



L'interstadio 2/3 del lanciatore VEGA C realizzato in composito grigliato

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SEMINARI INTERDISCIPLINARI DI CULTURA AERONAUTICA
II Serie, II Ciclo
II° incontro
12 ottobre 2019

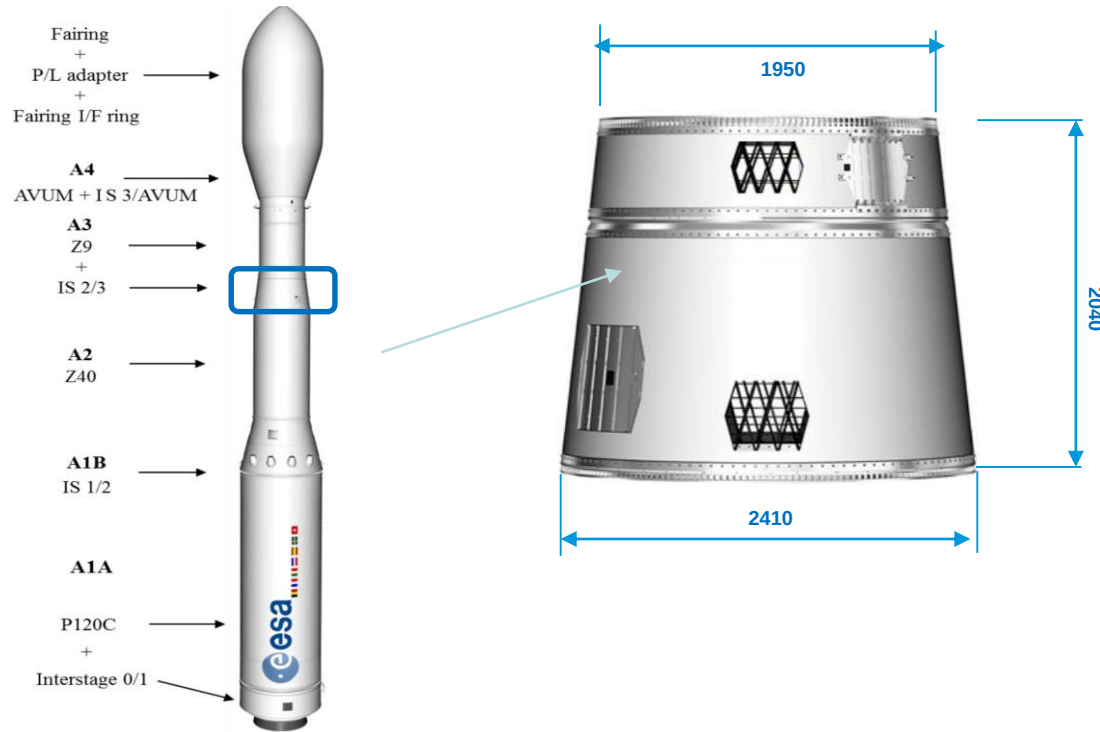
An important point, with which most people tend to agree, is that ‘nobody can teach swimming or ice skating in a lecture hall. This also holds for designing with composite materials.’ Design is one of the things you actually have to go out and do. People can assist you and help you, but the D in Design stands for Doing! That’s the only way one can learn it!

Burt Rutan, Dr. Clem Hiel, and Brandt Goldsworthy

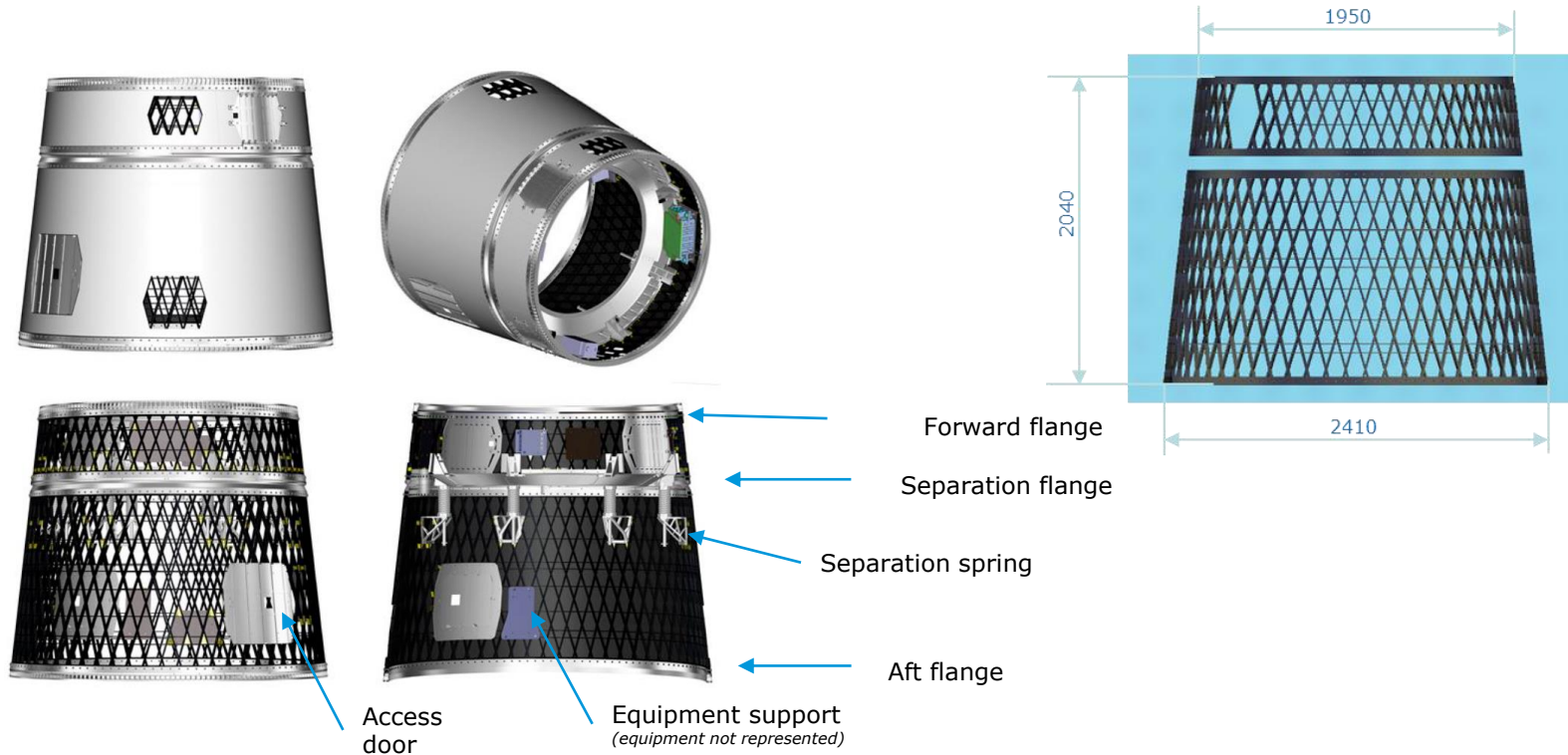
Prima applicazione industriale su un Lanciatore Europeo di una Grid structure in Composito



