SOLAR PANELS FOR TRISAT MISSION

M.A. Vázquez[1], V. Díaz[1], I. Sánchez[1], V. Burgos[1], F. Lázaro[1], M. Simarro[1]

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Cal Poly University, San Luis Obispo – CA (USA)

([1]) DHV Technology – Avda. Juan López Peñalver, 21 29590 Málaga (Spain).
m.vazquez@dhvtechnology.com

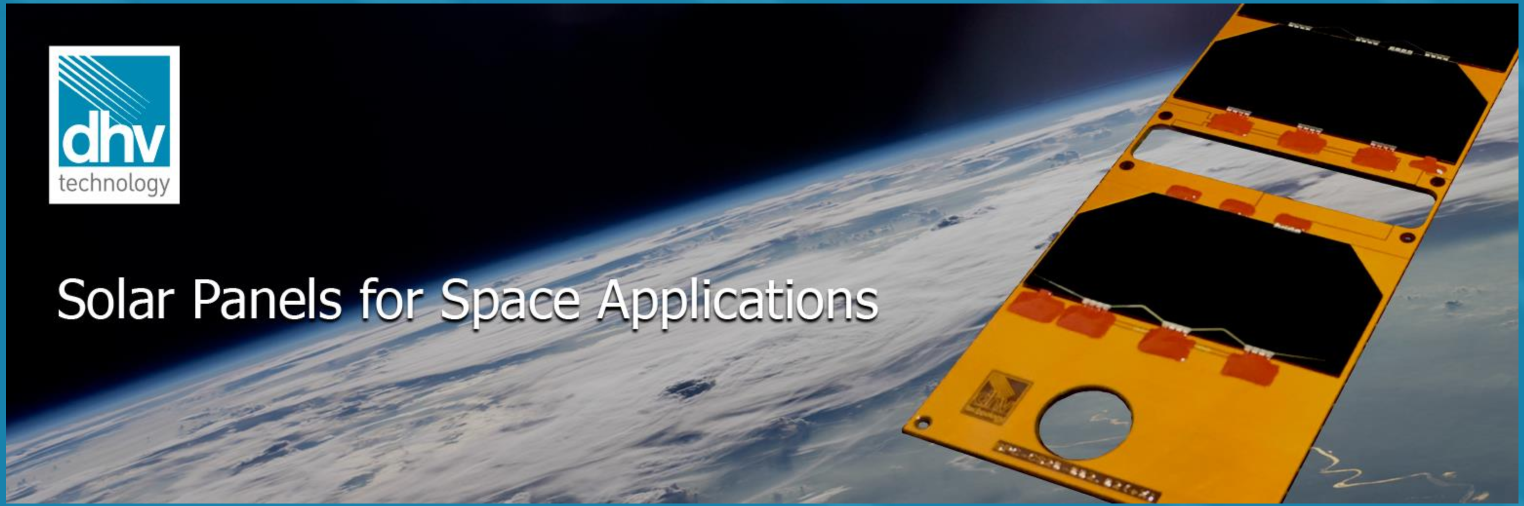
www.dhvtechnology.com

Presentation content

- Company presentation
- TRISAT mission
- Design of solar panels
- Test plan
- Simulations
- Conclusions

Company presentation

DHV Technology is a company specialized on the design and manufacture of solar panels for small satellites.



Company presentation

- **DHV Technology was funded on 2013, located in Malaga (Spain)**
- **Staff: 15, 2016 turnover: 330.000 €, 2017 forecast: >850.000 €**

Miguel A. Vazquez

PhD on Physics University of Sevilla. More than 20 years of profesional experience: University of Sevilla, Isofoton, DHV Technology.

Vicente Diaz

PhD on Physics Polytechnic University of Madrid. More than 25 years of profesional experience: Indra, University Carlos III Madrid, Isofoton, DHV Technology.

Francisco Rubiño

Industrial Engineer and MBA. Over 27 years of Executive positions, operations and general management: Schott, Isofoton, Flex, Ence, DHV Technology.

