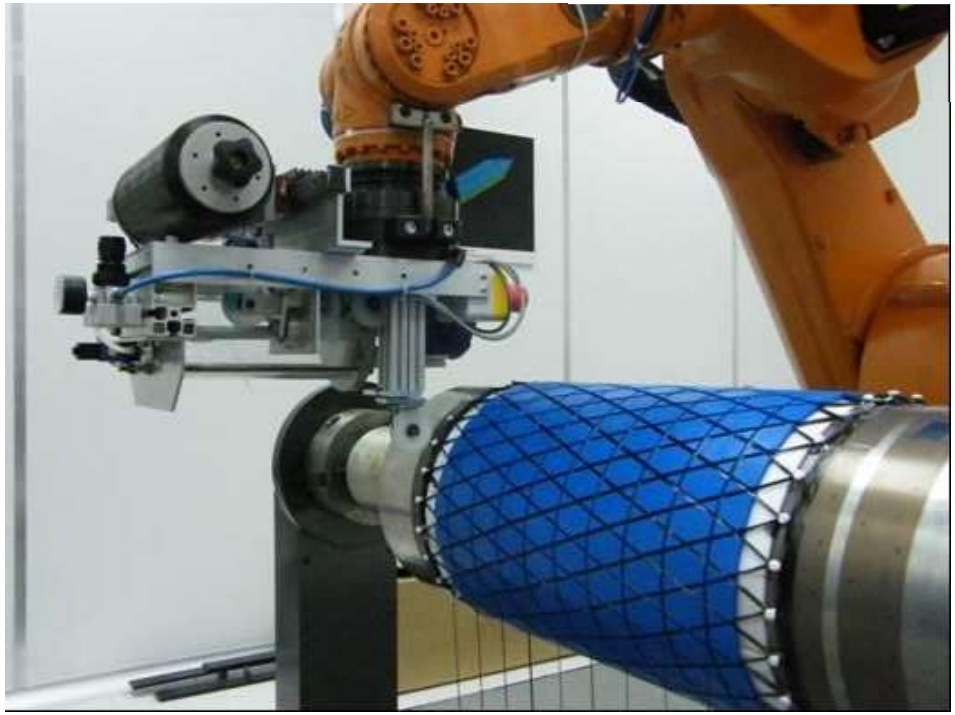
Strutture An-Isogrid

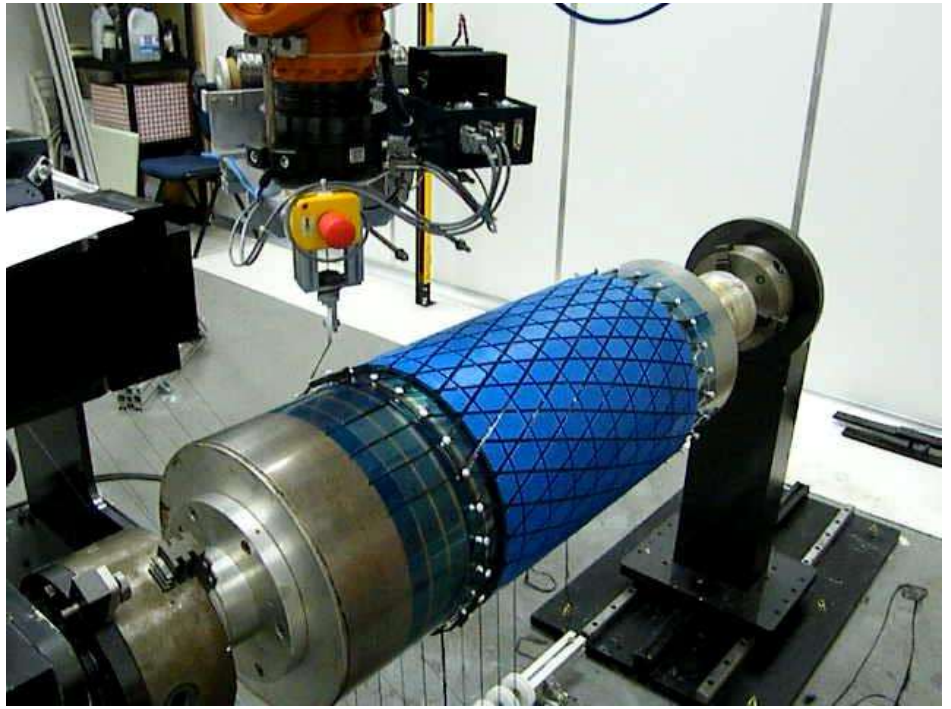


Elementi unidirezionali caricati in compressione tensione



parallel dry robotic winding + infusion





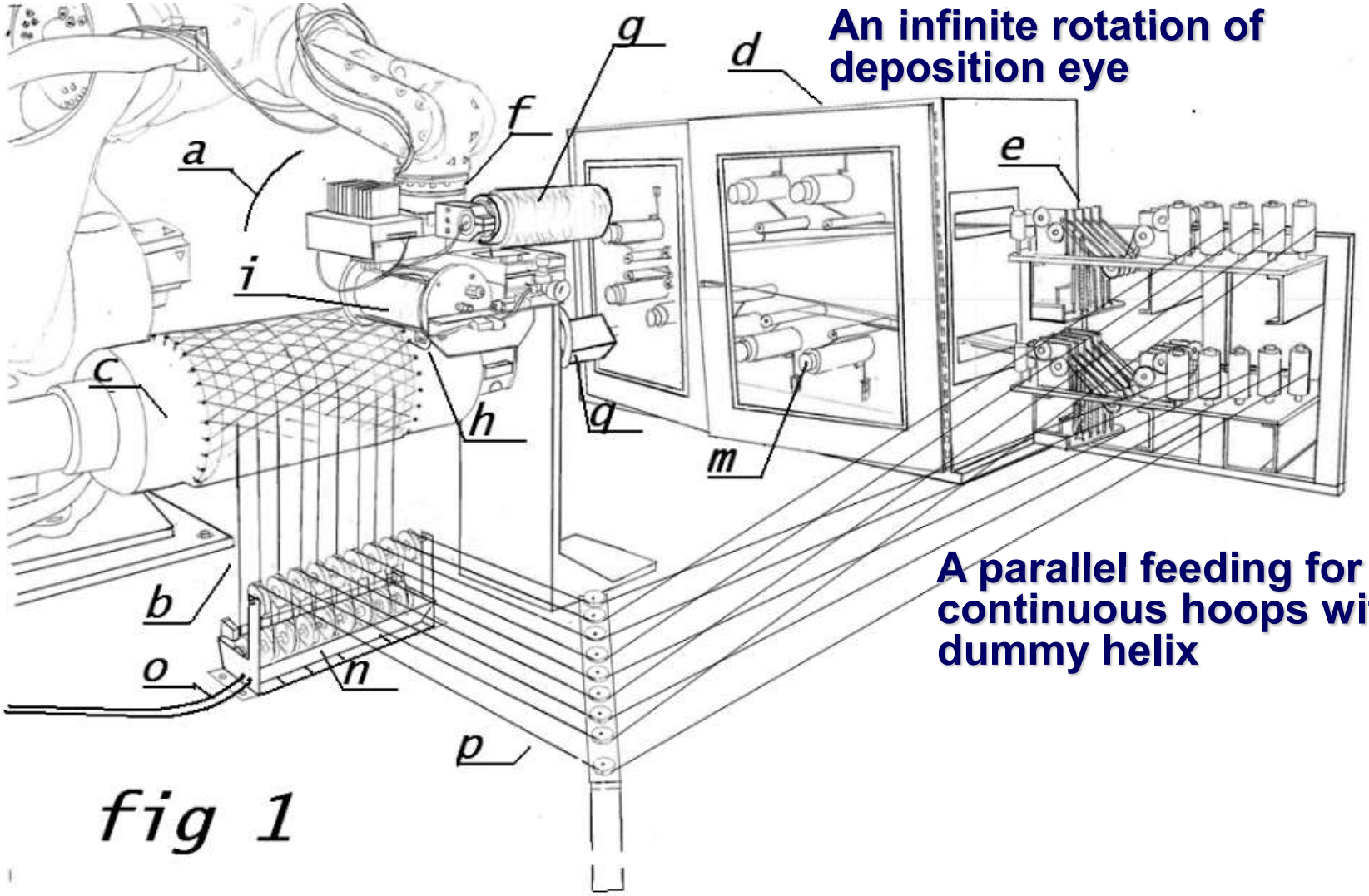
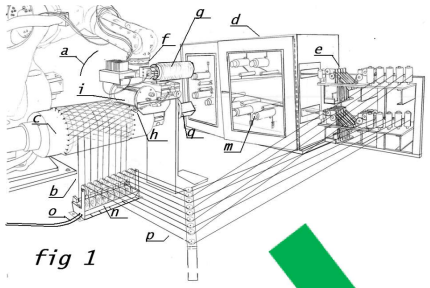


fig 1

An infinite rotation of deposition eye

A parallel feeding for continuous hoops without dummy helix



TRL 1 Basic principle

TRL 2 Application formulated

TRL 3 Proof-of-concept

TRL 4 Functional verification

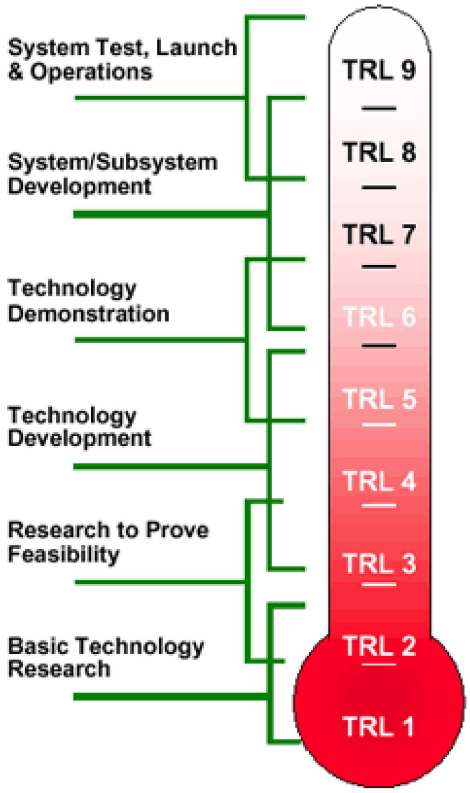
TRL 5 Breadboards (reduced scale) verification in relevant environment