Centro Italiano Ricerche Aerospaziali



Struttura generale dell'Interstadio



Strutture Grid

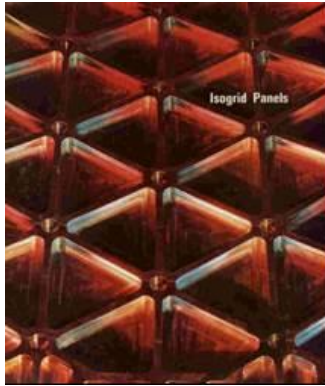
sinergia elica-hoop



effetti stabilizzanti sotto carico di compressione



Strutture Grid

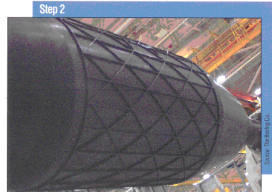
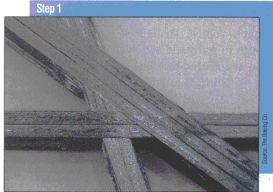


esperienza USA

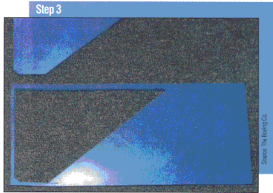
dall'isogrid metallica all'anisogrid
in composito

dal wet winding al fiber placement

Strutture Grid : manufacturing by Fiber Placement

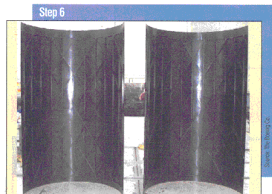
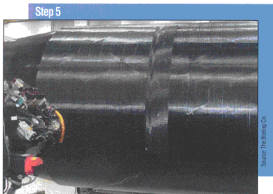


mandrino liscio (in composito)



materiale (prepreg)

accresciuto a strati per **Fiber Placement** (FP)



inserti in gomma larghi per compattare

High Performance Composites, vol 10, number 2, pp 48-51, 2002

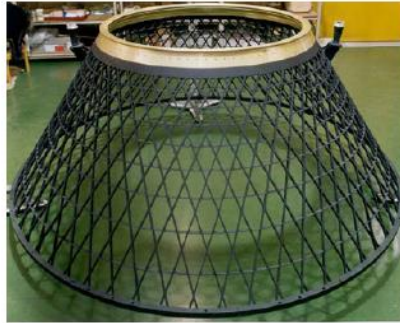
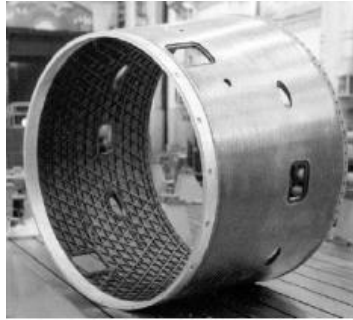
Strutture Grid : manufacturing by Fiber Placement



fairing per il
Minotaur
launcher

fonte Boeing

Strutture Grid



esperienza in URSS

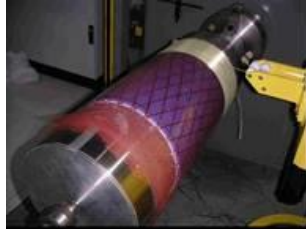
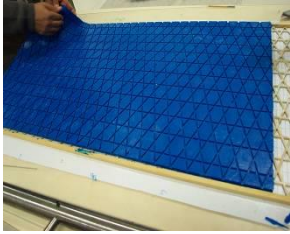
anisogrid in composito in wet
winding

Proton Launcher

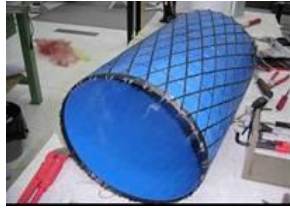


fonte CRISM

Strutture Grid : manufacturing by Wet Winding

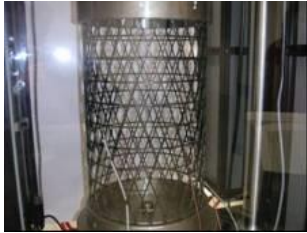


Wet Filament Winding (FW):
fibre bagnate di resina



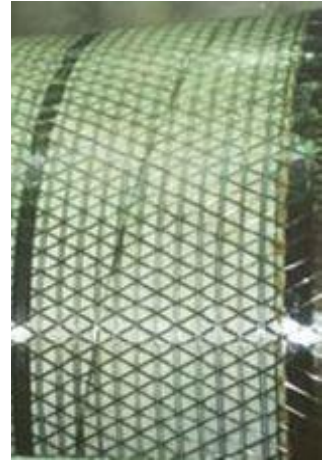
avvolte nelle cave di un tool di
silicone

(dummy helic di passaggio)



alternando eliche e
circonferenze

fonte CIRA

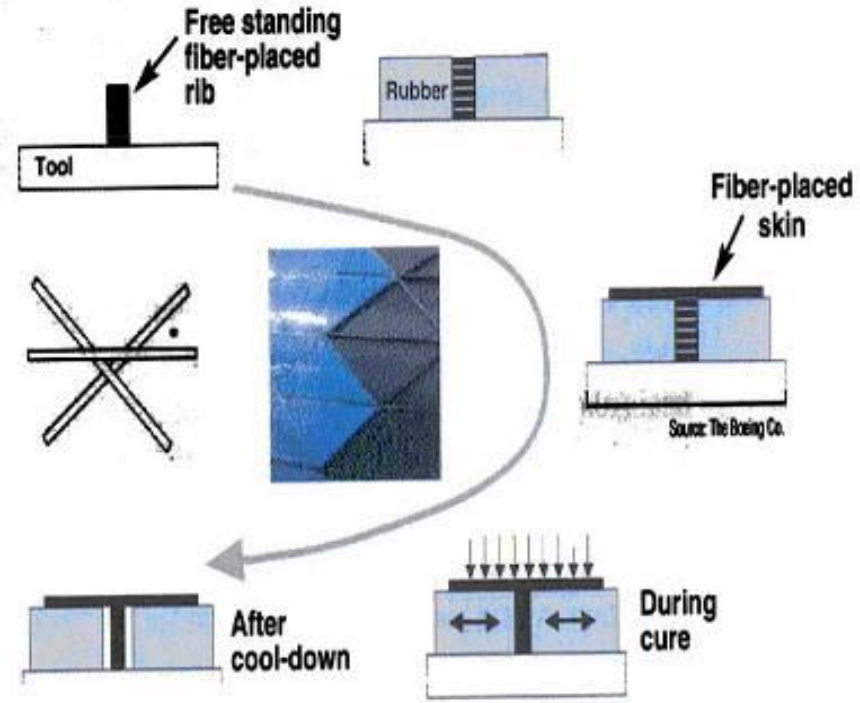


fonte CRISM

Strutture Grid : manufacturing by Fiber Placement

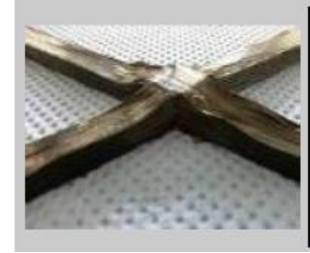
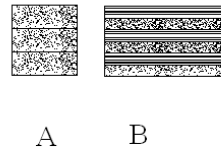
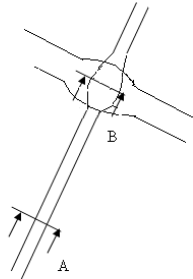
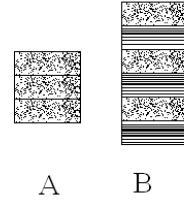
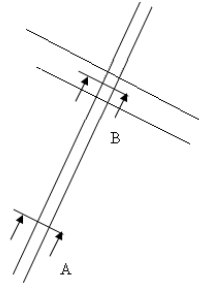
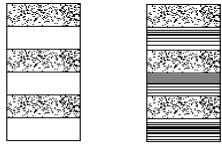
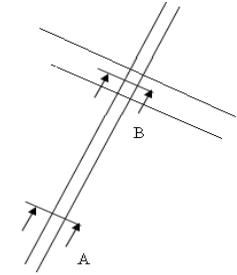
Spazi vuoti iniziali molto marcati