Company presentation

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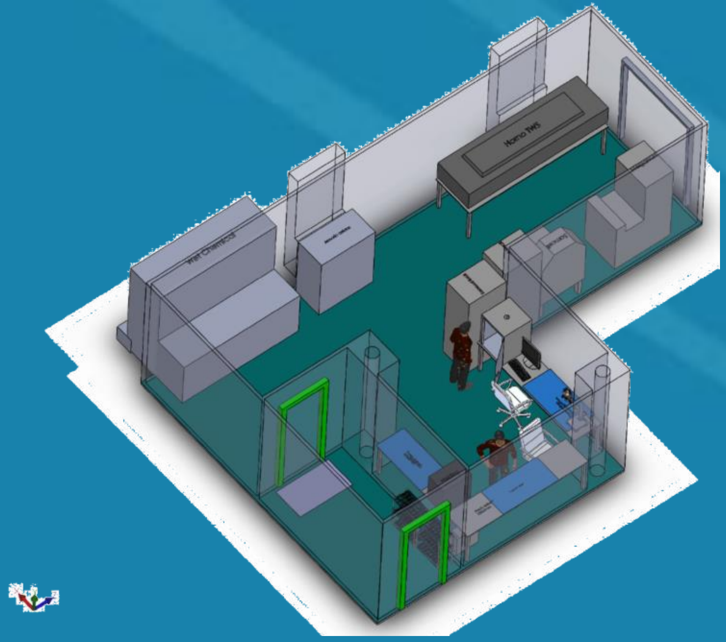

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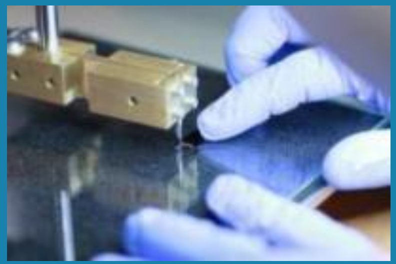

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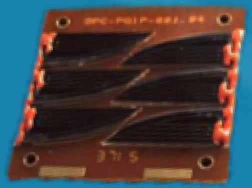
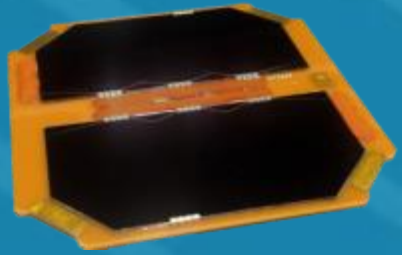
Company presentation

- **Solar Arrays of different architectures**

  PocketQube, CubeSat 1U, 2U, 3U, 6U, 12U

  Small Satellites

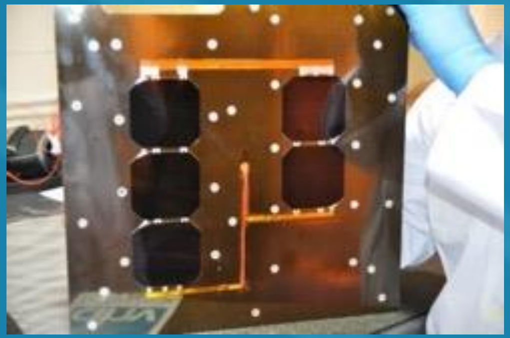


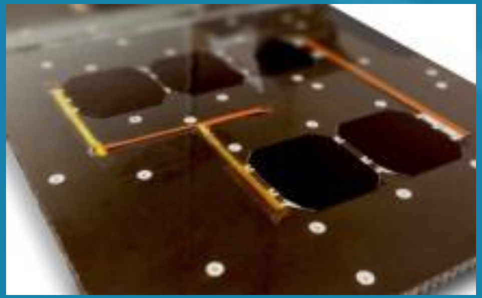


Company presentation

- **Solar Arrays for small satellite missions**

The solar panels manufactured using CFRP over an aluminium honeycomb core.





Company presentation

- **Solar Arrays designed and manufactures for G.A.U.S.S. Srl Rome Italy**

First flight 19th of June 2014, SSO 620 Km.

Mission: UNISAT-6.

Launcher: Dnper rocket. Yasni (Russia)

Company presentation

2014

2015

2016

TRISAT mission

- TRISAT is an educational 3U CubeSat mission lead by Maribor University from Slovenia funded by ESA.

- The TRISAT mission is primarily led by the On-Board Data Handling (OBDH) team, which was established in 2009, as part of University of Maribor’s involvement in the European Student Moon Orbiter (ESMO) mission from ESA.

