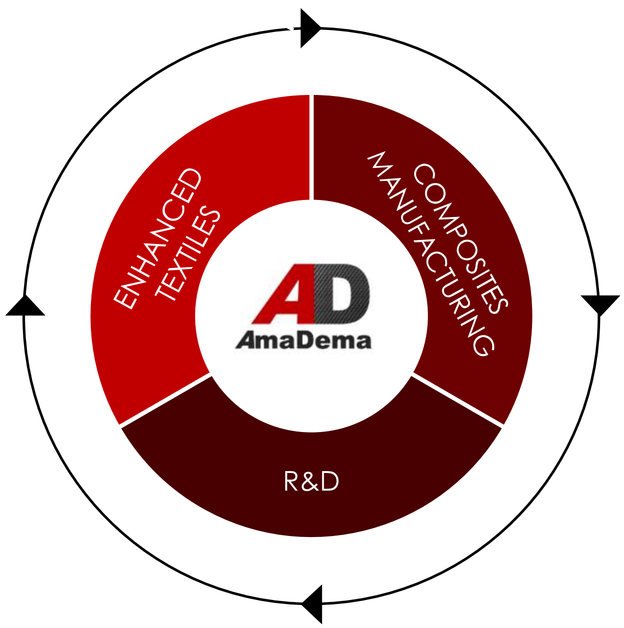
AMADEMA TECHNOLOGIES

STRONGER NOW MEANS LIGHTER

AmaDema

The company offers clients integrated additive manufacturing solutions through its three business divisions

AmaDema divisions



1 ENHANCED TEXTILES

- NanoWeld enhanced fabrics
- Nanofabrics
- Enhanced fabrics via printing
- Fabrics impregnation

2 COMPOSITES MANUFACTURING

- Design
- Analysis
- Prototyping / development
- Manufacturing / production

3 R&D

- R&D services
- Grants

High performing materials are being deployed in structural applications across multibillion industries

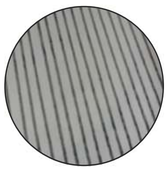
NanoWeld® developed for terrestrial applications and adapted to space applications through ESA tenders

- Aviation
- Space
- Energy
- Construction
- Automotive
- Sports

Portfolio of Technologies

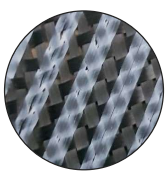
AmaDema has developed different technologies to enhance technical fabrics, which are already available in the market. These technical fabrics include carbon, glass, or aramid fabrics of any type of knitting (UD, woven, biaxial, etc.)

Technologies:

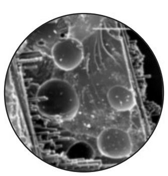


- **NanoWeld® -** spearhead technology, uses reinforced polymer nanofibers which are attached to both surfaces of existing technical fabrics enhancing mechanical properties of the final composite (Product in market)

- **Screen Printing -** uses roll to roll screen printing to coat polymer nanocomposites on both surfaces of existing technical fabrics enhancing thermal and electrical properties of the final composite (R&D Development)



- **3D Printing -** uses continuous 3D printing to deposit several types of polymers, reinforced or not, on both surfaces of existing technical fabrics enhancing mechanical, thermal, and electrical properties of the final composite (R&D Development)

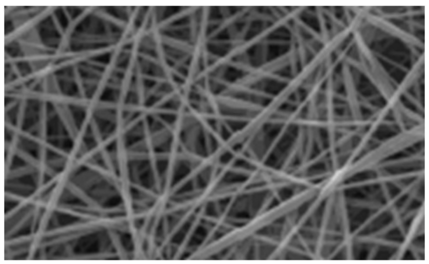


- **Nano-reinforced Foaming Systems -** use different nano-reinforcements in foaming systems to be used as core materials in composite applications and tackle mechanical, electrical, thermal, and flammability properties (R&D Development)

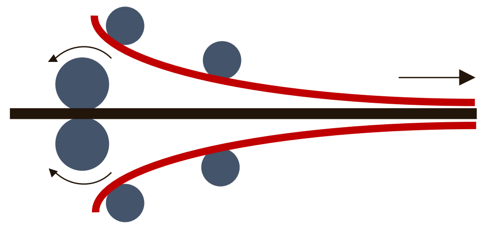
NanoWeld - Spearhead technology

AmaDema's NanoWeld enhances the performance of technical fabrics **with the use of reinforced nanofibers**

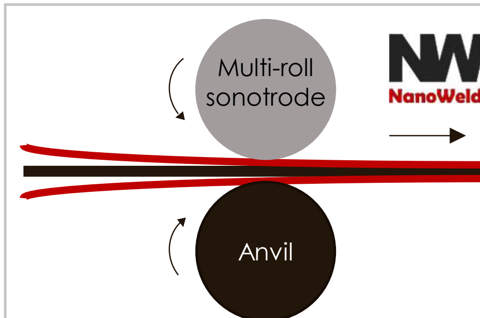
Nano creation

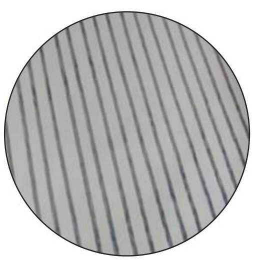


Nano insertion



Nano consolidation

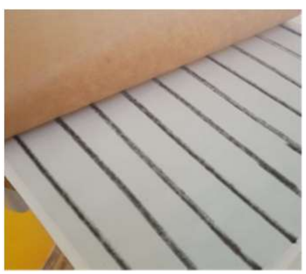




- AmaDema has developed different technologies to enhance technical fabrics which are already available in the market. These include carbon, glass, aramid or other technical fabrics of any type of knitting (UD, woven, biaxial, etc.)
- NanoWeld®, the company's spearhead technology, uses reinforced polymer nanofibers which are attached to both surfaces of existing technical fabrics enhancing the mechanical properties of the final composite component. Its final form is a dry fabric

SpaceNanoWeld™

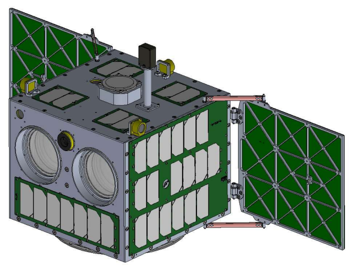
TRL 3-4
2019-2022



Material development for space applications

HyperNanoWeld™

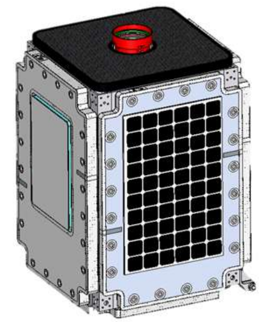
TRL 4-5
2021-To date



Development of solar panel frames using SpaceNanoWeld™

PIP NanoWeld®

TRL 5-6
2022-To date



Development of payload interface plates using SpaceNanoWeld™

SpaceNanoWeld – NanoWeld® Technology Assessment for Space Multi - Functional Composites (PECS 2)