TRL 6 Models (full scale) demonstration in relevant environment

TRL 7 Model demonstration for operational environment

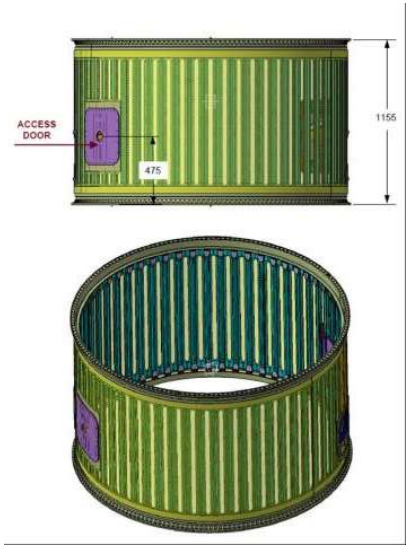
TRL 8 Flight qualified

TRL 9 Flight proven

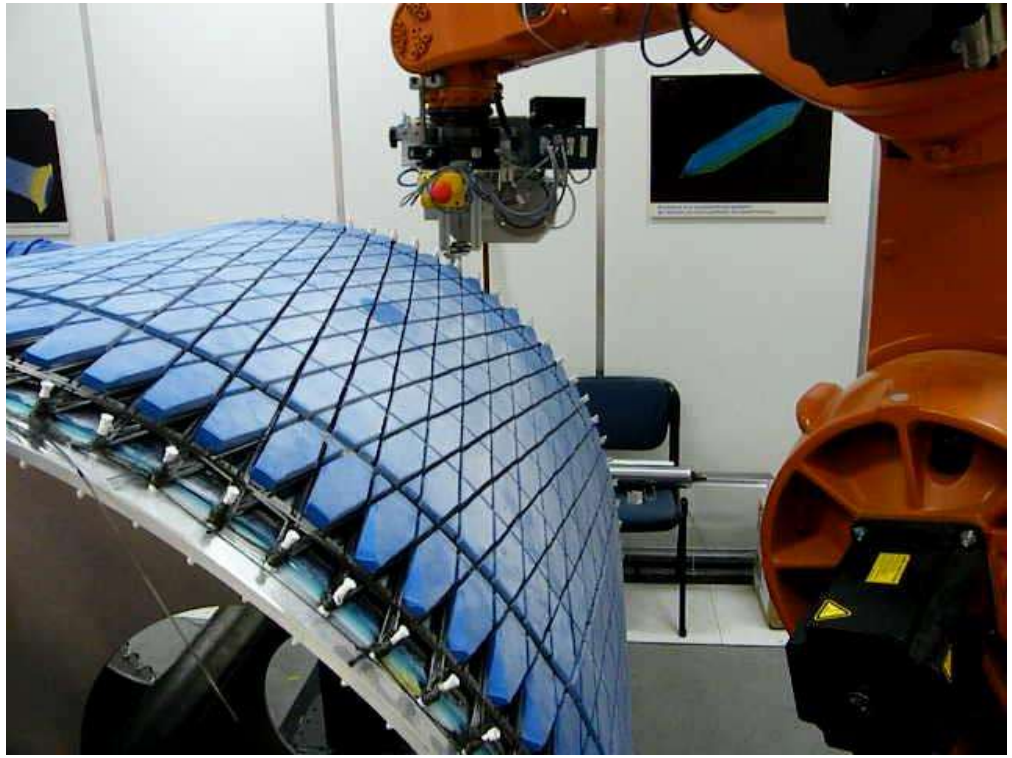


Technology Readiness Level

interstage model design, manufacturing and testing



VEGA Intestage 2/3 :
a feasibility study to compare the Aluminum and the Anisogrid Composite Structure



Radius 0.65 m Mass < 25 kg Load 146 tons

40% less than aluminum benchmark

TRL 1 Basic principle

TRL 2 Application formulated

TRL 3 Proof-of-concept

TRL 4 Functional verification

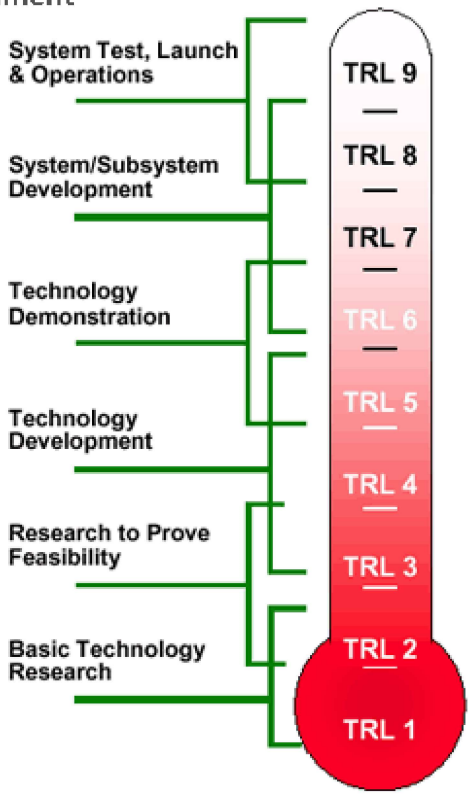
TRL 5 Breadboards (reduced scale) verification in relevant environment

TRL 6 Models (full scale) demonstration in relevant environment

TRL 7 Model demonstration for operational environment

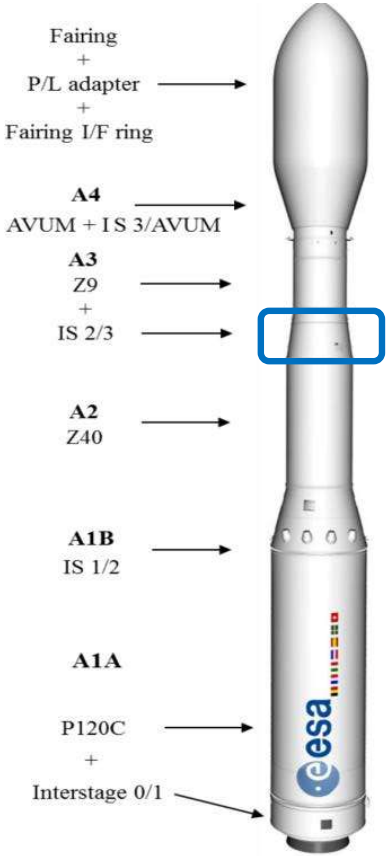
TRL 8 Flight qualified

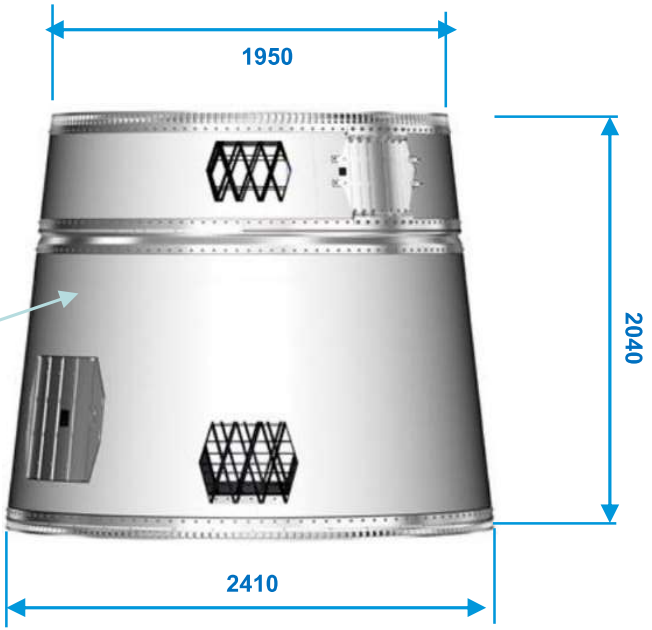
TRL 9 Flight proven



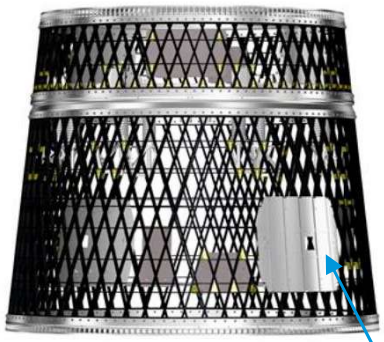
Technology Readiness Level

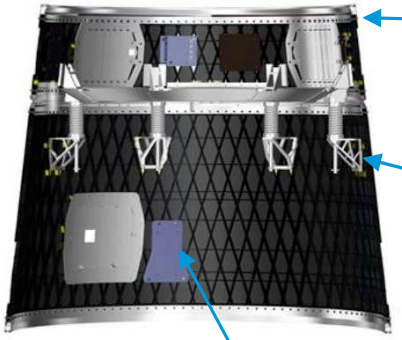
Prima applicazione industriale su un Lanciatore Europeo di una Grid structure in Composito