TRISAT mission

- The TRISAT mission also contains a technology demonstration aspect to develop miniaturized flight hardware:

  Electrical Power System (EPS) subsystem

  Communication Module (COMM) subsystem

  On-Board Computer (OBC) subsystem.

TRISAT mission

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  On-Board Computer (OBC) subsystem.

They will form the base of a basic OBDH platform, which will allow different payloads to be delivered into orbit.

The development of the subsystems will be performed by university students.

TRISAT mission

- TRISAT is a small spacecraft, capable of capturing short-wavelength infrared spectrum images of the Earth.
  - Detect various vegetation patterns (green areas)
  - Assess damage caused by natural disasters
  - Detect volcanic dust.

TRISAT mission

- The data obtained during the mission will be kept by the University and used for academic research purposes and will be made available to potential users.

- The TRISAT spacecraft will remain operational for a minimum of two years in a day-night sun synchronous orbit with an altitude of 700 km.

Design of solar panels

System overview

5 solar panels.

Panels 1, 4 and 5 are fixed to structure.

Panels 2 and 3 deployable from 4 and 5 respectively.

Panels 2 and 3 have solar cells in both of sides.

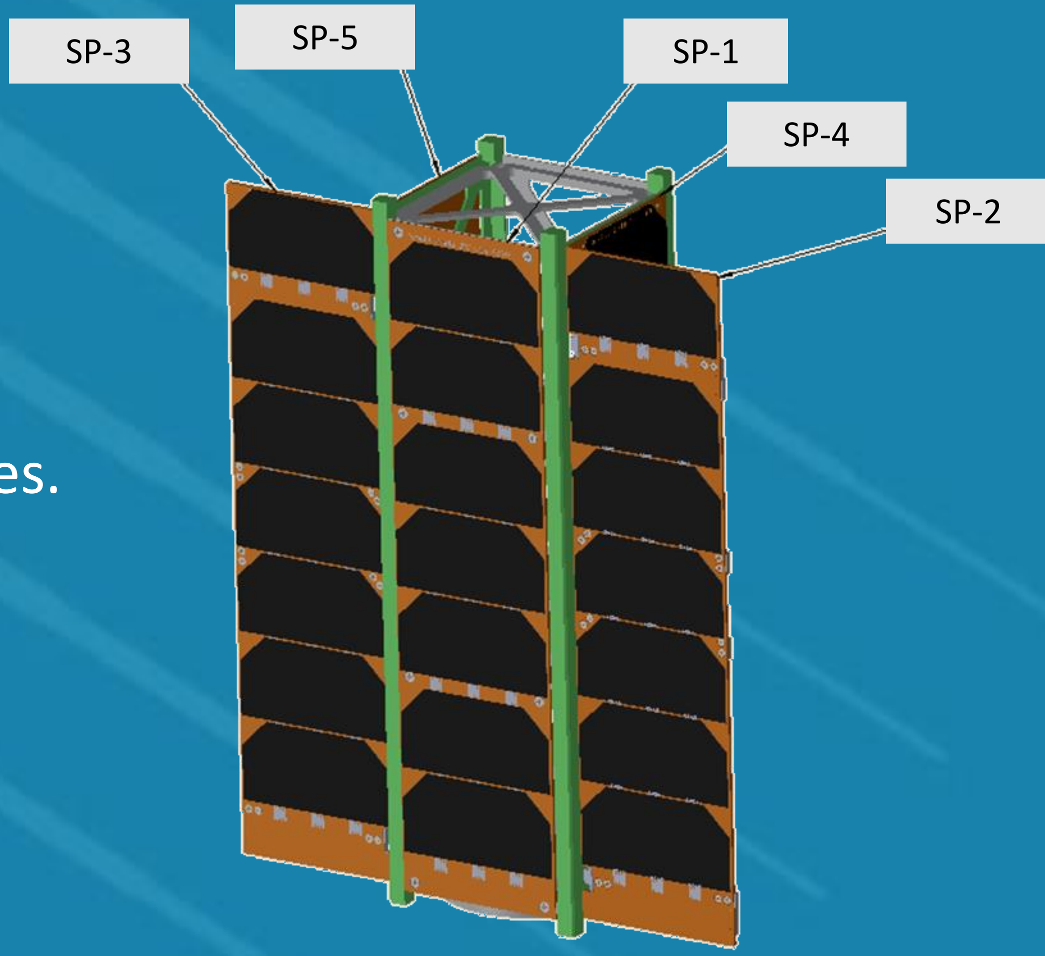
Azur Space 3G30A, 30% efficiency, 30cm^2