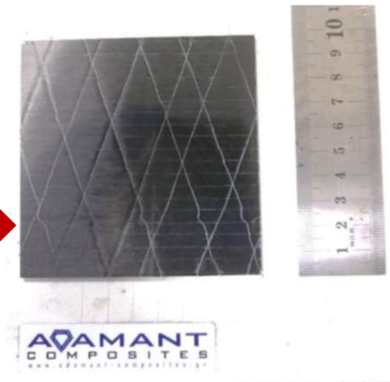
ADAMANT

Scope: Investigation of the potential application of NanoWeld in Space Applications

Nanofabric Development & Production

SpaceNanoWeld Dry Fabric Development

SpaceNanoWeld Prepreg Development

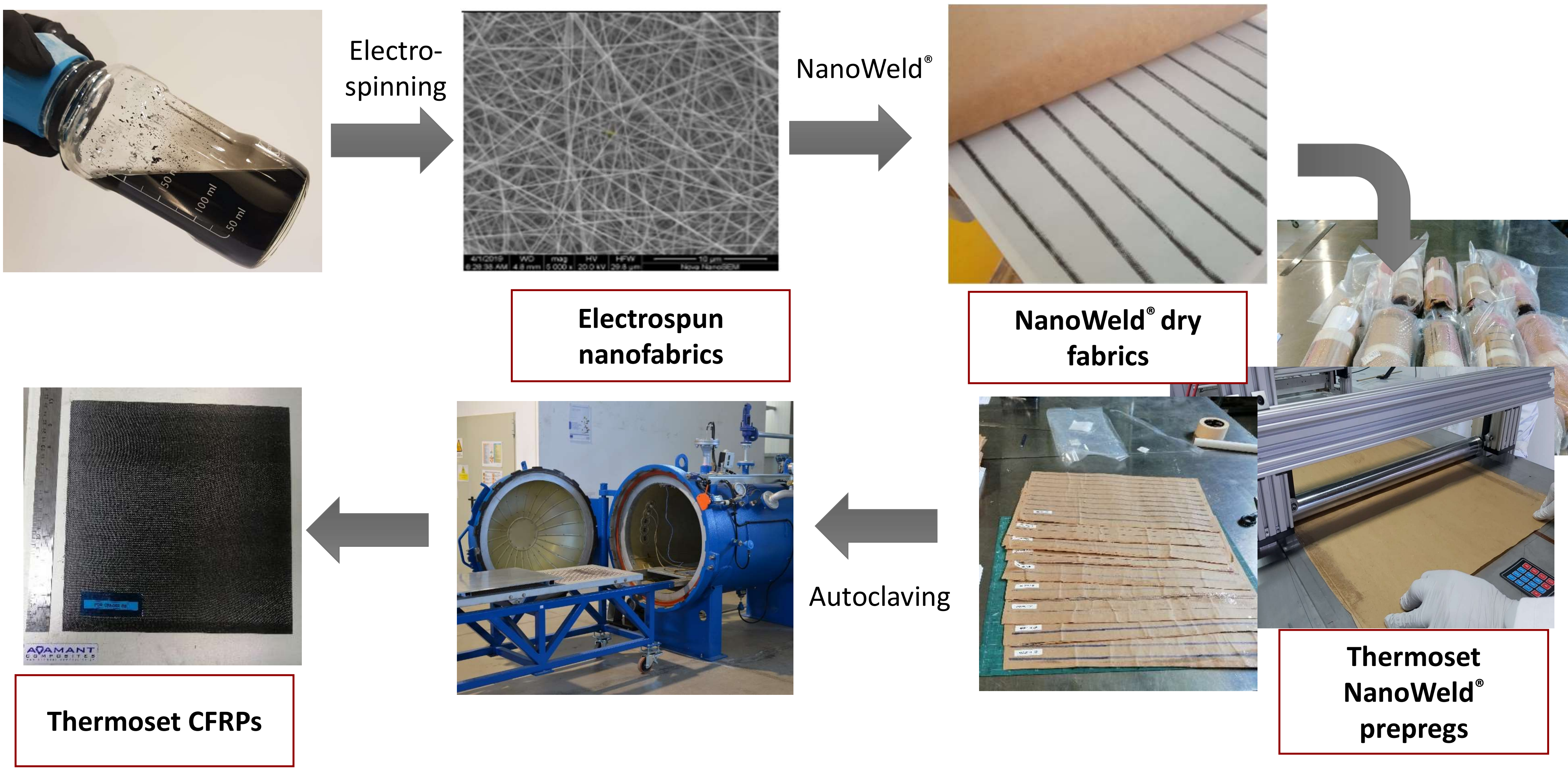


SpaceNanoWeld Composite Development

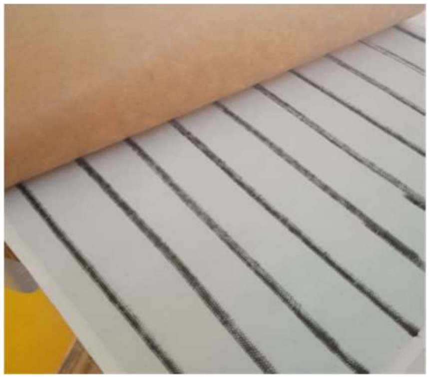
Testing Certification

AmaDema

Overview of SpaceNanoWeld Products



Overview of SpaceNanoWeld Products



Thermoplastic prepregging

Thermoplastic NanoWeld® prepregs

Hot pressing

Thermoplastic CFRPs

Main results

Scope: Developed successfully a NanoWeld® system to meet space application requirements

Stiffness-Thermoset specimens
NanoWeld and NanoWeld+CNT CFRP specimens demonstrated **9%** increase in measured stiffness through accredited tensile testing (ASTM D3039).

Stiffness-Thermoplastic specimens
NanoWeld+CNT CFRP specimens demonstrated a **15%** increase of the measured stiffness along with a **17%** increase of the tensile strength.

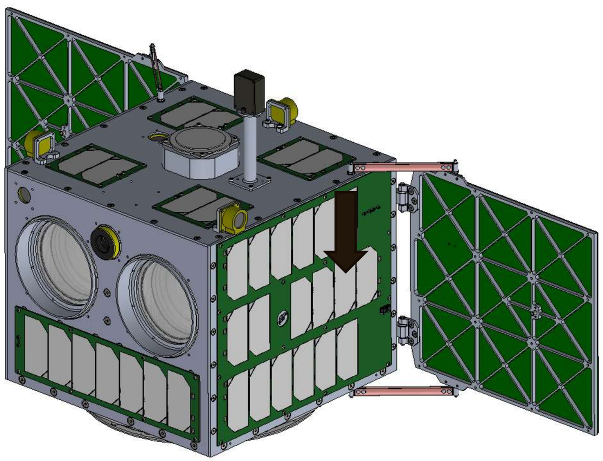
Damping- Thermoset & Thermoplastic specimens
Damping results using the cantilever method were not conclusive. Nevertheless, Dynamic Mechanical Analysis performed has demonstrated that the employment of NanoWeld technology results in significantly increased damping factor in frequencies ranging from 0 to 200 Hz.