Compattazione esasperata:
necessità di ampi blocchi di gomma



High Performance Composites, vol 10, number 2, pp 48-51, 2002

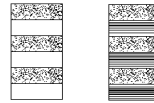
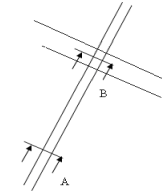
Strutture Grid : manufacturing by Fiber Placement



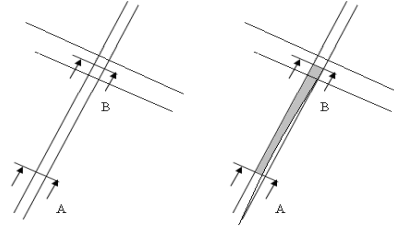
fonte EADS

Strutture Grid : manufacturing trade off

WET



PREPREG

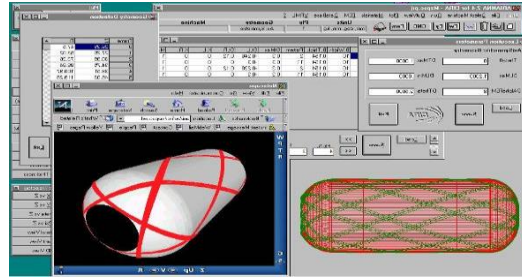


Before Curing

After Curing

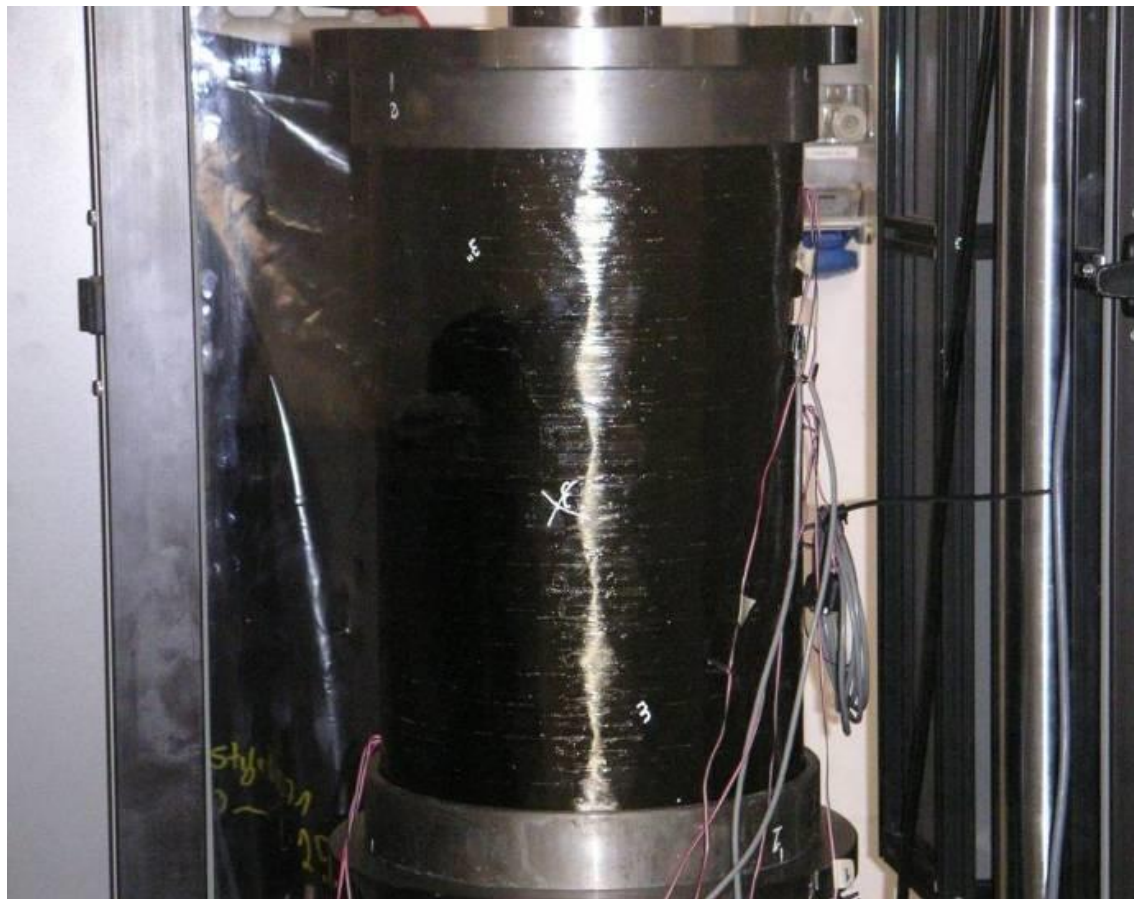
Esperienze del laboratorio Prototipi in Materiale Composito