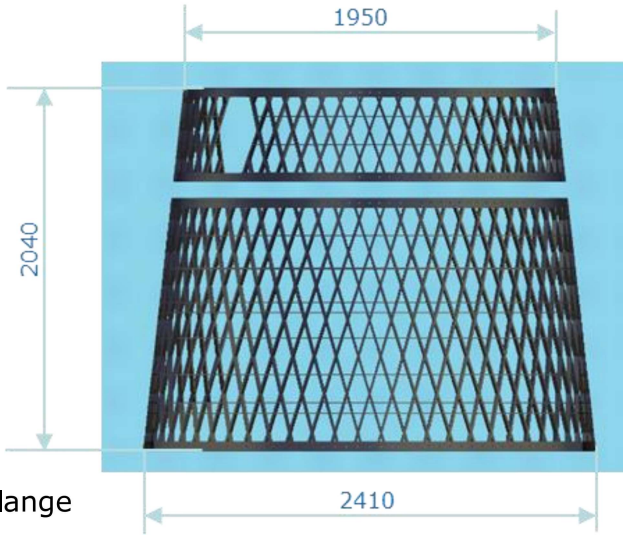




Struttura generale dell'Interstadio







Forward flange

Separation flange

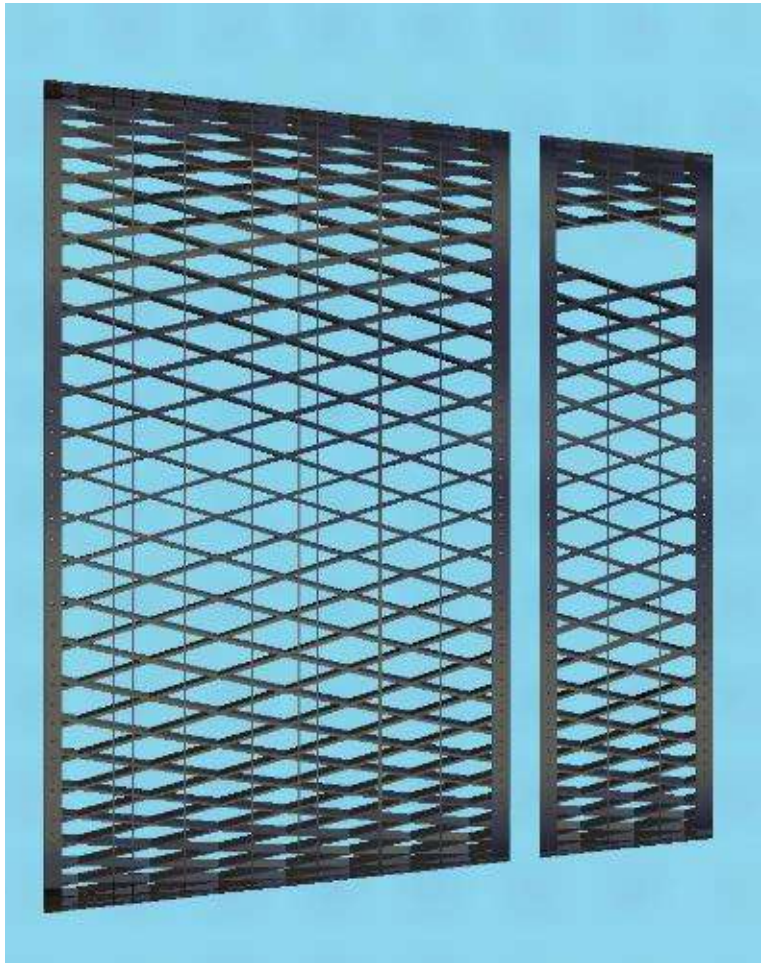
Separation spring

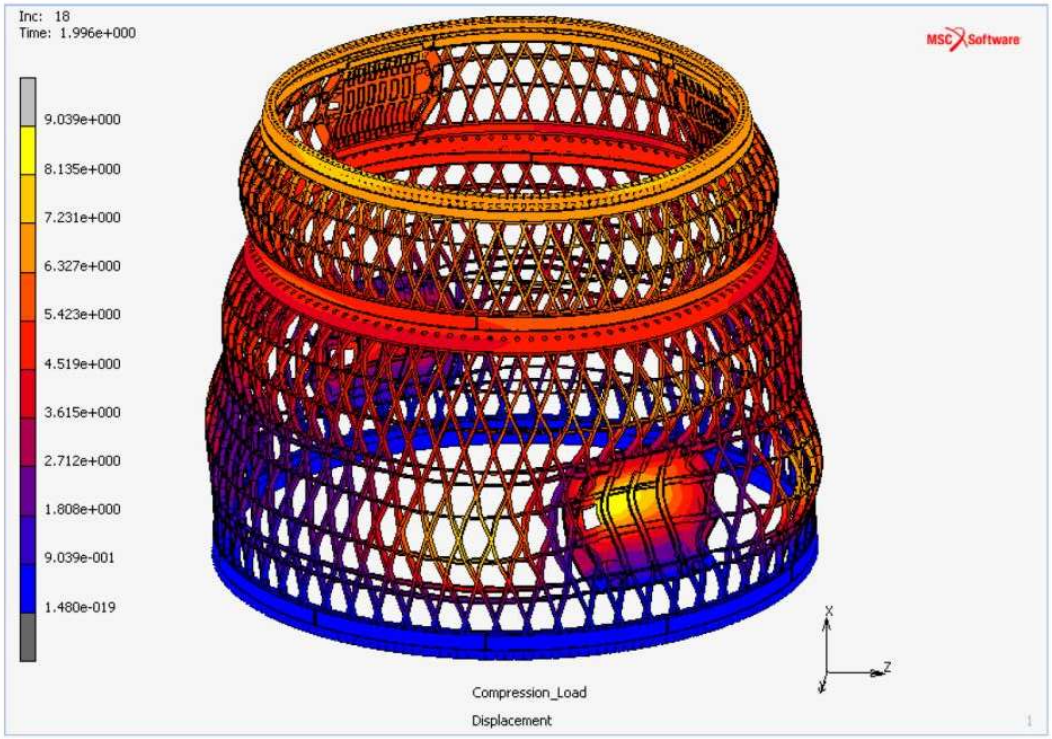
Aft flange

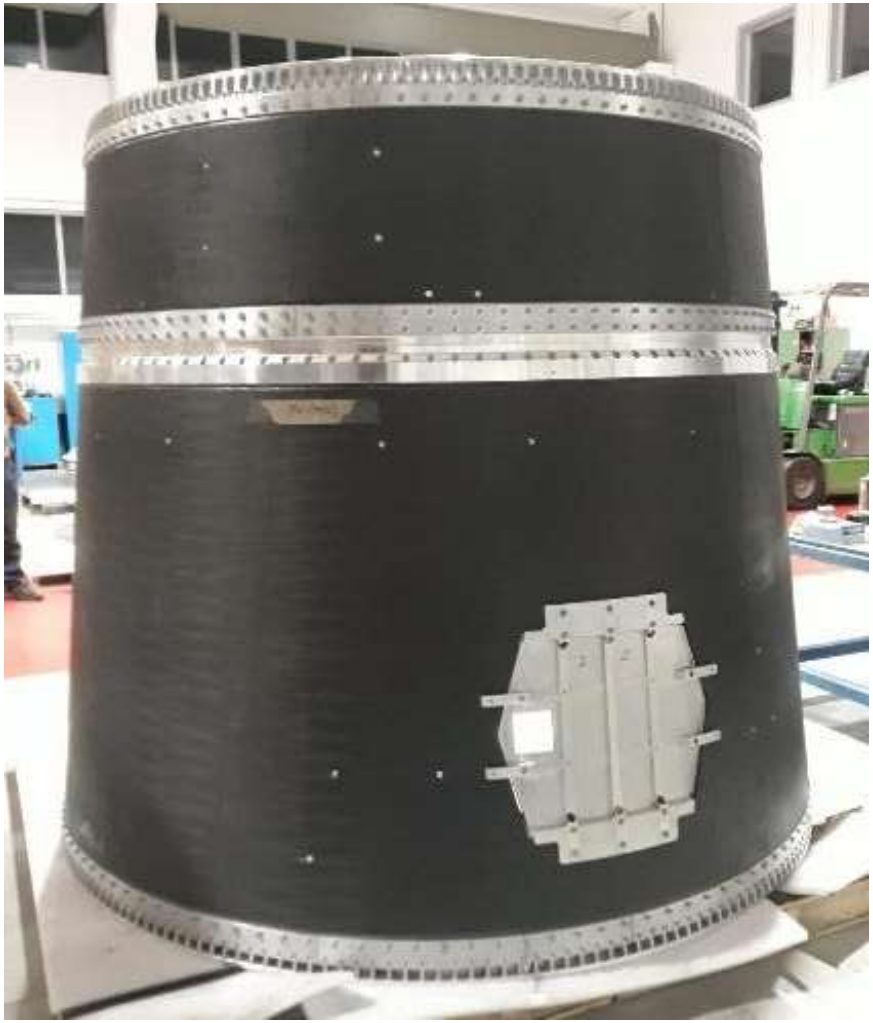
Access door

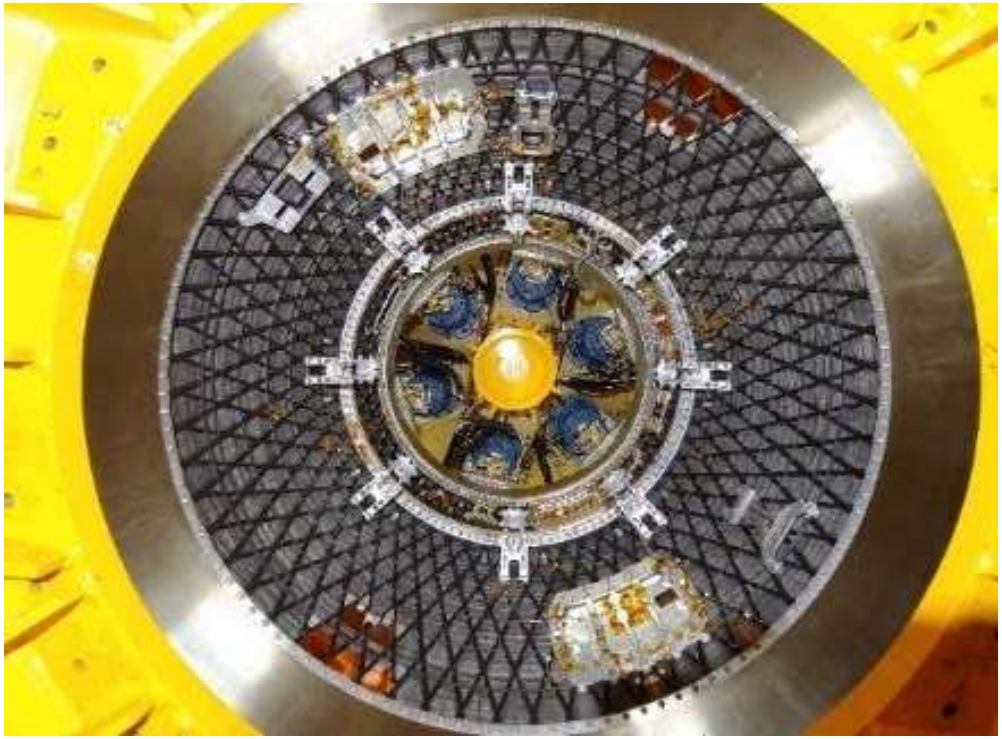