Electrical Conductivity-Thermoplastic specimens
NanoWeld technology has demonstrated a significant increase of the through thickness electrical conductivity of thermoplastic specimens, increasing the measured conductivity by **17%.**

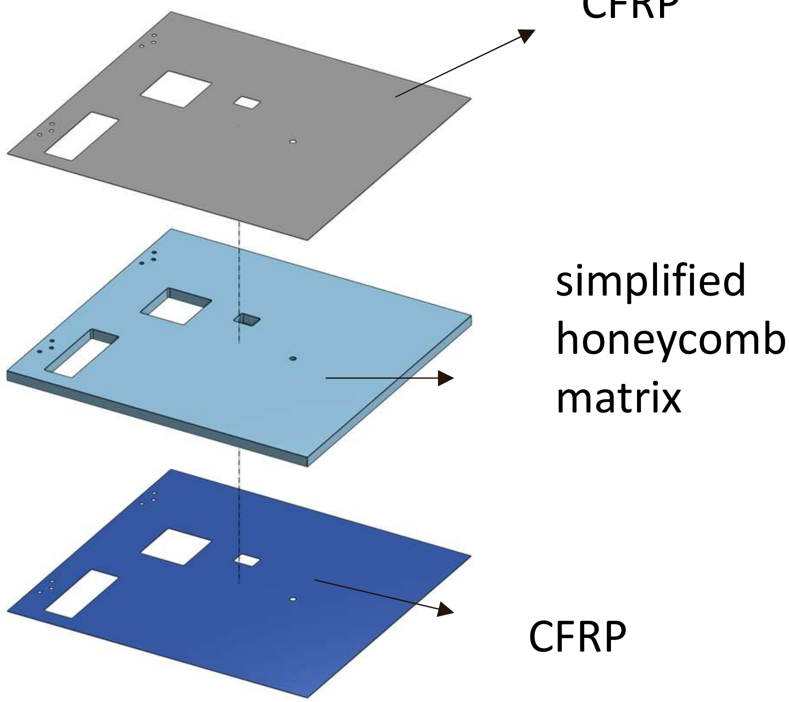
HyperNanoWeld – NanoWeld® Carbon Fiber Reinforced Polymer Composite Frames for Supporting Hypersat Satellite Solar Panels (PECS 3)

Scope: Develop the SpaceNanoWeld™ CFRP version of the Hypersat's Solar Panel Supporting Frames and advance SpaceNanoWeld™ to TRL4-5

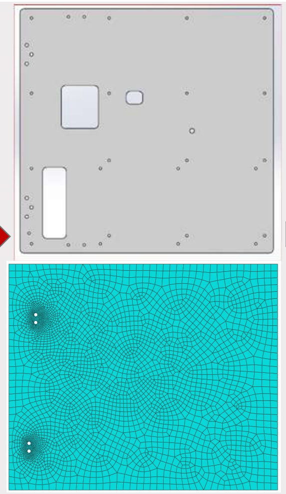
Satellite render

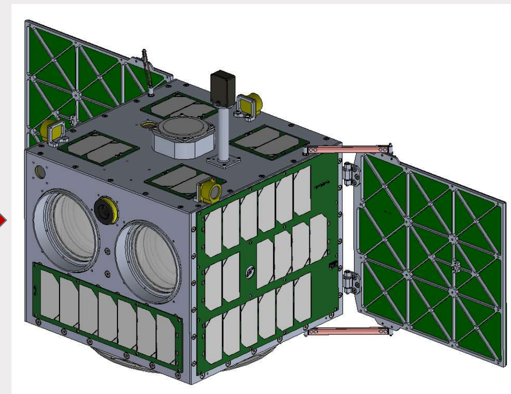


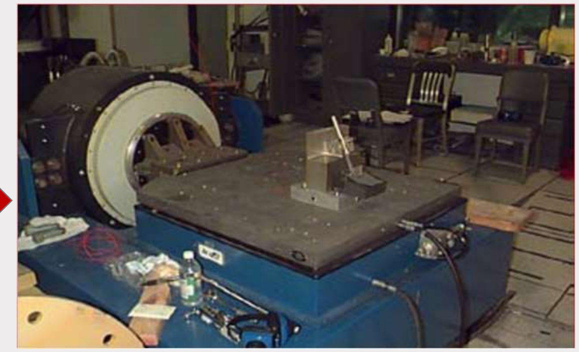
Solar panels redesigned for CFRP



HyperNanoWeld – Project Flowchart







SpaceNanoWeld Dry Fabric Selection and Development

CAD, FEM, Manufacturing plan

Testing- Phase 1

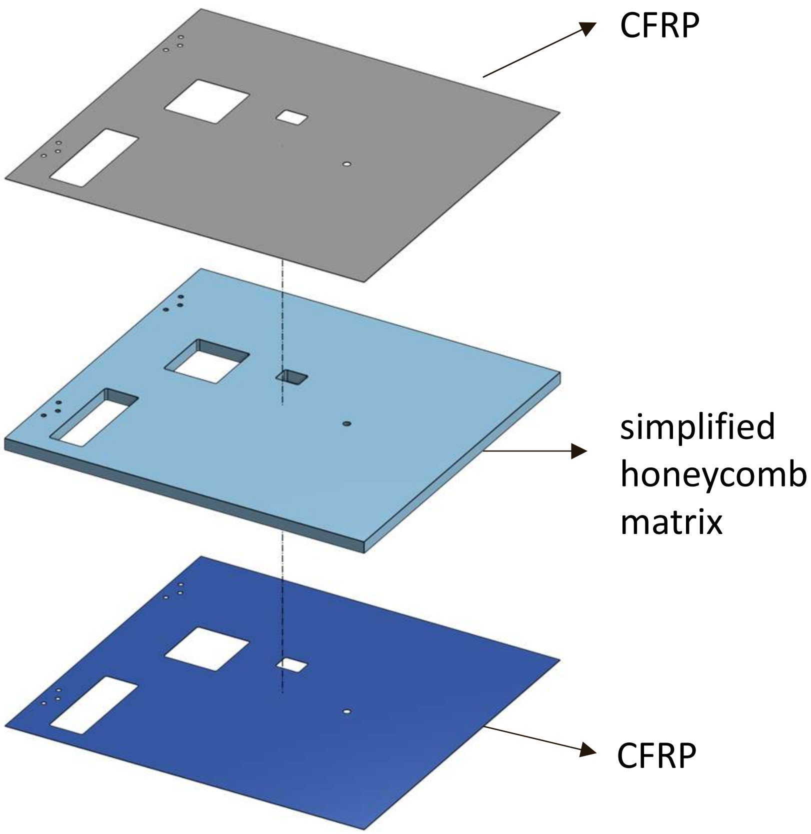
Hyper NanoWeld Solar Structure Development