FW



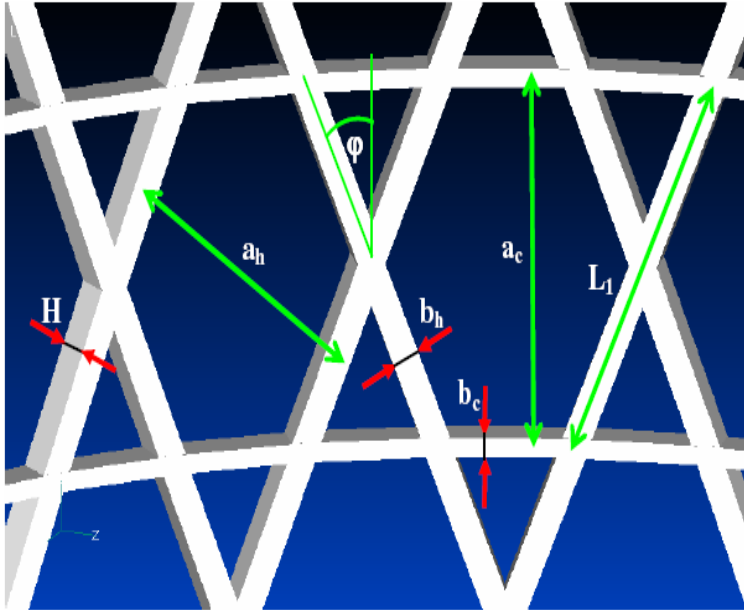
Liquid
Infusion /RTM





**23
Tonnellate
Di
Compressione**

Massa 0,9 Kg



parametri geometrici

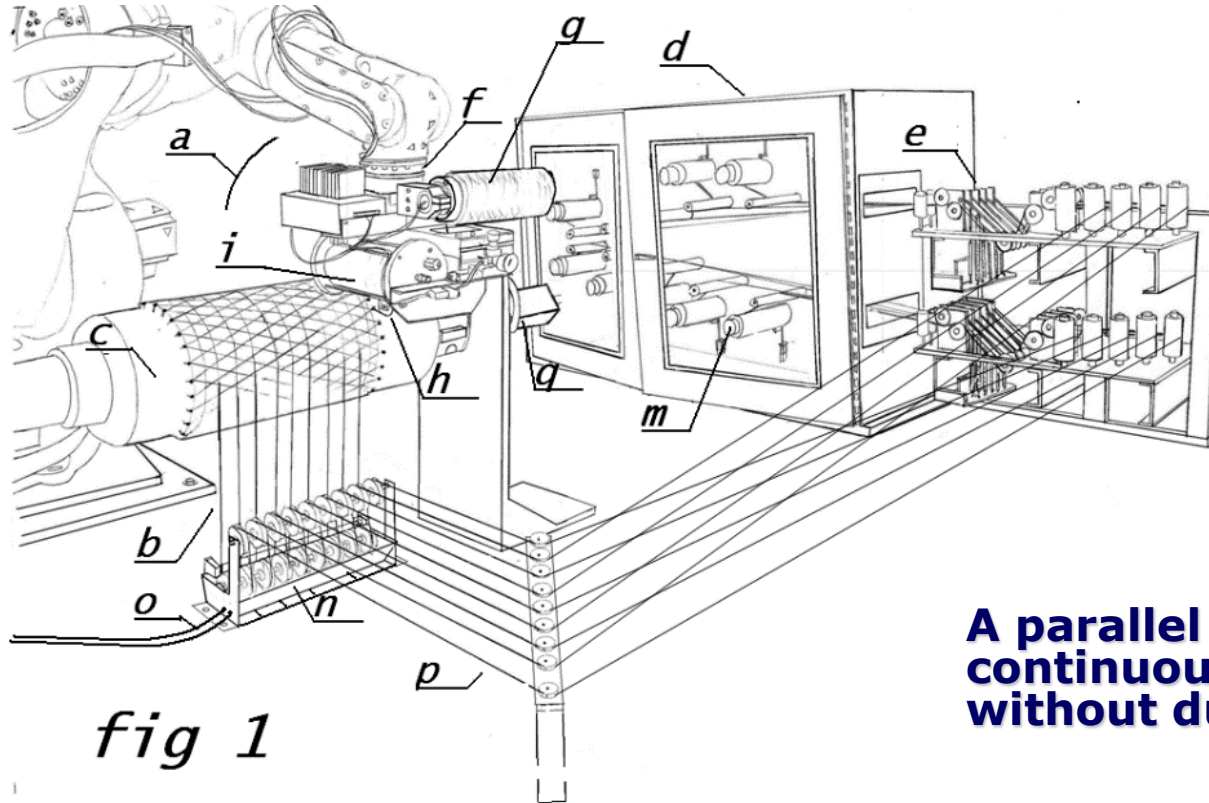
**massa minima
resistenza a compressione
rigidezza**

**buckling locale grid
buckling globale grid
pocket buckling skin**

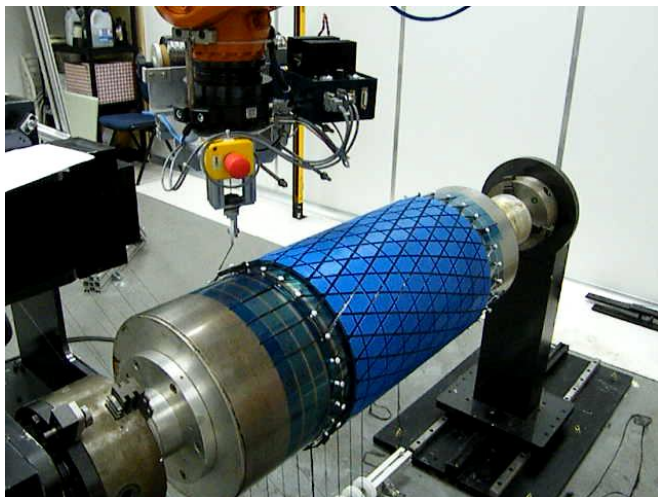
vincoli di manufacturing

**An infinite rotation of
deposition eye**

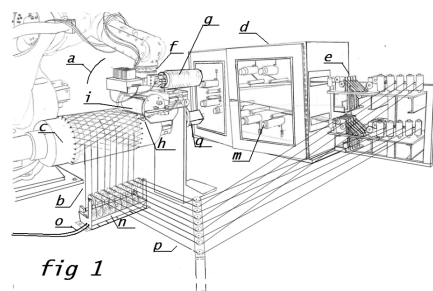
Sistema di avvolgimento parallelo



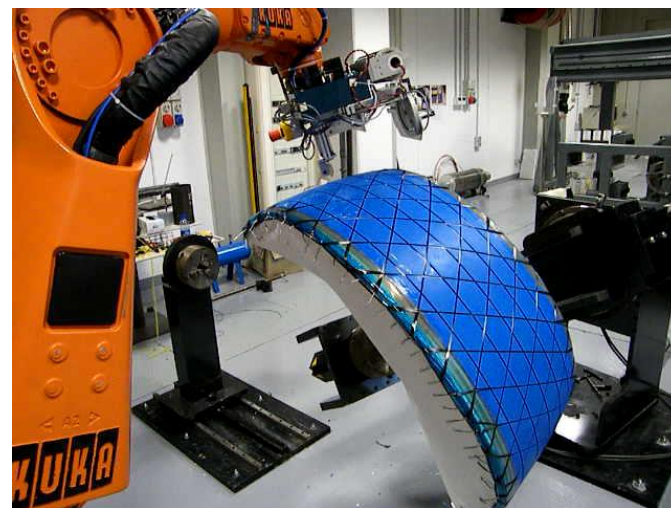
**A parallel feeding for
continuous hoops
without dummy helix**



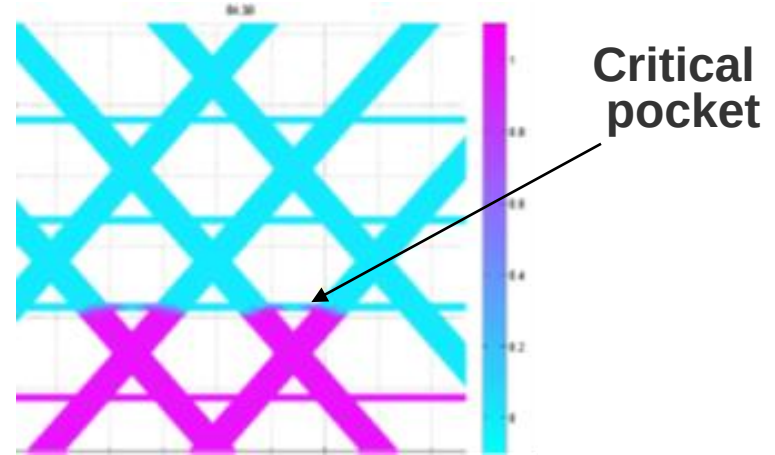
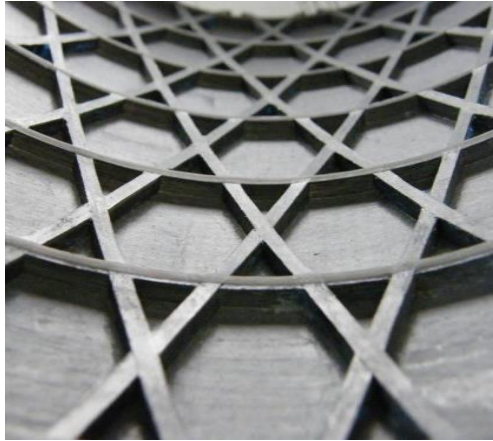
Cilindric