InGaP/GaAs/Ge on Ge substrate

Bypass diode for each solar cell

Protection diode for each string

5 thermistors



Design of solar panels

System overview

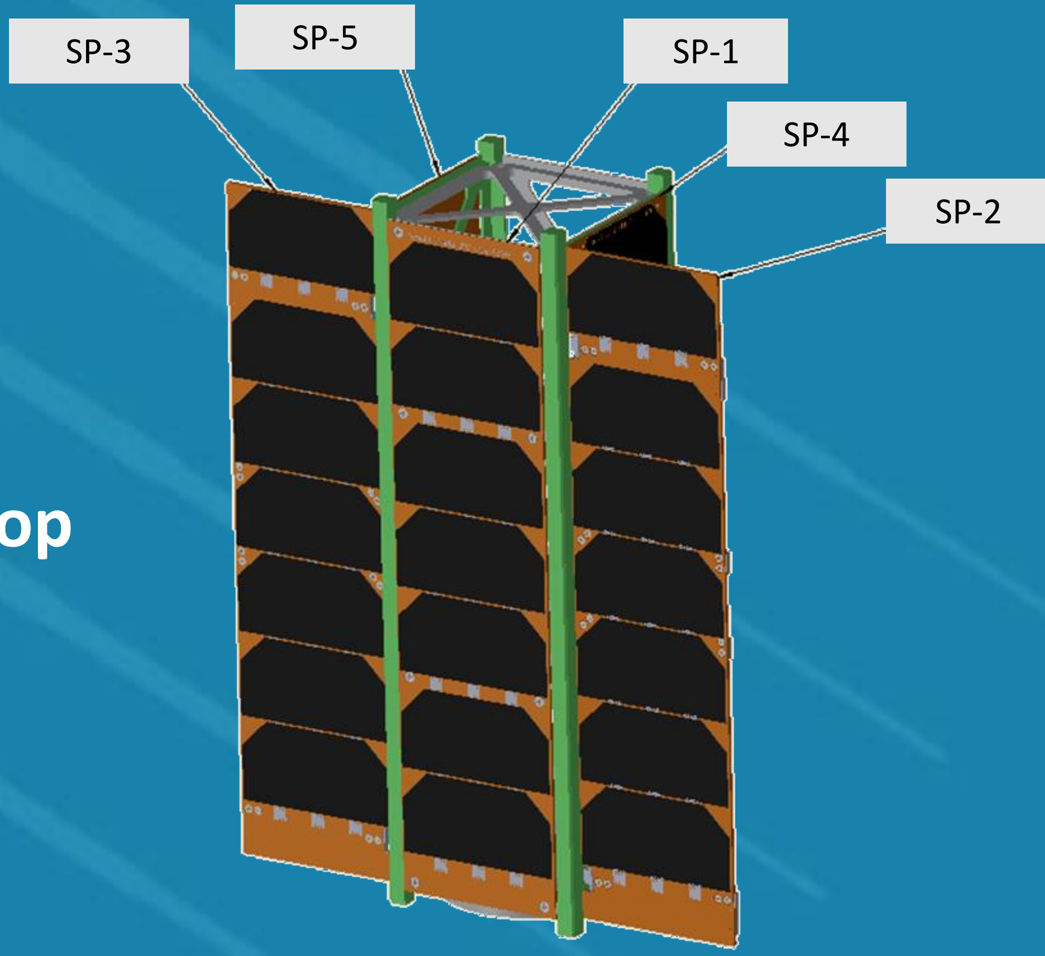
3 photodiodes

2 thermal knife circuit

4 hinges with springs and integrated end-stop at 90 deg. for deployed position.

4 hinges as guides.

8 end-stops at 0 deg. at folded position.