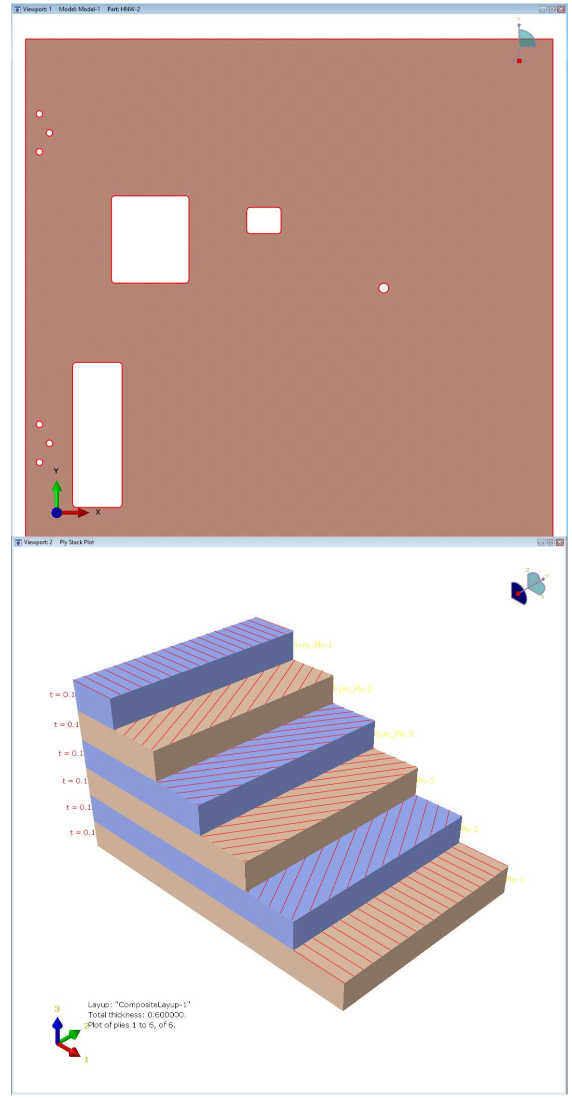
Testing- Phase 2

HyperNanoWeld Solar Panel Supporting Frame Testing

Testing- Phase 3

CAE Simulation

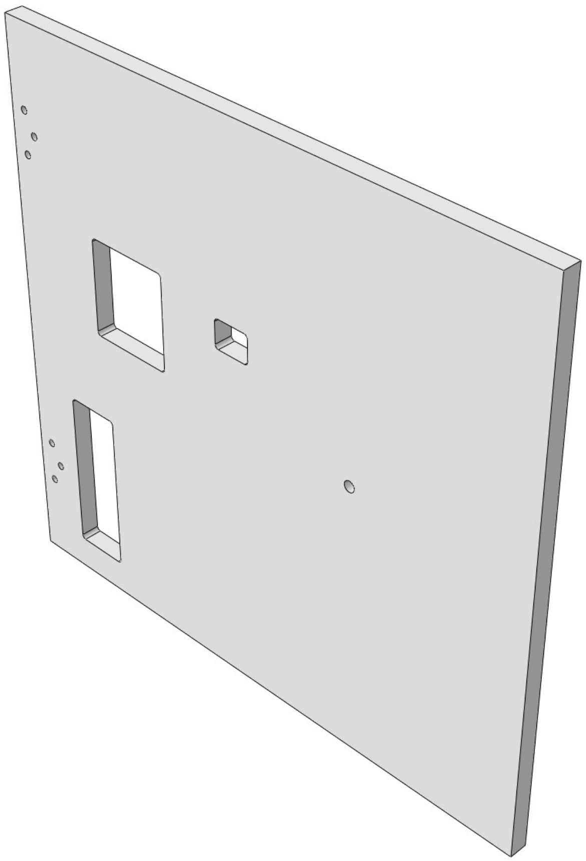




Ply Name	Rotation Angle
Ply-1	0
Ply-2	-60
Ply-3	60
Sym_Ply-3	60
Sym_Ply-2	-60
Sym_Ply-1	0

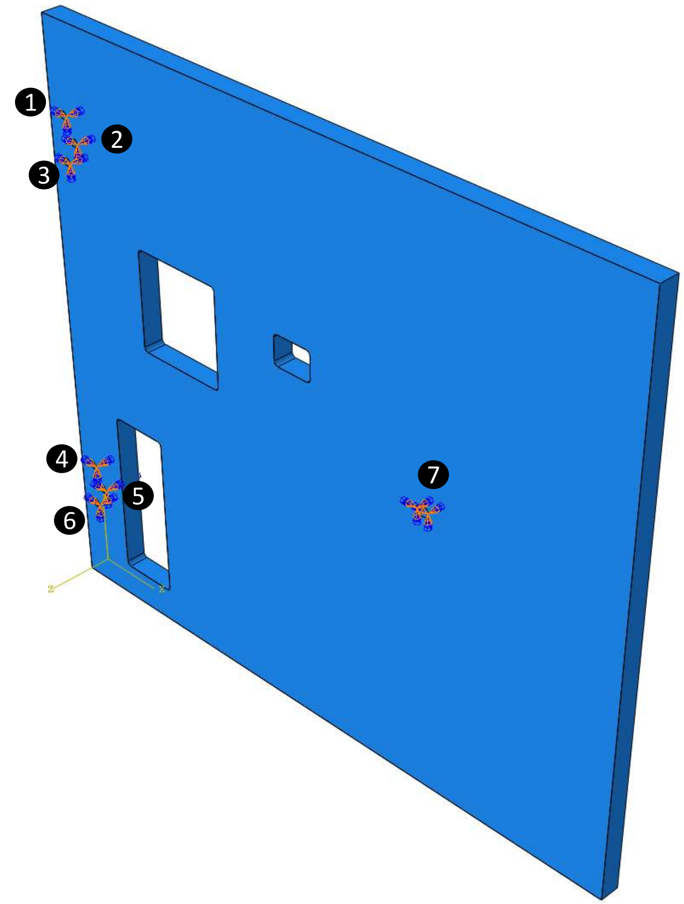
CFRP Property	Value
d	1.546 E-09 t/mm³
E1	145730 MPa
E2	4180 MPa
E3	4180 MPa
v12	0.2
N13	0.2
N23	0.2
G12	1420 MPa
G13	3620 MPa
G23	3620 MPa