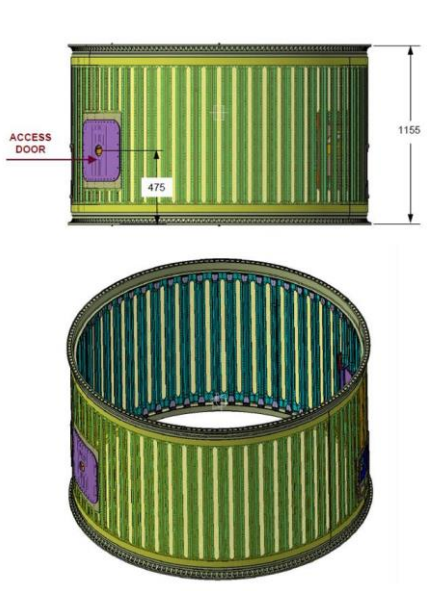


**Pannelli
doppia
curvatura**



Approccio alla liquid infusion per le strutture grid





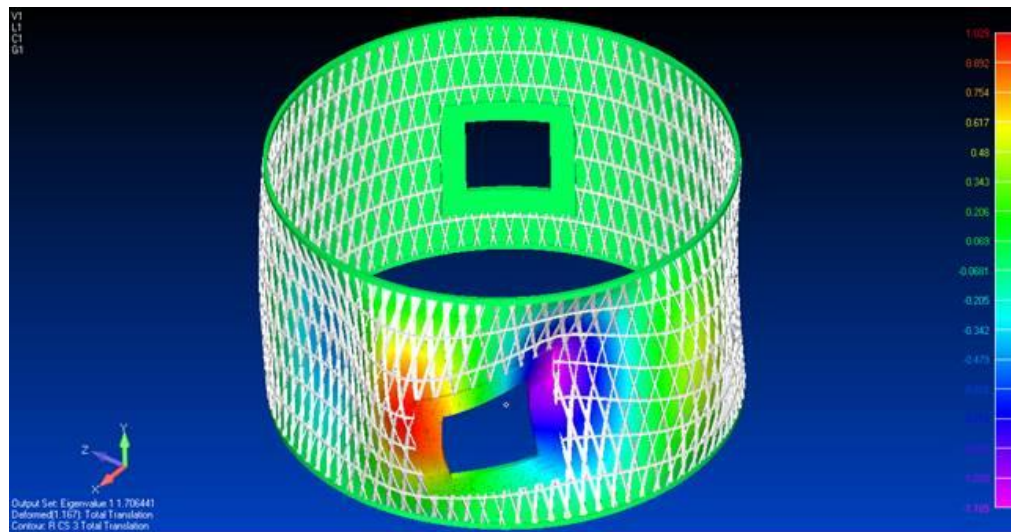
Alluminio

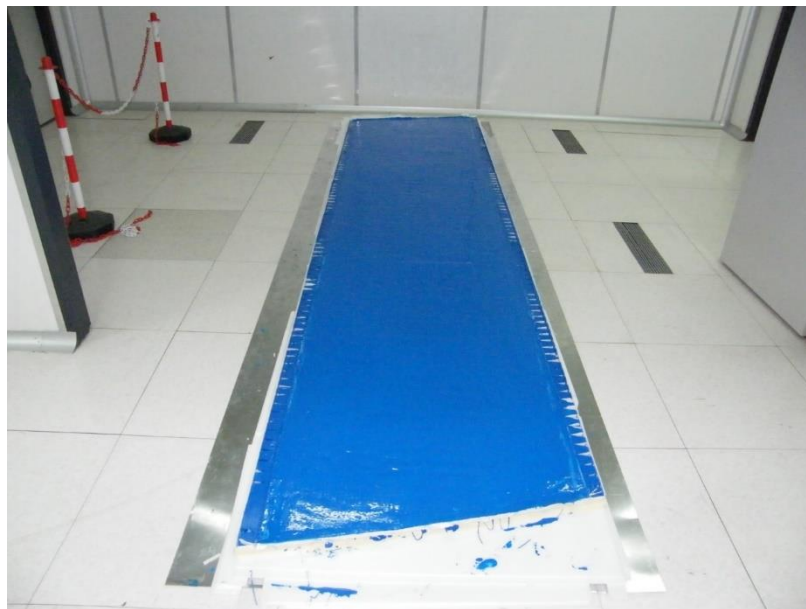


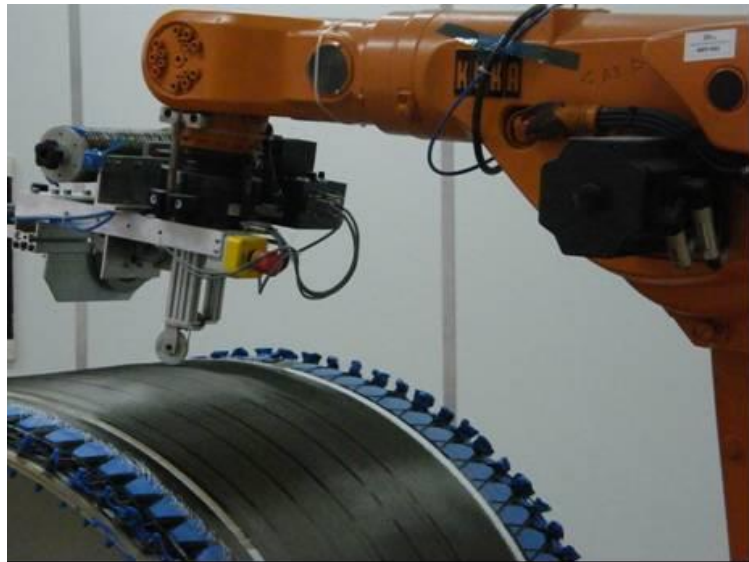
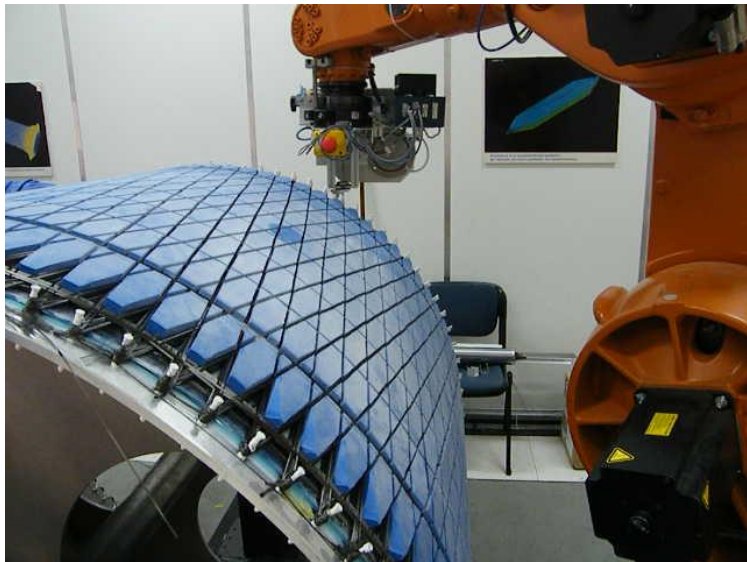
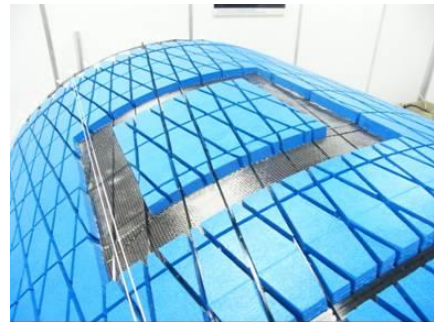
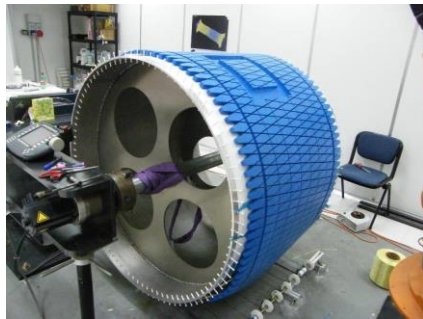
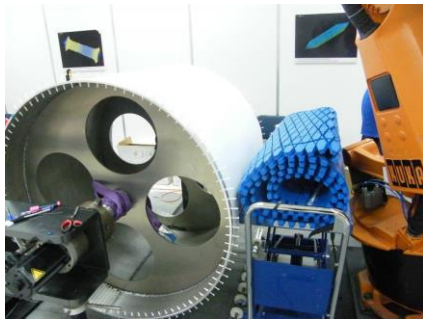
Confronto