Design of solar panels

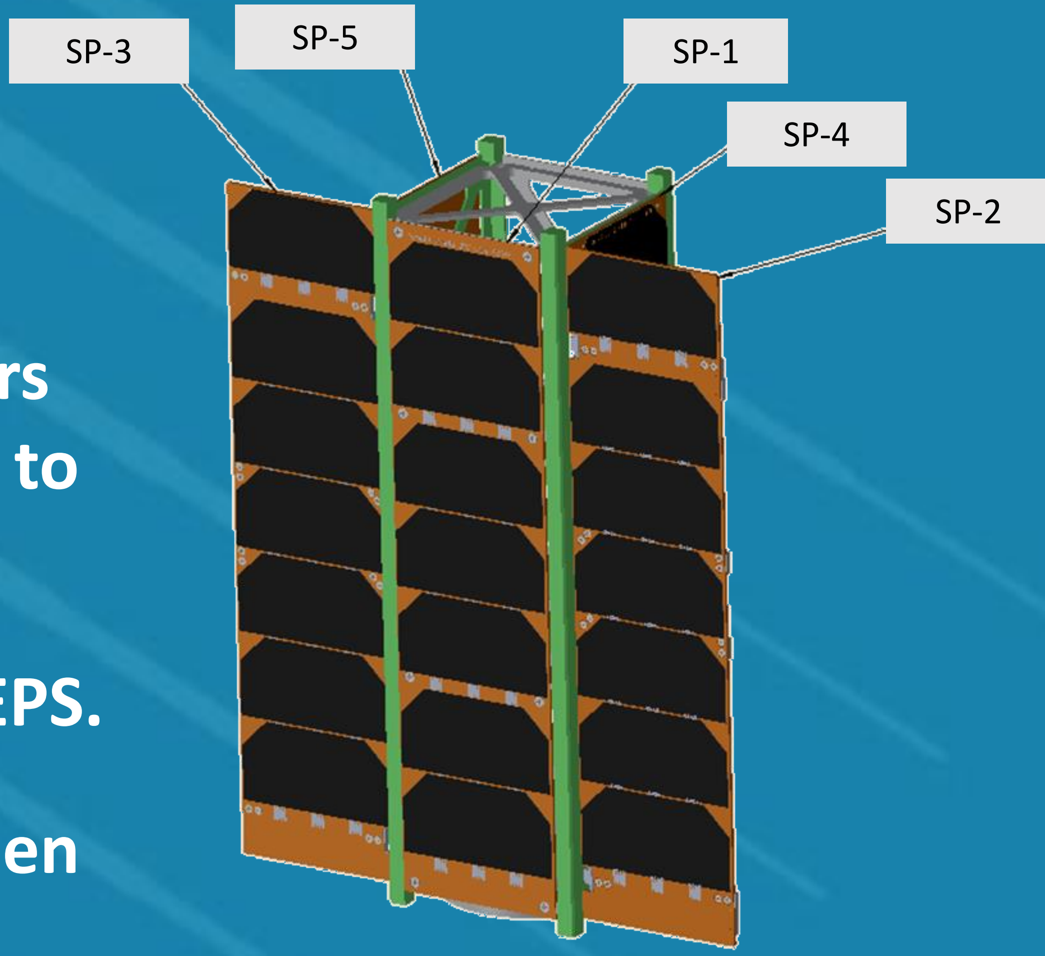
System overview

4 thermal knifes with tie-holder.

3 connector for EPS and 4 microstrip headers connectors to attach the deployable panels to the fixed ones.