Honeycomb Structure



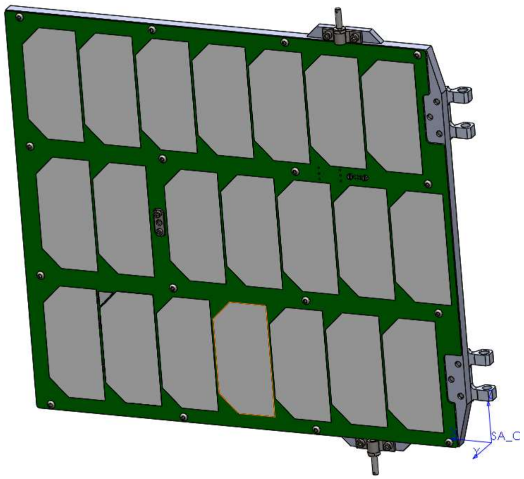
Supplier	HexWeb CRIII
Material	Al 5056
Type	Honeycomb
Thickness (mm)	10
Cell Size (mm)	3.969
Cell Size (inc)	5/32
Density (tonne/mm³)	1.1057E-10
Weight for panel	116.1

Property	Value
E1	3500 Mpa
E2	3500 Mpa
E3	70000 Mpa
v12	0.03
N13	0.03
N23	0.03
G12	1250 Mpa
G13	25000 Mpa
G23	25000 MPa

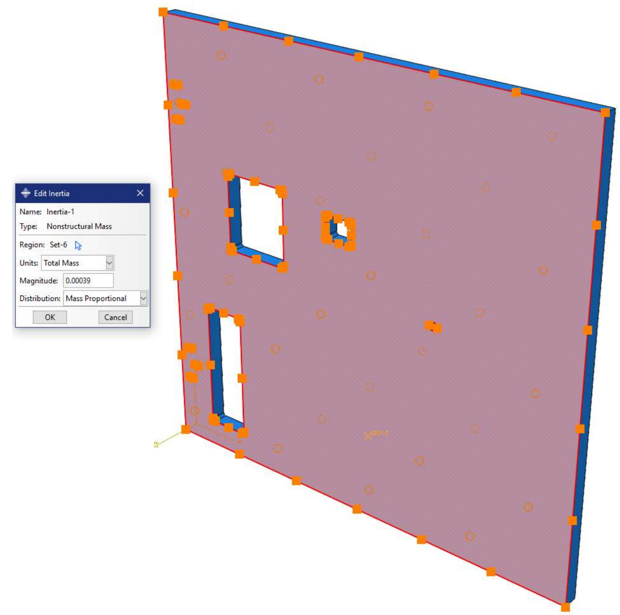


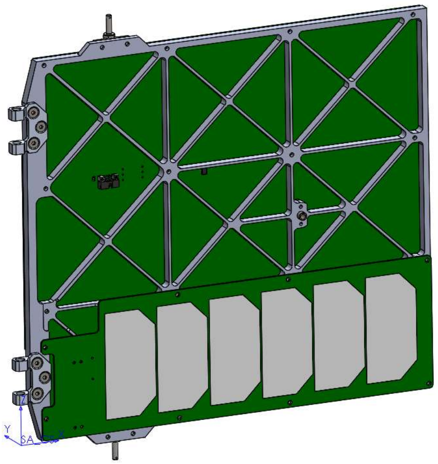
Boundary Conditions

Non-structural mass from PCBs

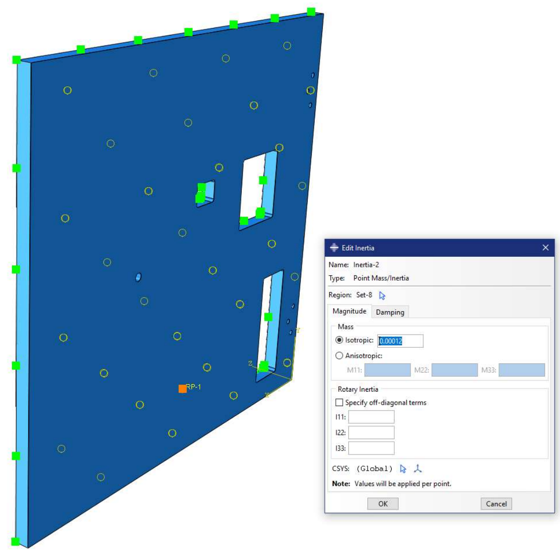


PCB mass = 390 gr





PCB mass = 120 gr



Assumption: The mass from the PCB was determined at reference point 1 (RP1), in which the center of mass is located.

The reference point 1 was constrained with tie contact with the CFRP face (discretization method: node to surface)

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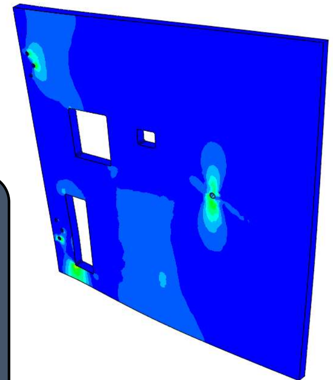
Preliminary Results

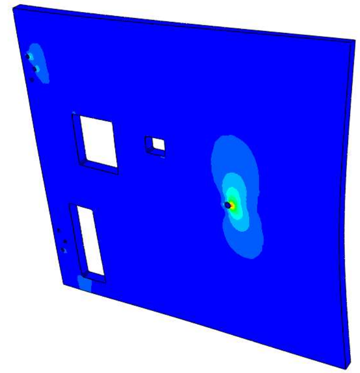
Total mass (PCBs included) = 765 gr.