Equipment support
(equipment not represented)

2005 **2010** **2015**



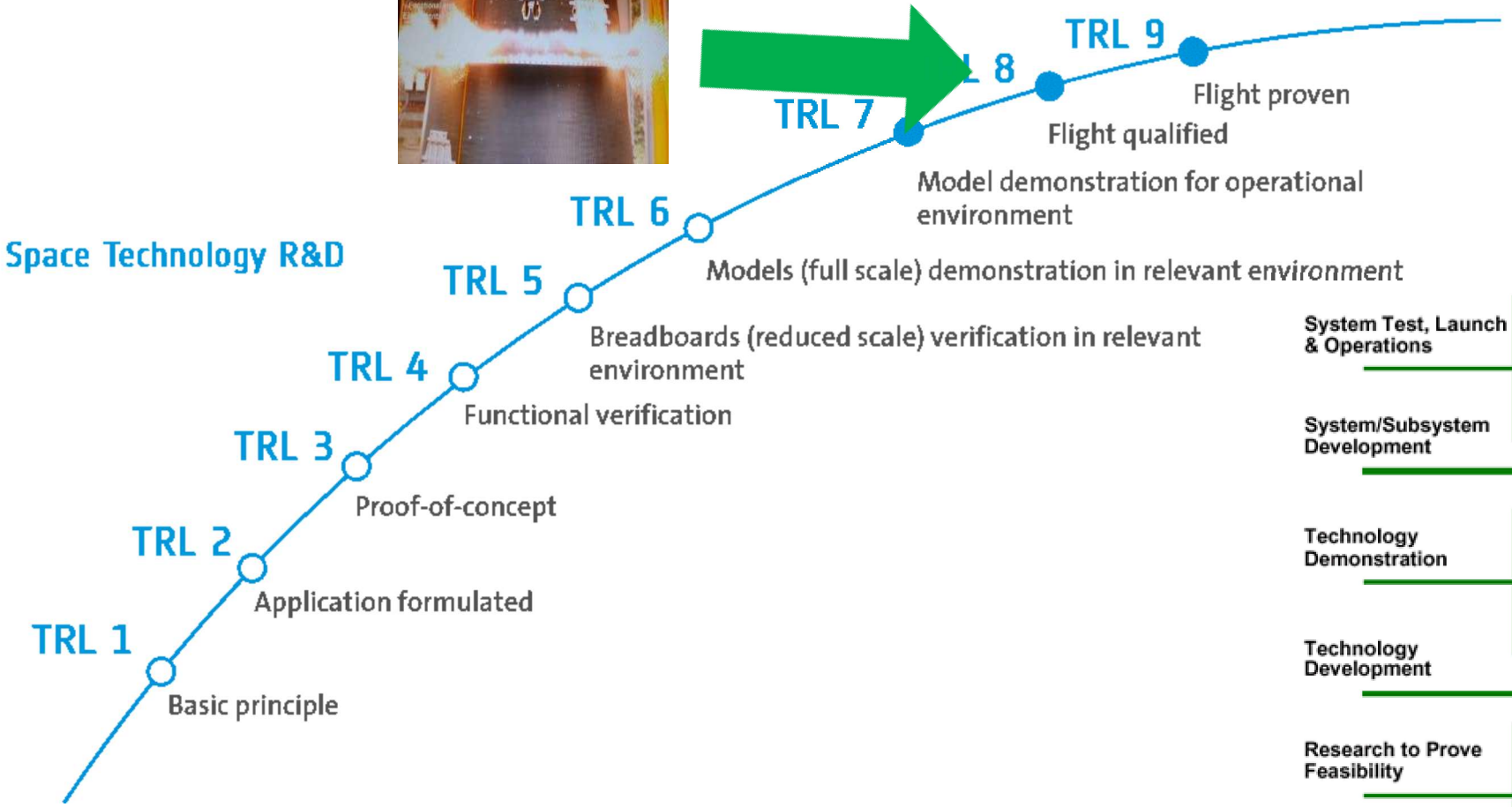

Inc: 18
Time: 1.996e+000
MSC Software
9.039e+000
8.135e+000
7.231e+000
6.327e+000
5.423e+000
4.519e+000
3.615e+000
2.712e+000
1.808e+000
9.039e-001
1.480e-019
X
Z
Compression_Load
Displacement