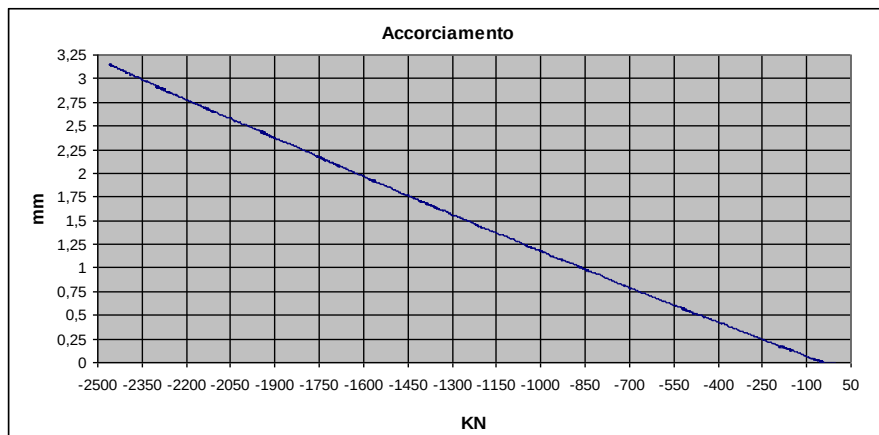
Composito Grid











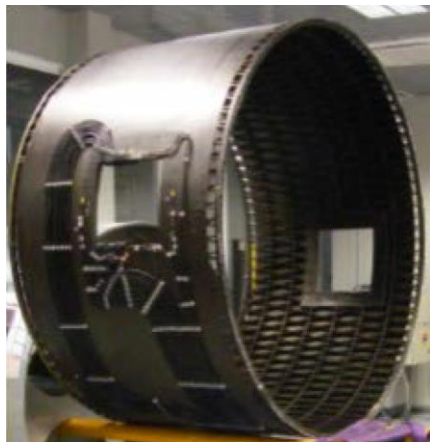
250 Tonnellate di carico

40% risparmio di massa rispetto ad
alluminio

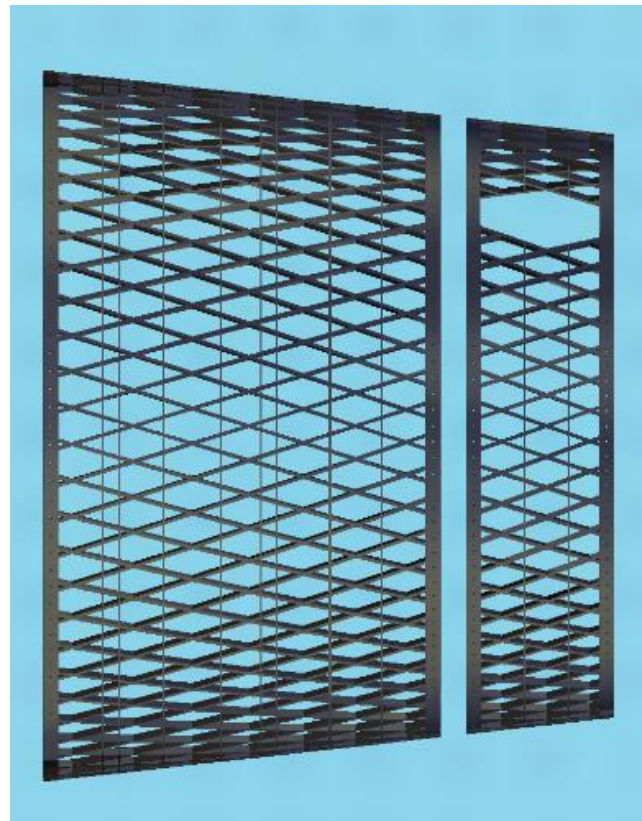
2005

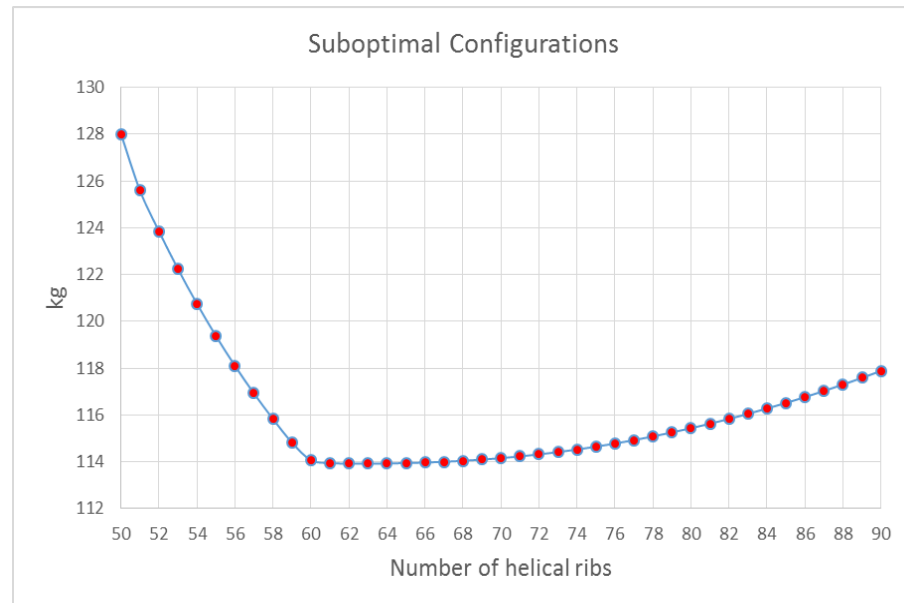
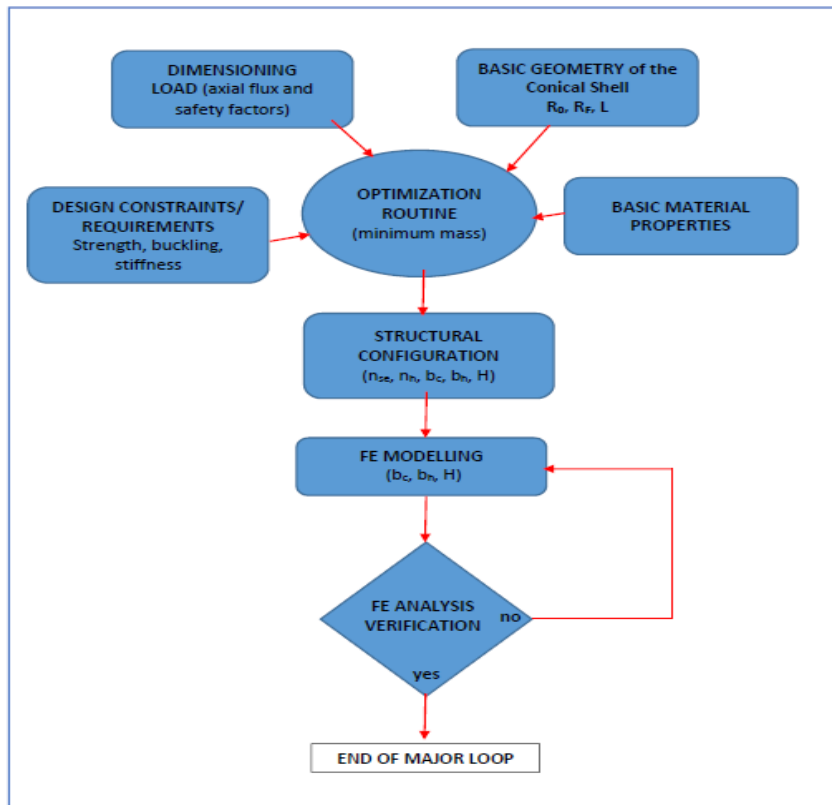