EFFECTIVE MASS		
X - COMPONENT	Y - COMPONENT	Z - COMPONENT
749.752 gr	722.813 gr	741.102 gr

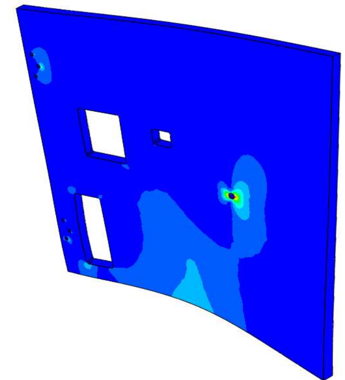
RATIO EFFECTIVE MASS / TOTAL MASS		
X - COMPONENT	Y - COMPONENT	Z - COMPONENT
98.1%	94.5%	96.9%



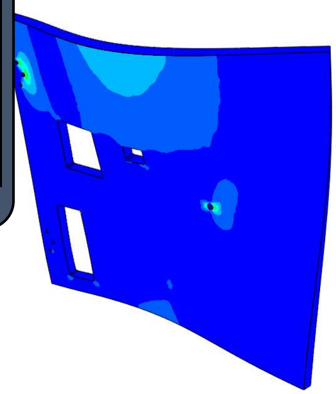
Mode 1



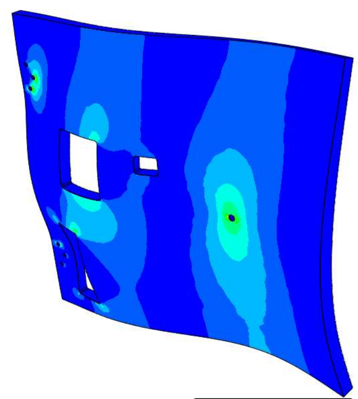
Mode 2



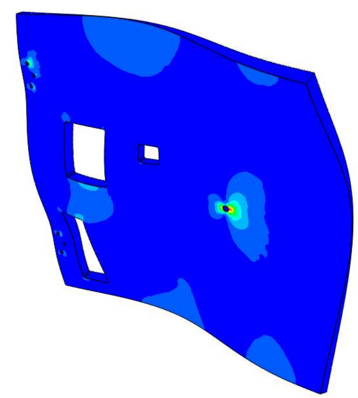
Mode 3



Mode 4

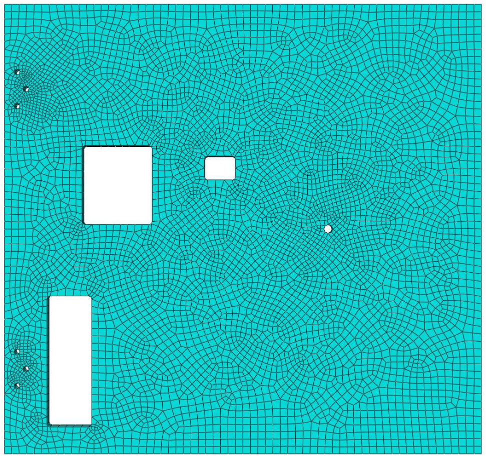


Mode 5



Mode 6

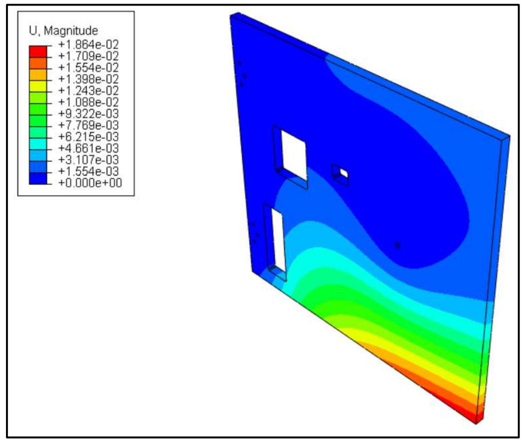
Preliminary Results

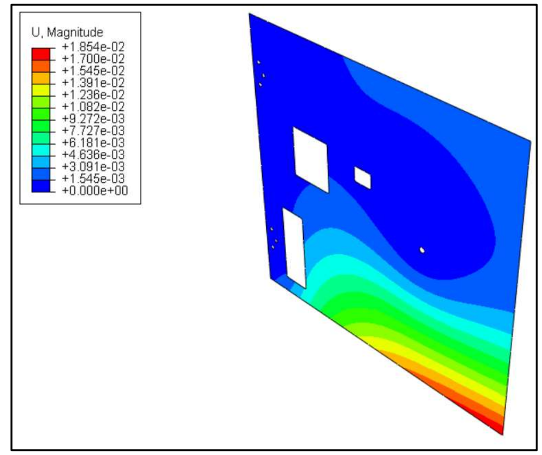


- Quasistatic Loads
- Sine Vibration
- Random Vibration

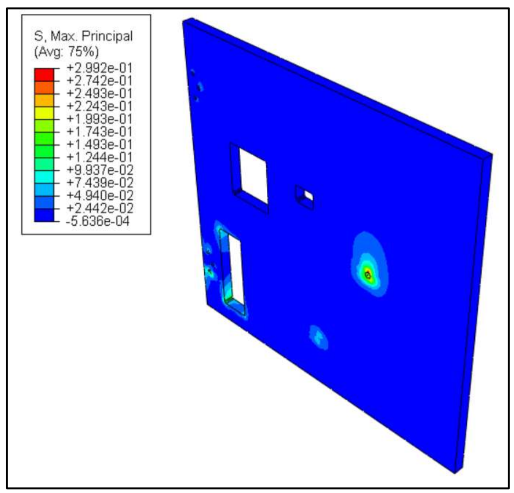
Quasi-static analysis for an exemplar point

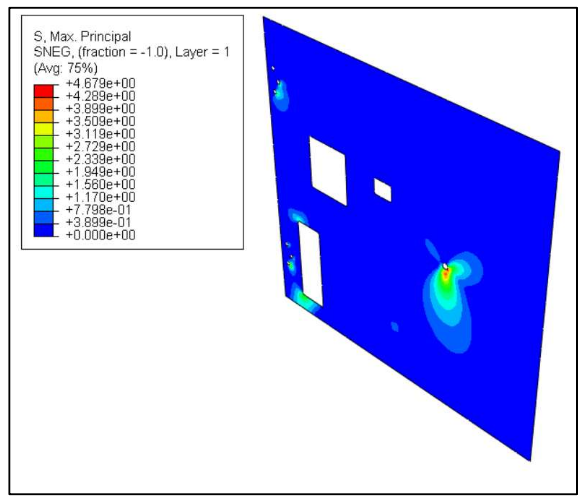
Deformation field of the sandwich structure.





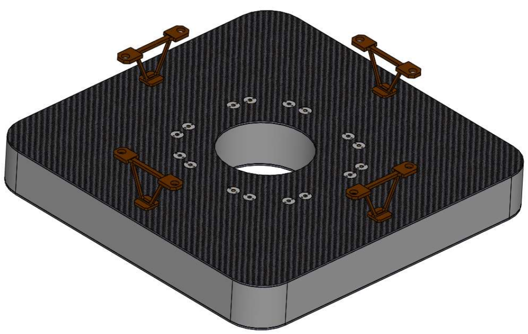
Stress field of the sandwich structure (1st principal stress).