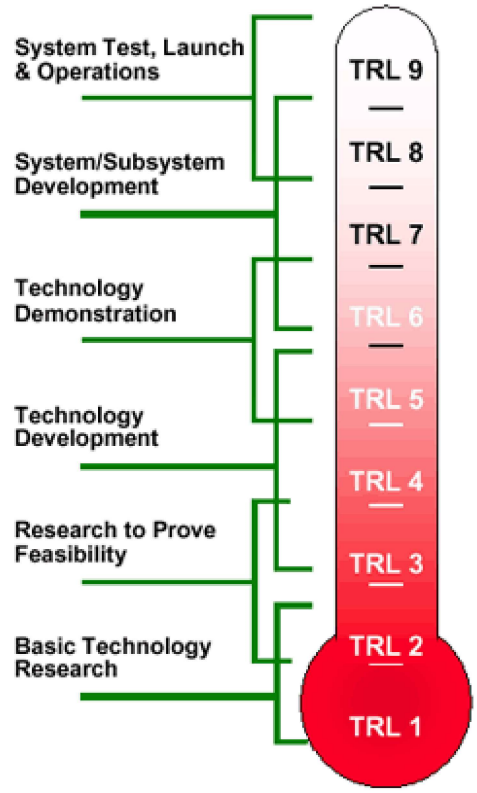




750 tons

Separation testing

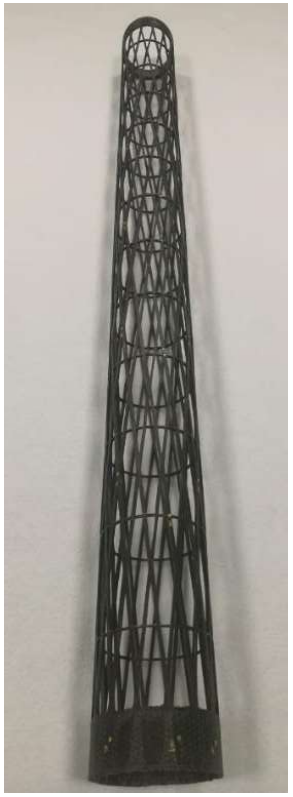


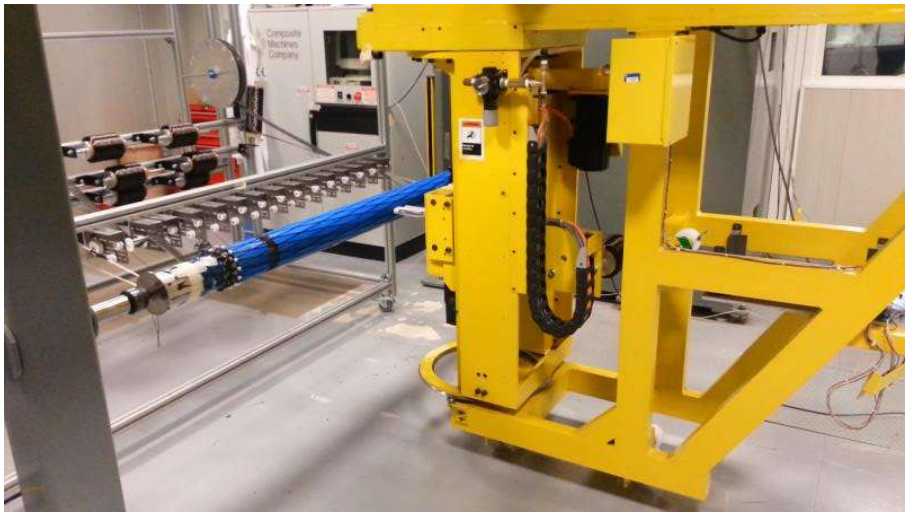


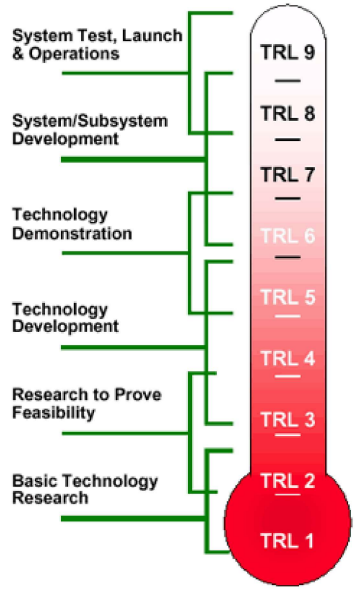
Technology Readiness Level

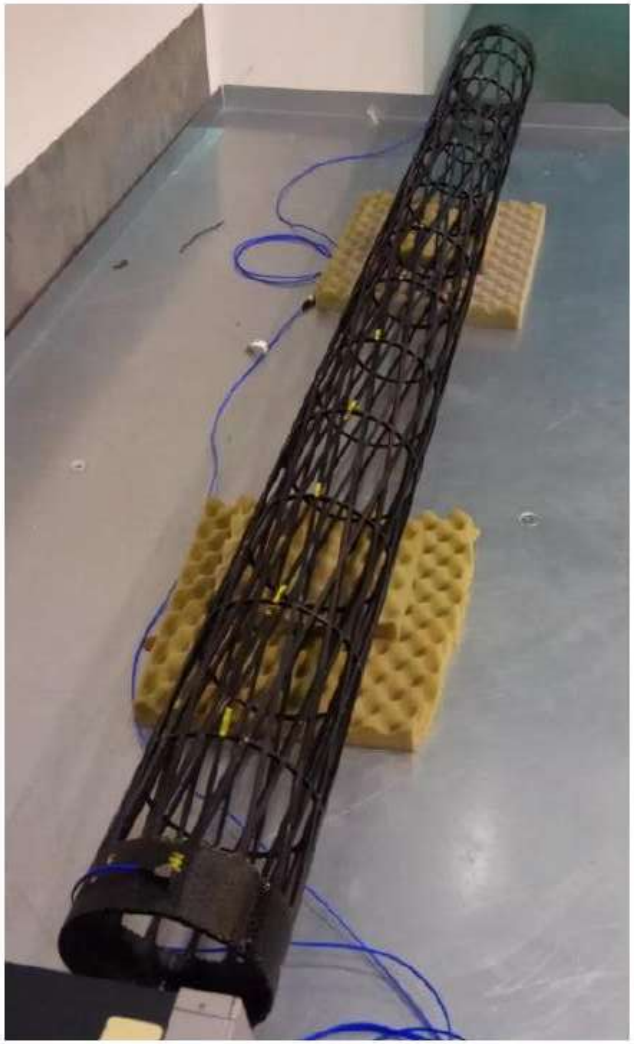
Boom segment of a deployable antenna

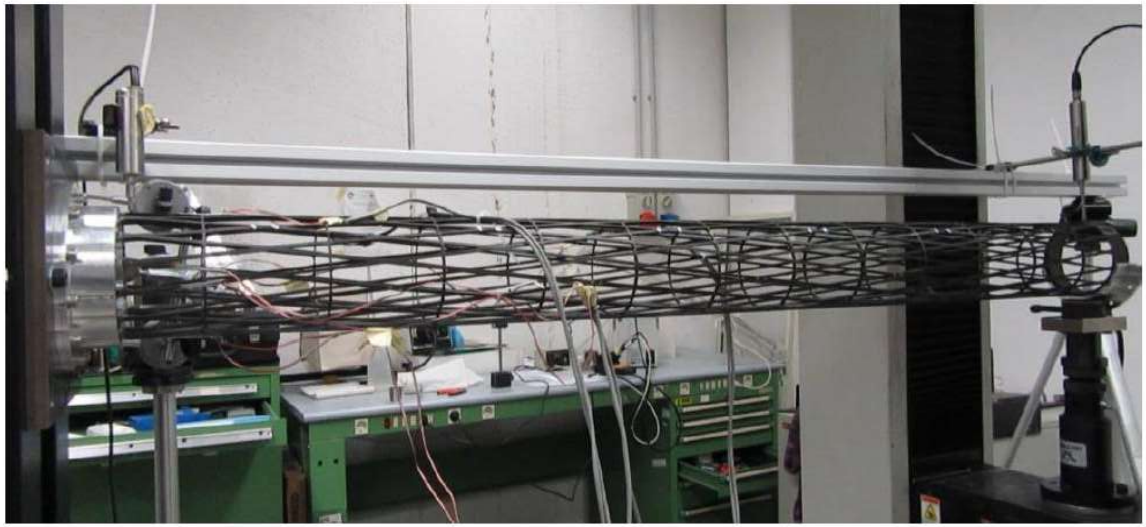
ESA project

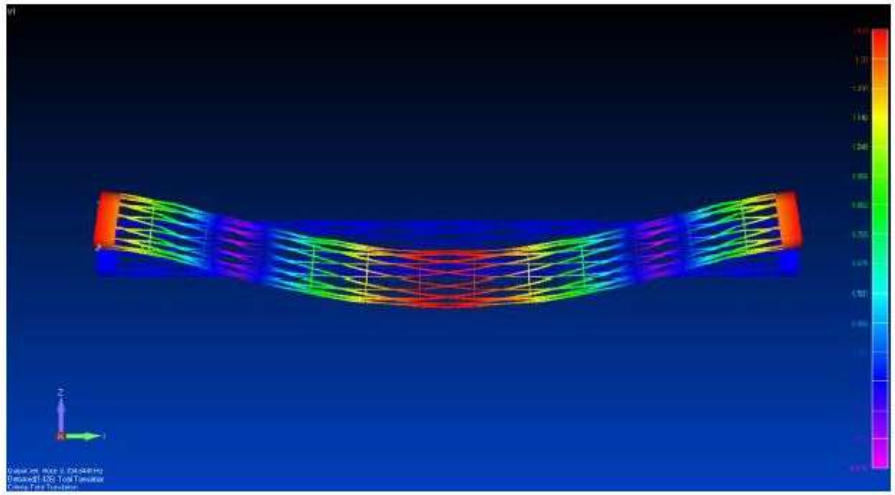