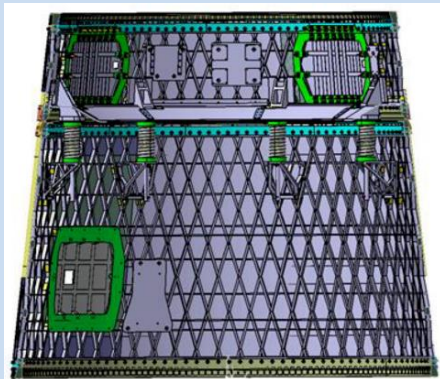
2010



2015

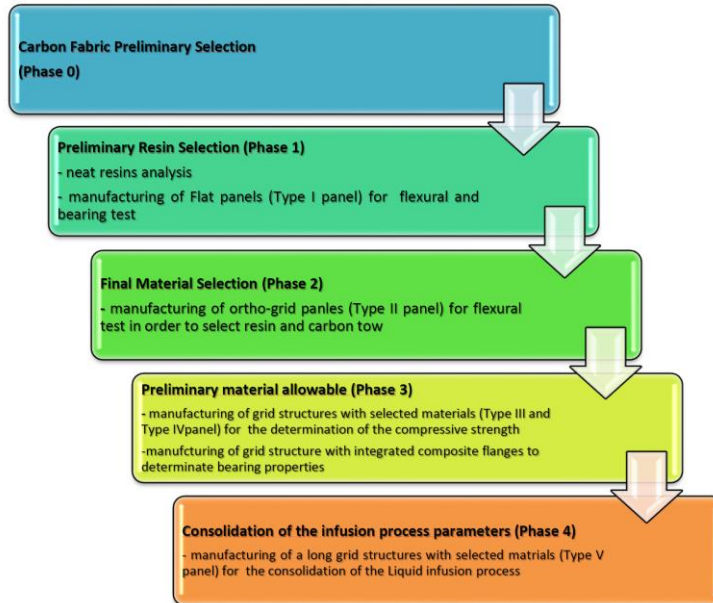




		VEGA	VEGA-C
Design			
Geometry		Cylinder H1630 D1950	Cone H2040 D2410 d1950
Description		Aluminum shell with inner riveted aluminum stiffeners	CFRP shell co-bonded with lattice CFRP structure
Mass *	kg	293	400
Surface	m ²	10.0	14.1
Dimensioning Flux	kN/m	545	575
Min Margin of Safety	-	7%	61%
Performance mass / (surface*Flux)	kg/(m*kN)	0.0538	0.0495

-8%

➤ Work Logic



Phase 0: Preliminary Carbon Fabric selection

Simple tests on raw materials

Phase 1: Preliminary Resin selection

Resin analysis, flexural and bearing tests on Type I specimens (from flat panels)

Phase 2: Final Materials selection (Resin and Carbon Tow)

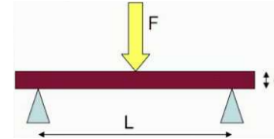
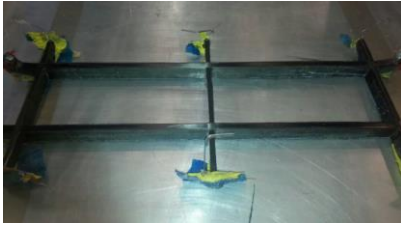
Flexural tests on Type II specimens

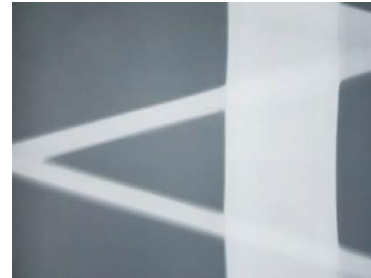
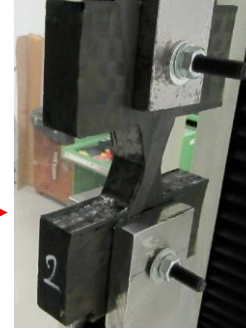
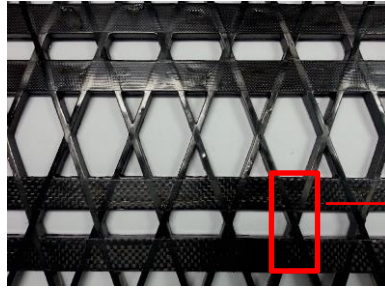
Phase 3: Preliminary Material Allowable Values

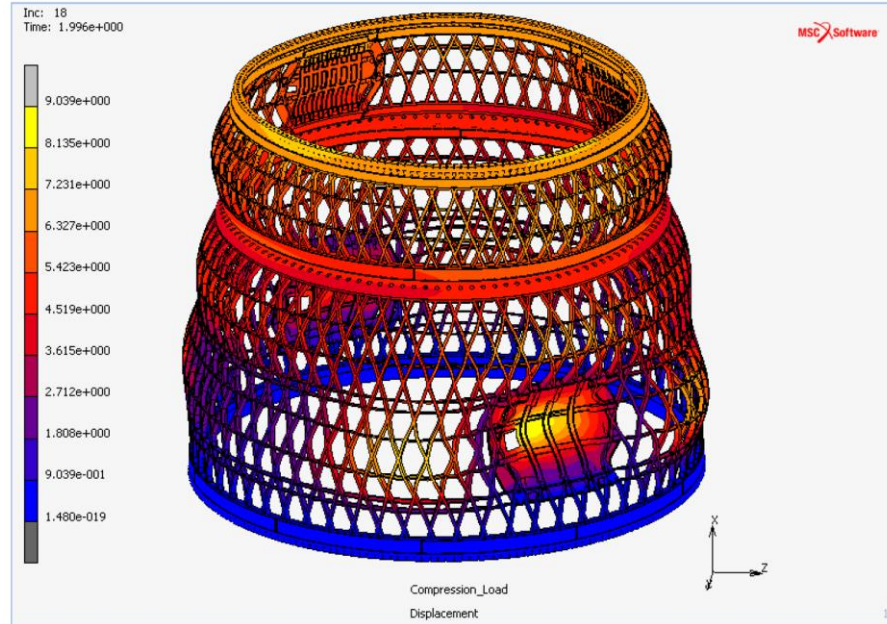
Compressive strength tests and bearing tests on Type III and Type IV samples