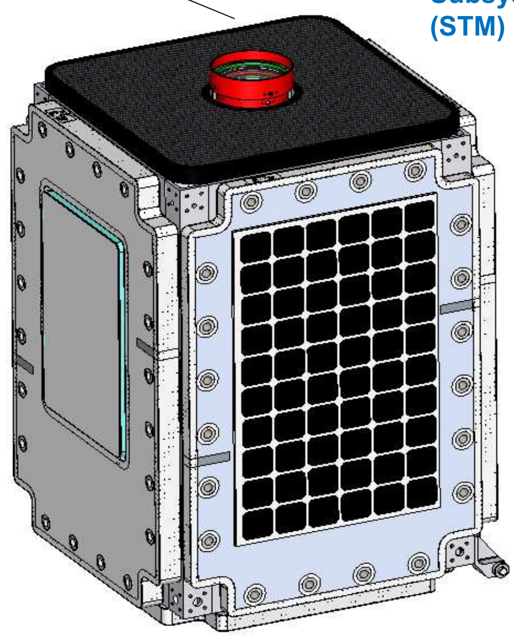


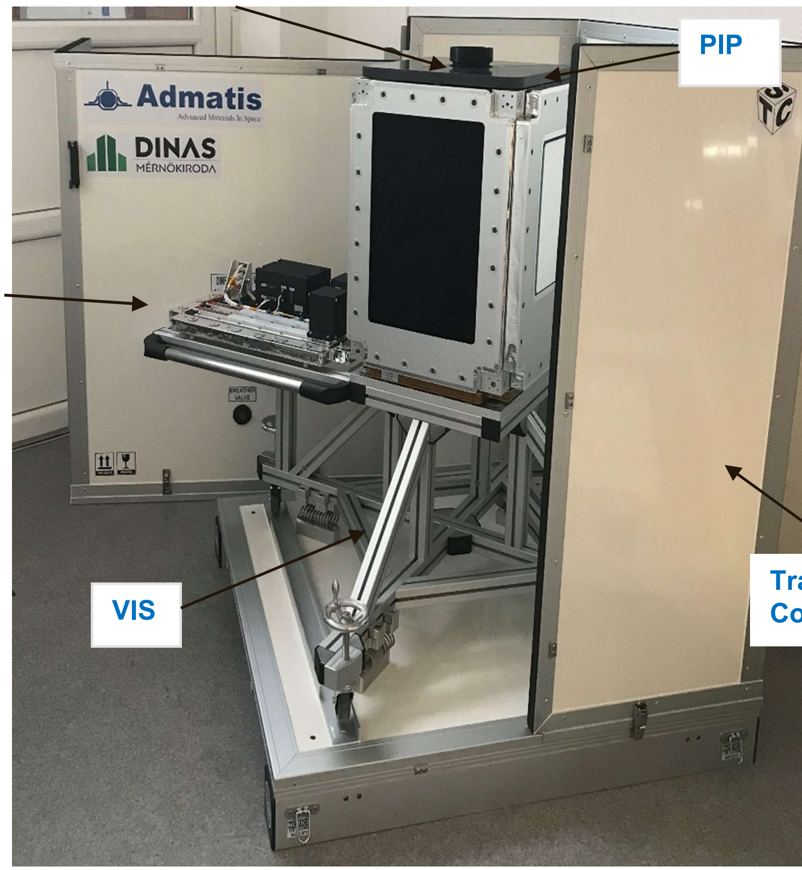


PIP-NanoWeld NanoWeld® Carbon Fiber Reinforced Polymer Sandwich Composite Plate as a Satellite Payload Interface (PECS 4)

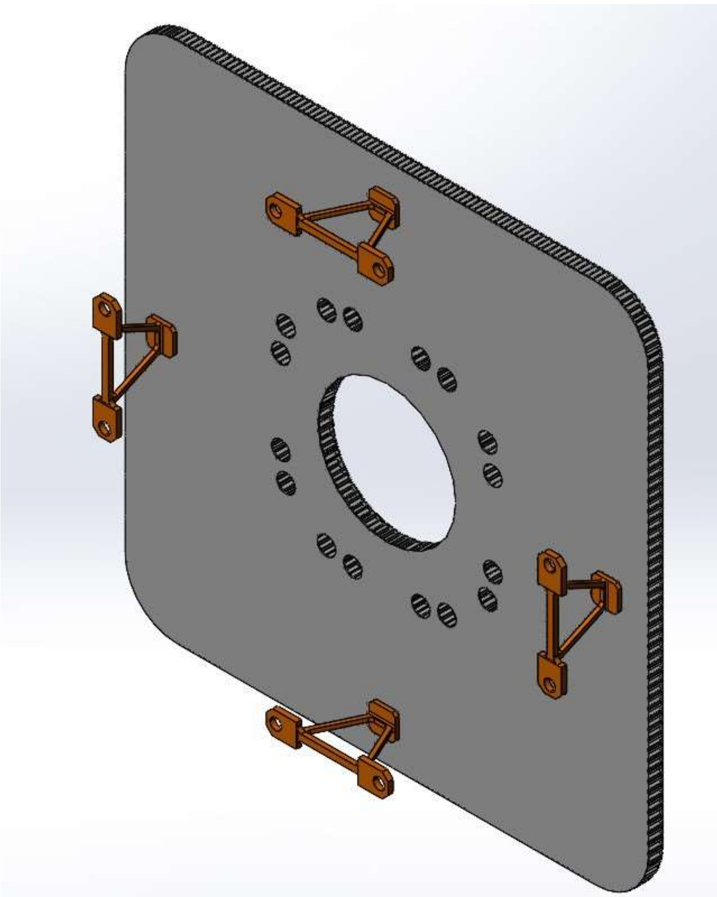
Scope: To provide the SpaceNanoweld® CFRP version of the Payload Interface Plate and To undertake a performance validation of SpaceNanoWeld® Payload Interface Plate in space relevant environments