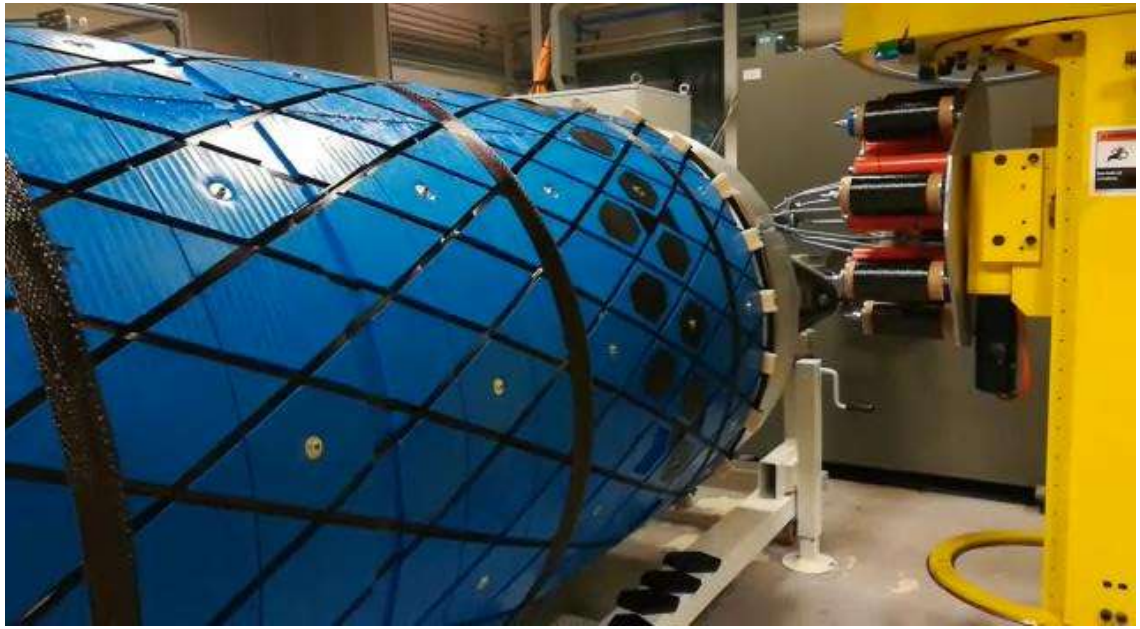


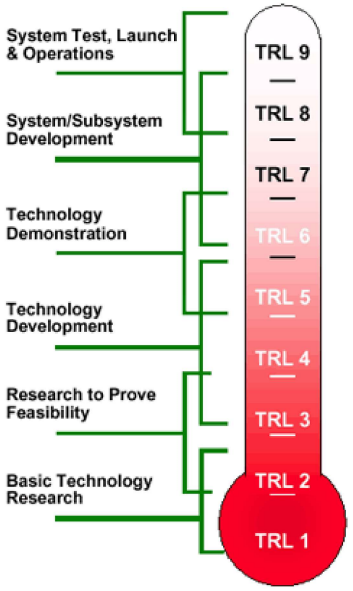


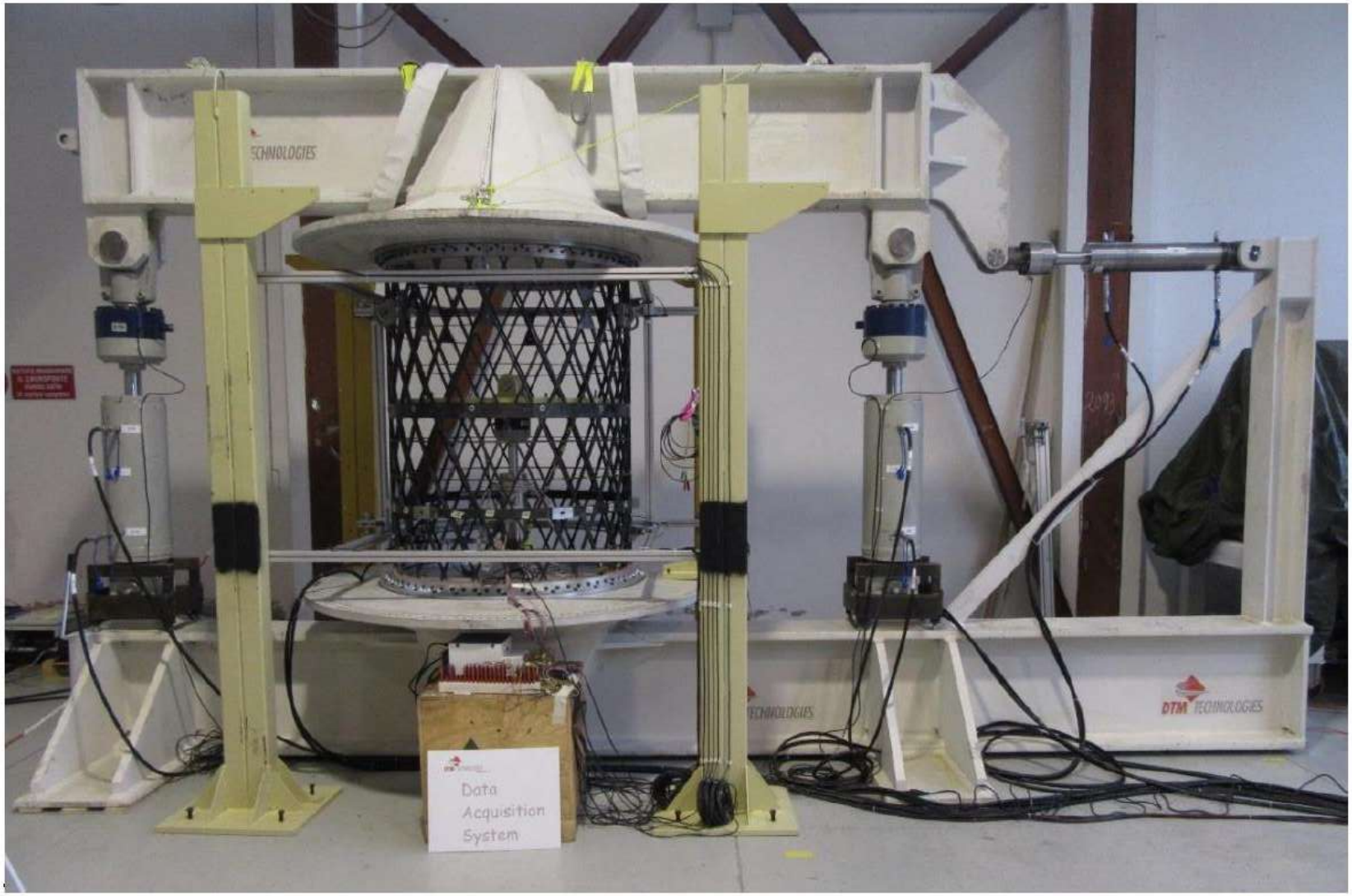


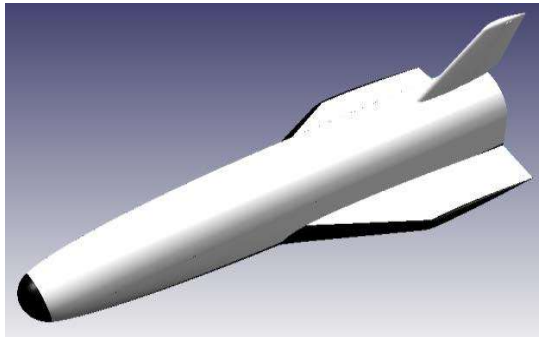
Central Tube

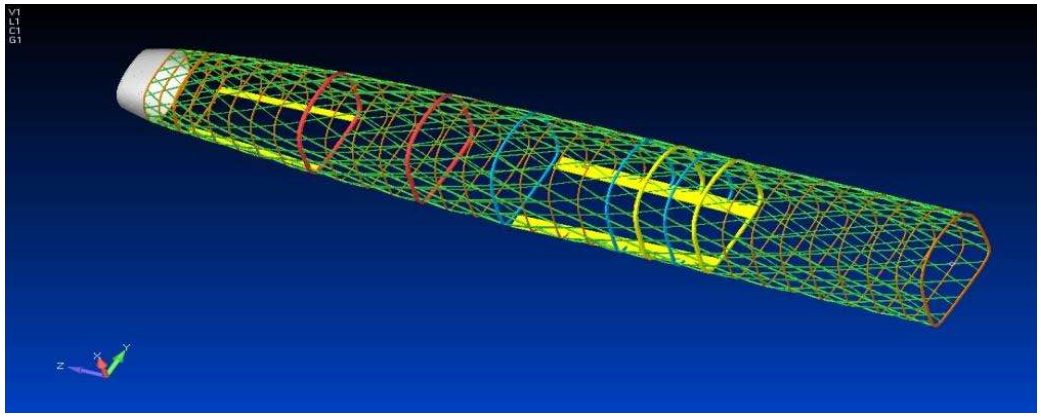
ESA project

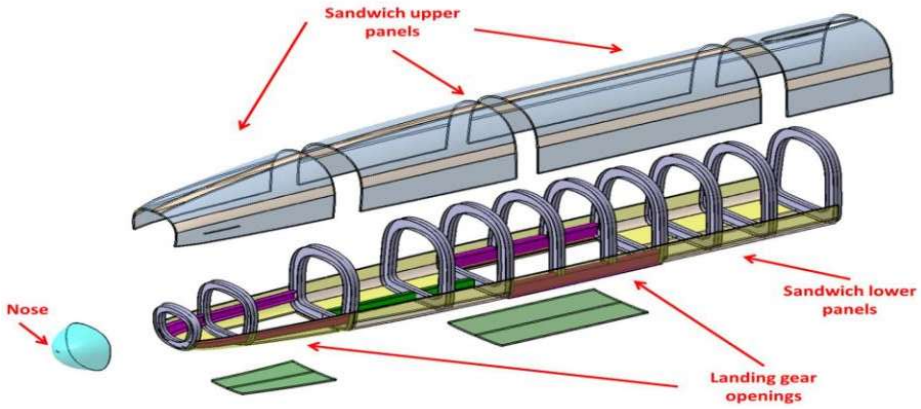





Data
Acquisition
System

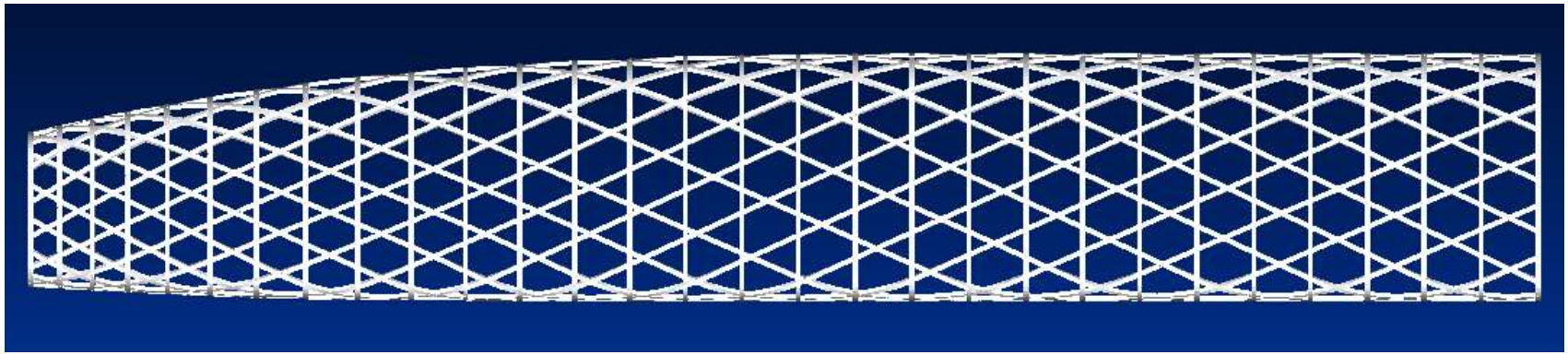






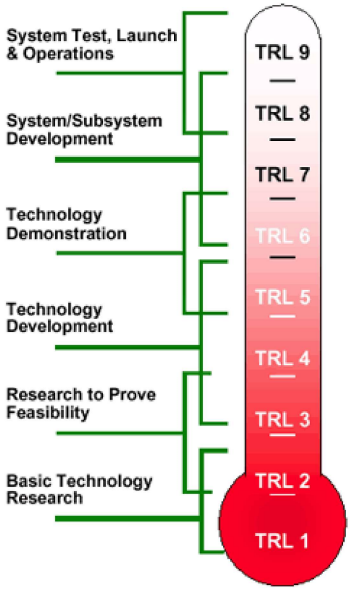
anisogrid hypothesis **Vs** **benchmark : sandwich**