Phase 4: Consolidation of the Infusion Process Parameters

Manufacturing feasibility of Type V panel























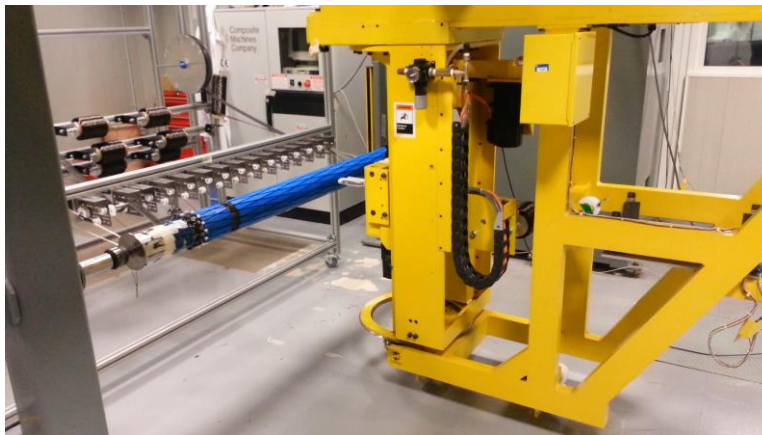






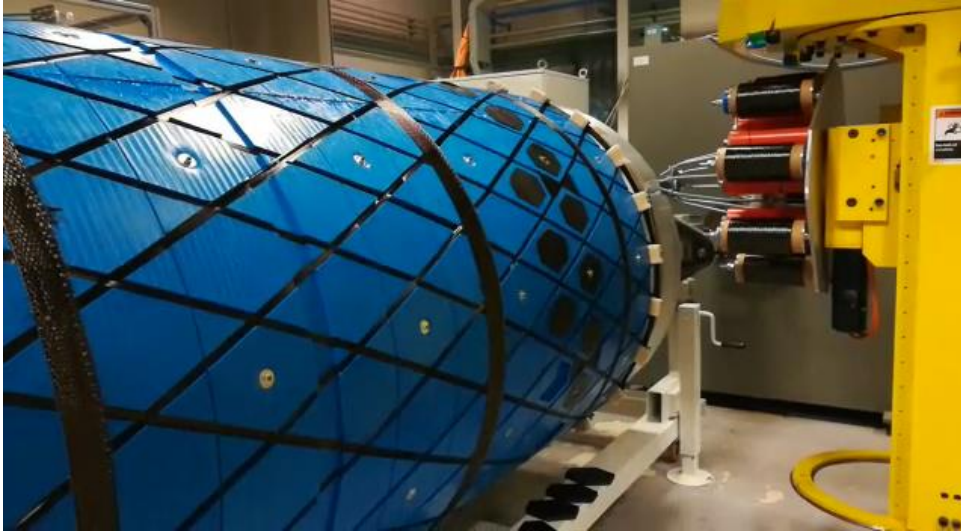
Boom segment of a deployable antenna

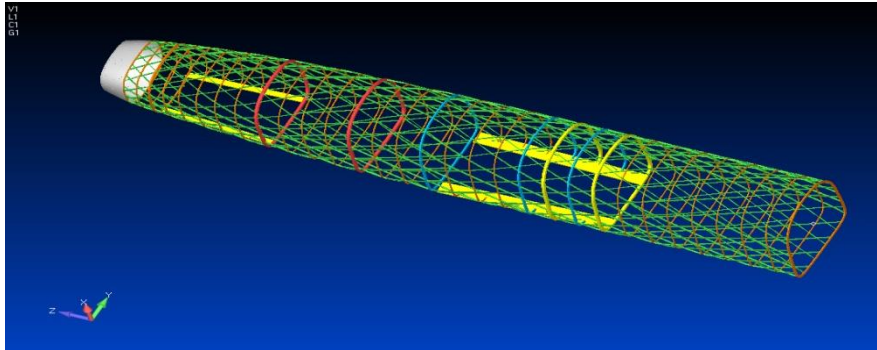
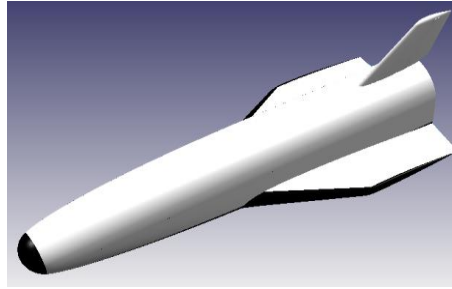
ESA project



Central Tube

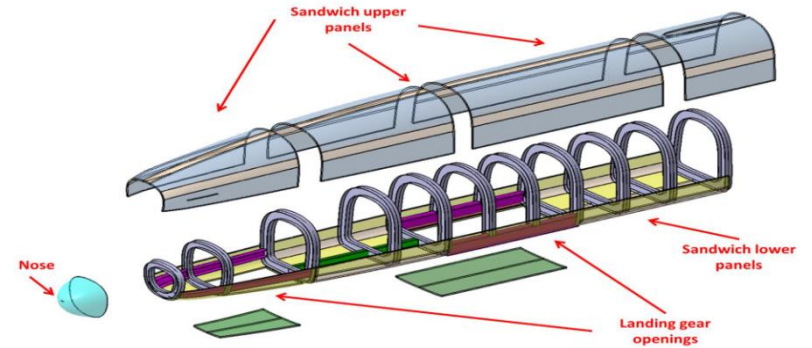
ESA project



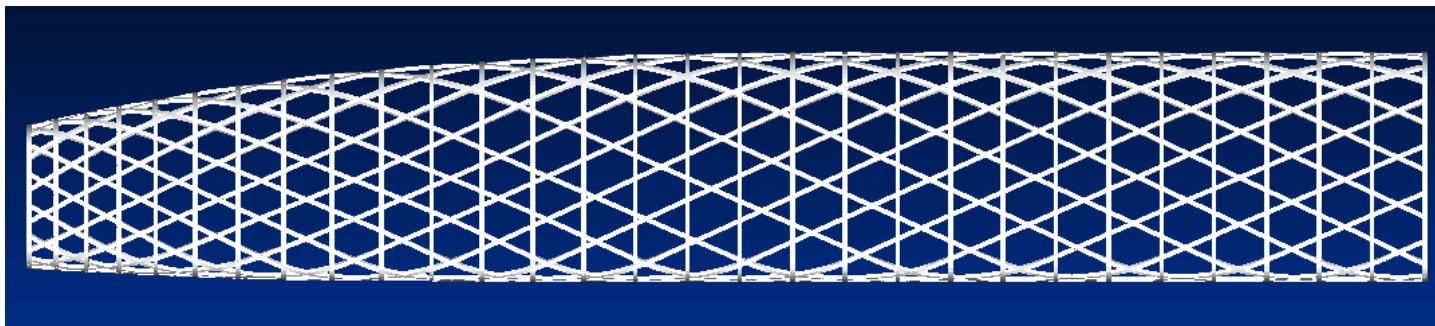


anisogrid hypothesis

Vs



benchmark : sandwich



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