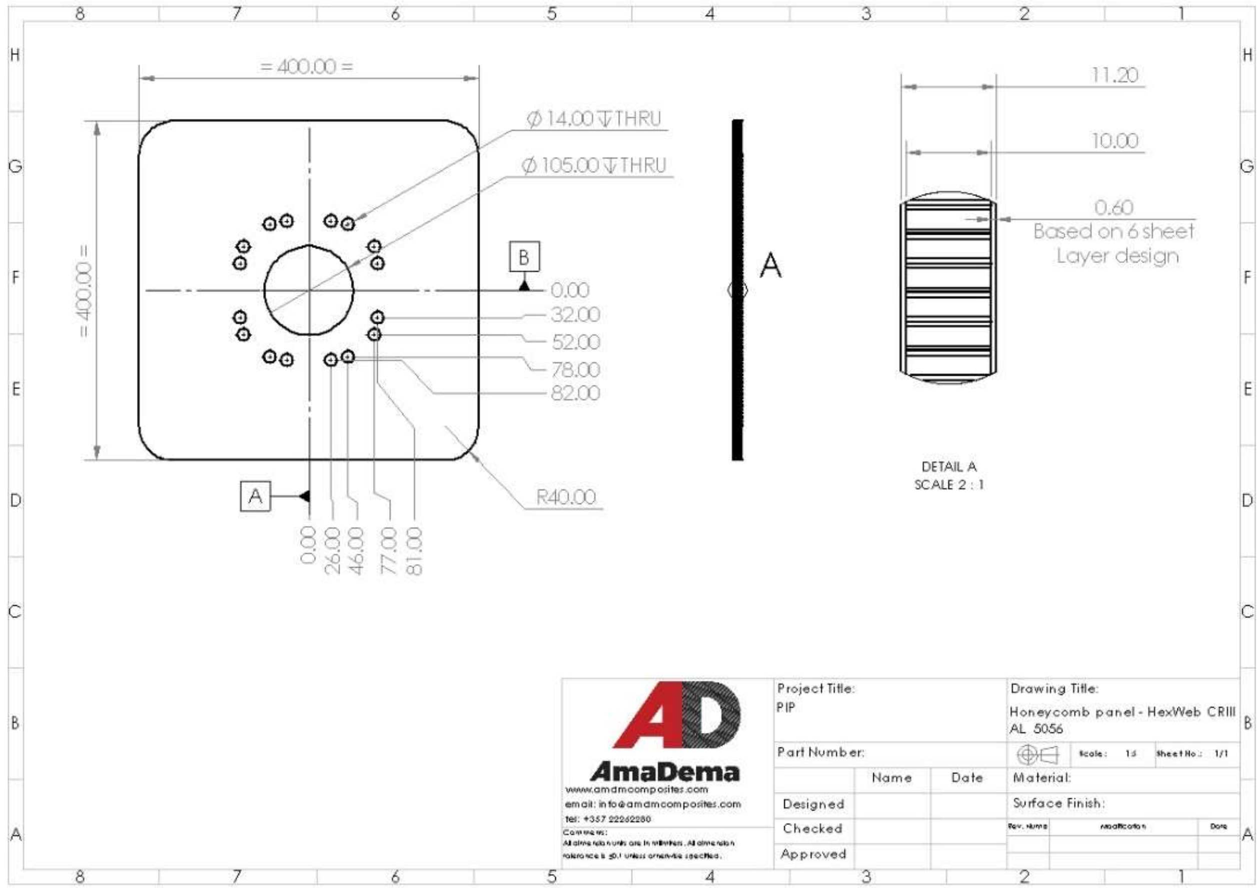






Preliminary Design



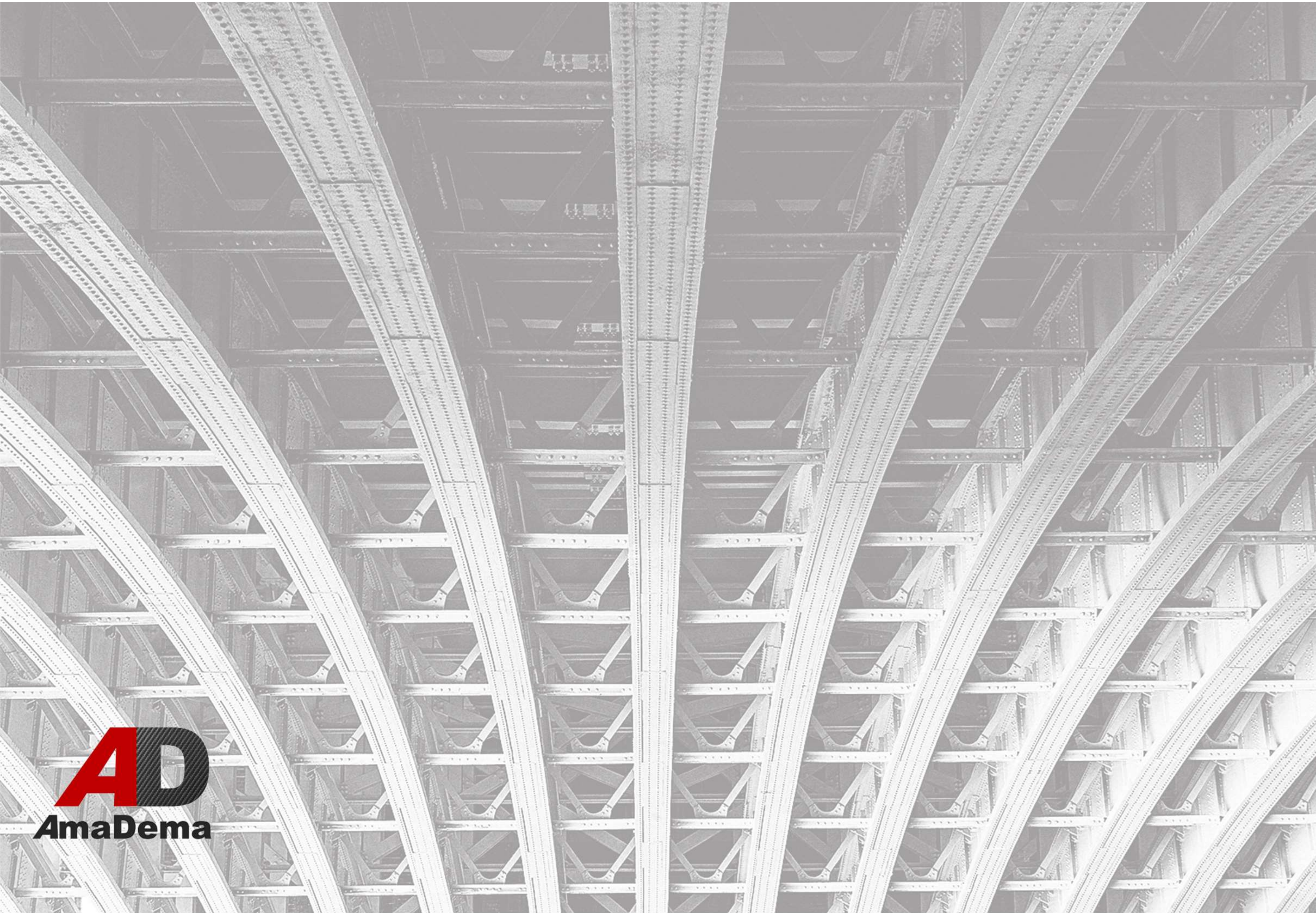


Testing Campaign

Phase A – Skin Level
- Lamina and/or Laminate coupon testing
- Materials data for setting up initial FE model
- Inform material selection procedure
- By CDR

Phase B – Sandwich/Laminate Level
- TVAC to precede testing
- Material's data to validate initial FE model
- Finalize material selection
- CTE/CME
- Insert testing
- By CDR

Phase C – Component Level
- TVAC to precede testing
- Vibration testing as described in tech. req.
- By Qualification Review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