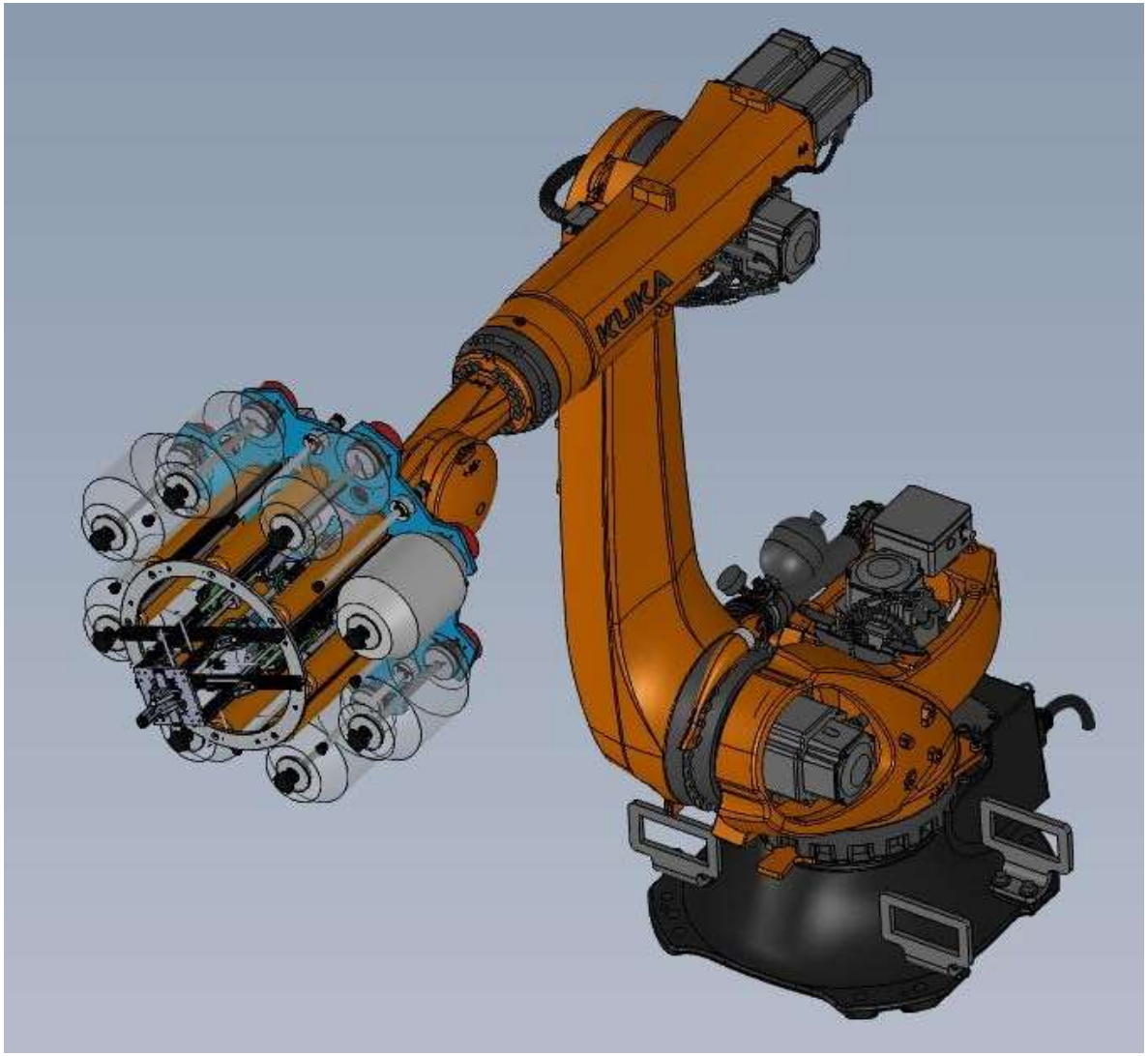
ICCS project



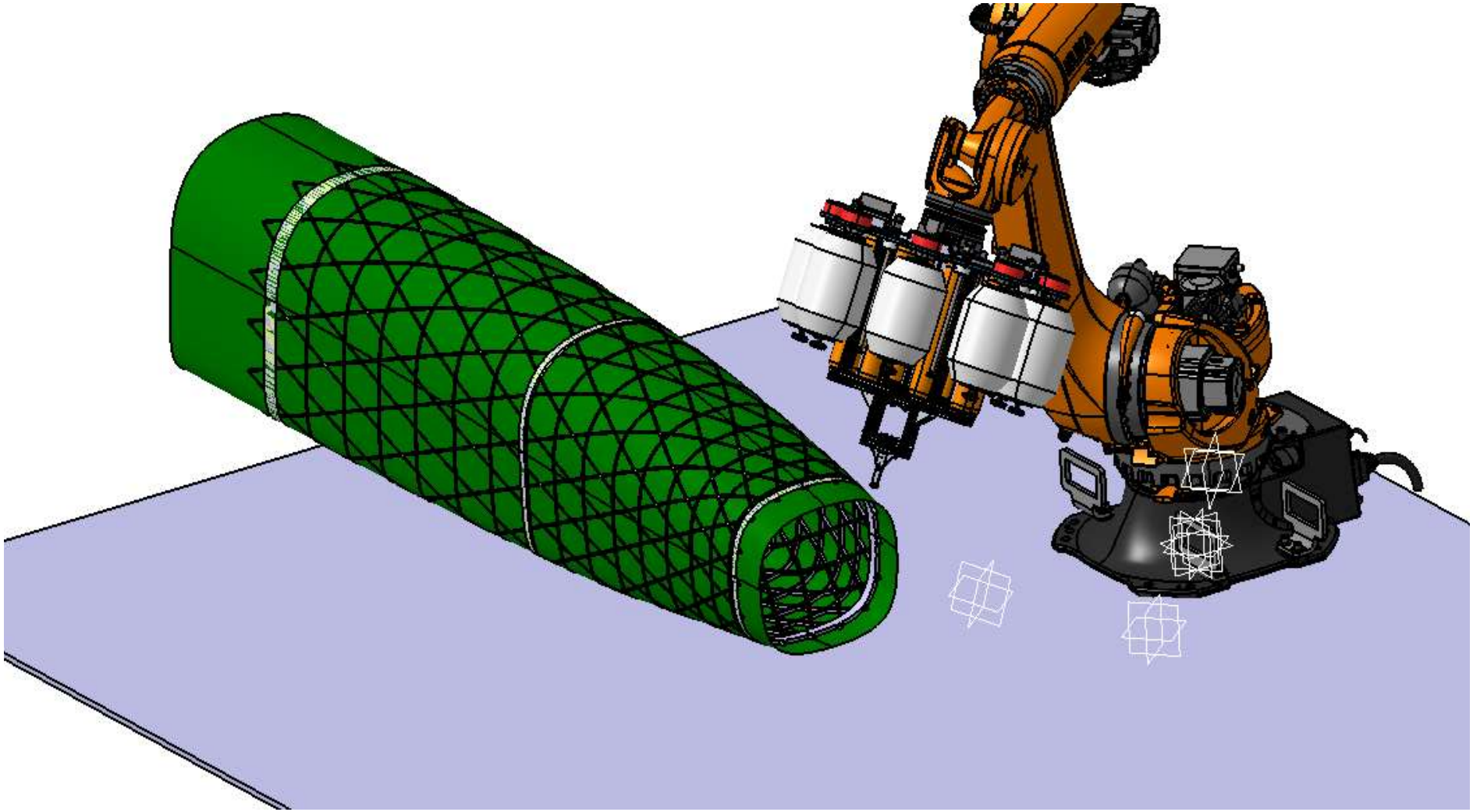
Strutture di Fusoliera USV di tipo Grid

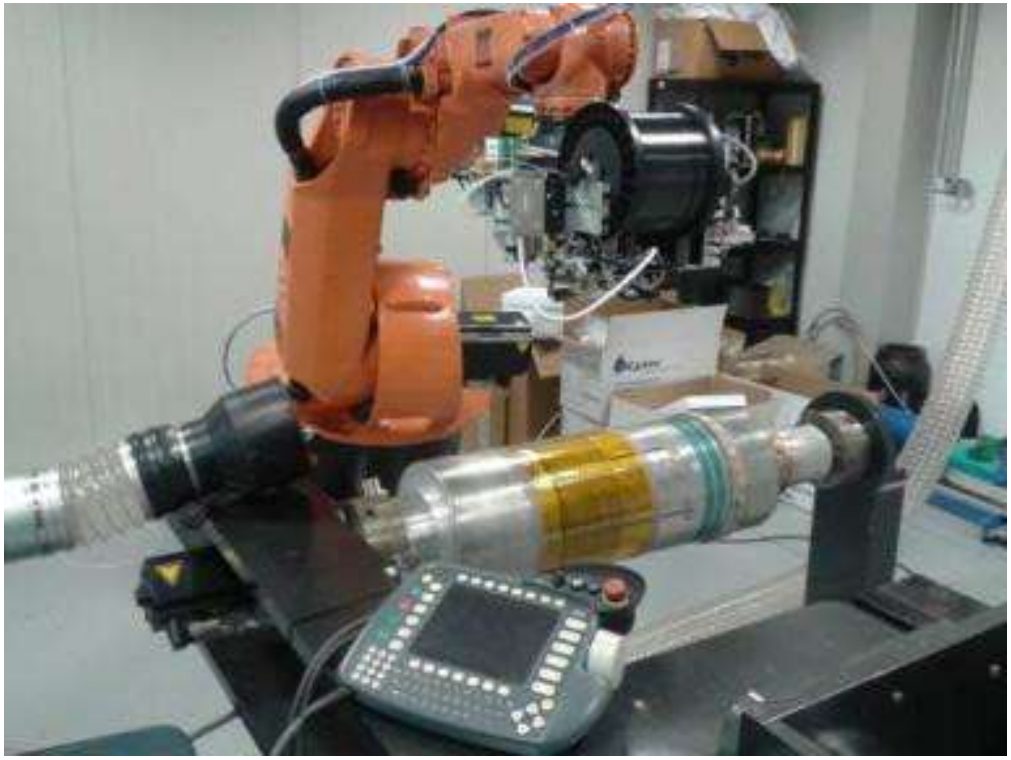
studio, realizzazione e sperimentazione su test-article intermedi al fine di validare i metodi nuovi di design-processo



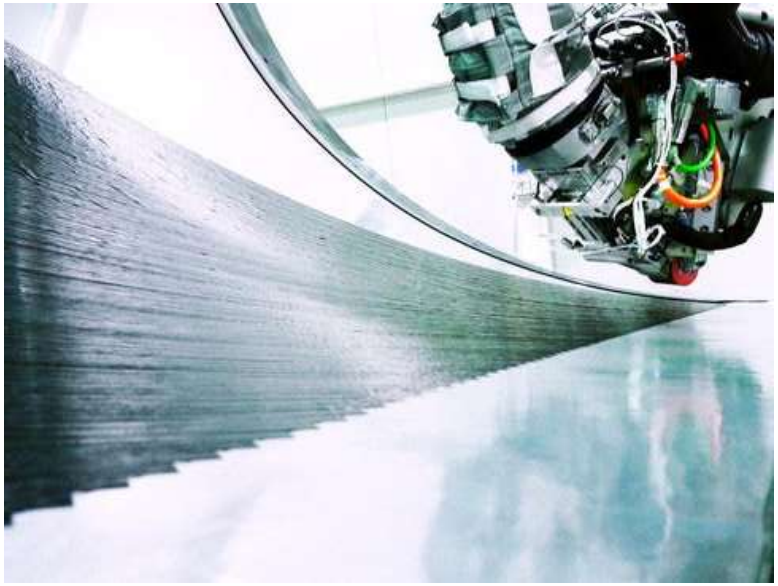


robotic winding

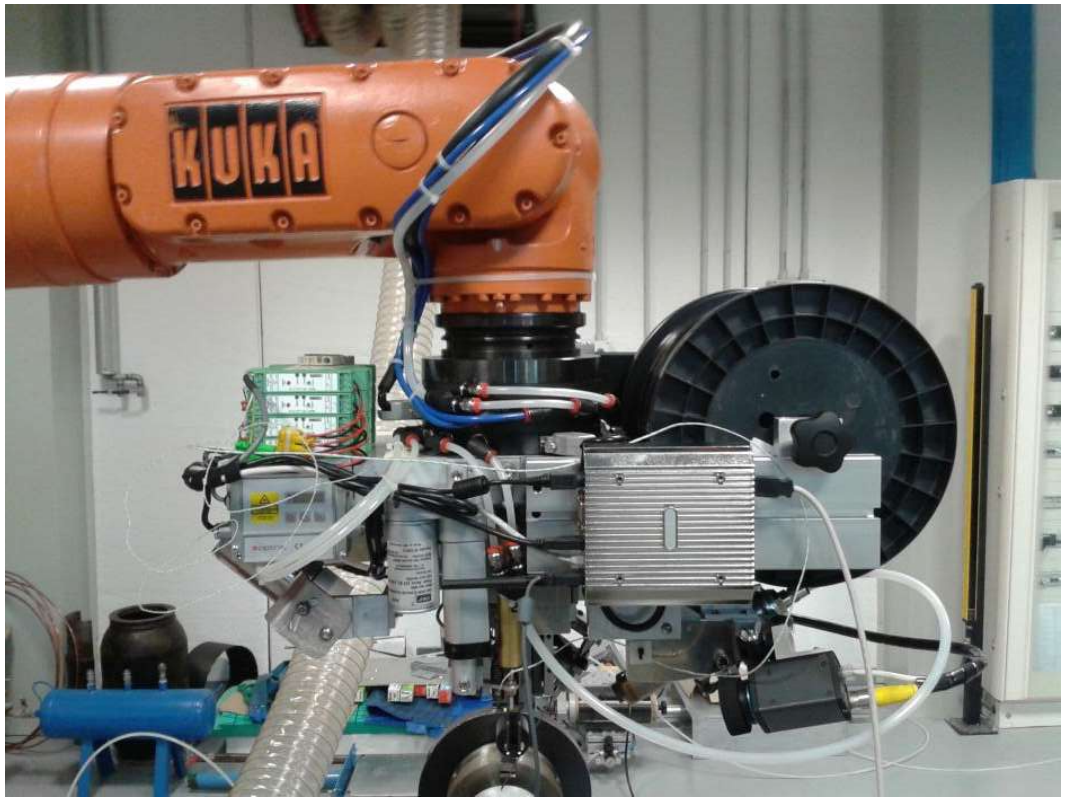




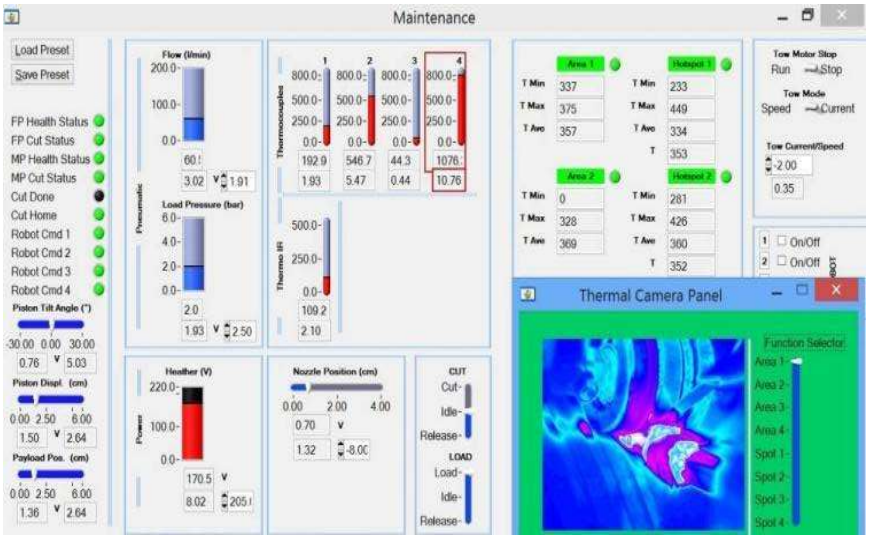
Thermoplastic Placement



Thermoplastic Fiber Placement



Hot Gas Torch temperature and pressure control



The message is that engineers should use more creative thinking when designing composite structures. It is important that you don't get tied down by all the traditional methods, which slow you down, and the standards and procedures, which usually only tell you 'what not to do!' Creative engineering design, enriched by comprehension, imagination, and proper judgment, will provide the gateway for tapping the full potential of composite materials.

Burt Rutan, Dr. Clem Hiel, and Brandt Goldsworthy