3 Cables to interconnect solar panels with EPS.

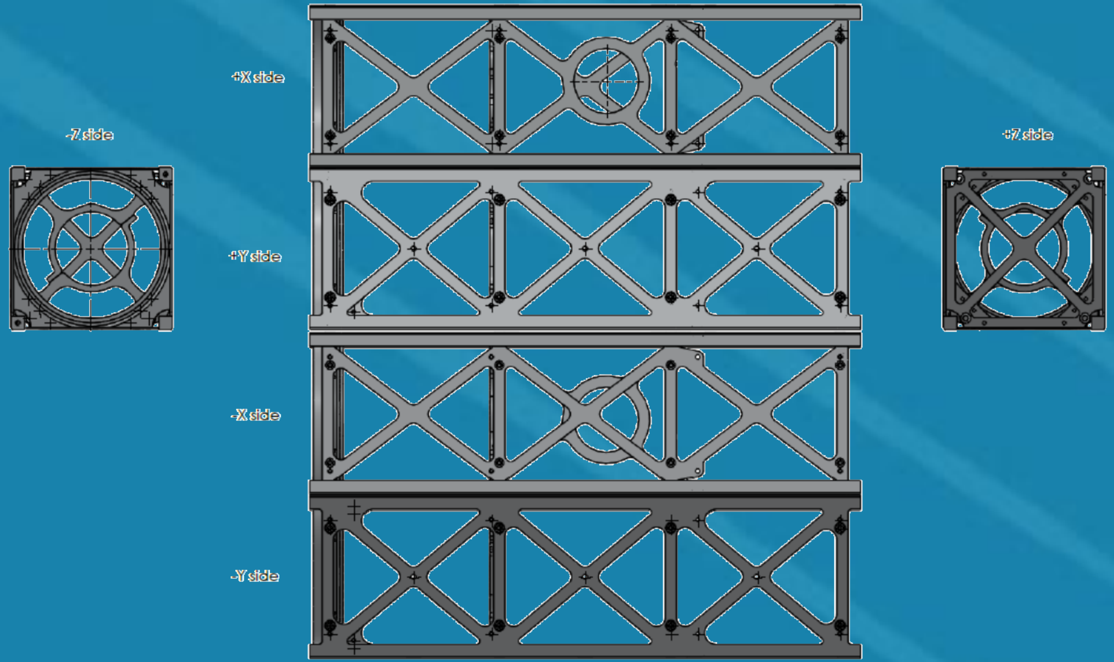
2 cables to interconnect solar panels between them.



Design of solar panels

<u>Mechanical design</u>

Mechanical structure is a customized design of Maribor University



Design of solar panels

Mechanical design

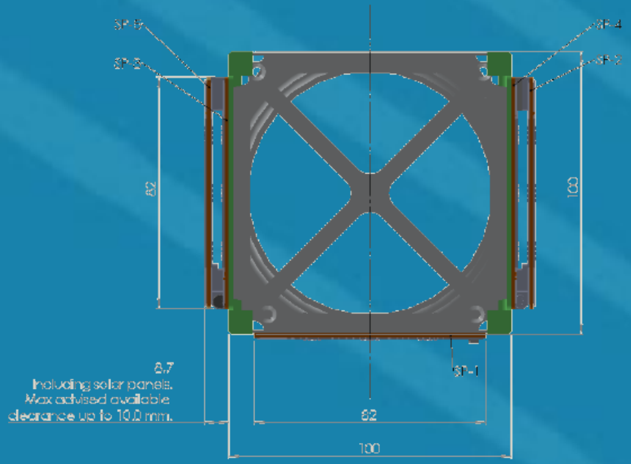
Solar panel substrate is a rigid PCB made on polyimide and with two side copper layers.

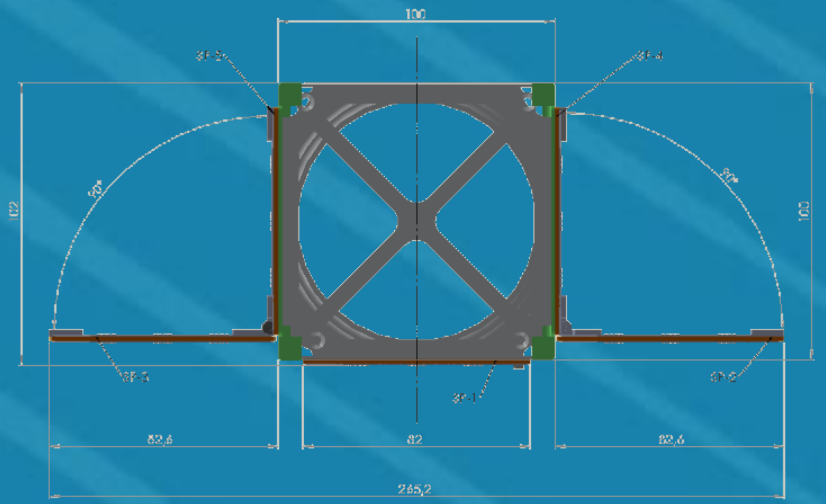
This material is high temperature resistant (Tg > 250°C). The PCBs are manufactured under ECSS-Q-ST-70-10C (ESA standard)

Solar panels are capable to be folded and released by the hinges and springs provided. The total envelope height is less than 8.7 mm

Design of solar panels

Mechanical design

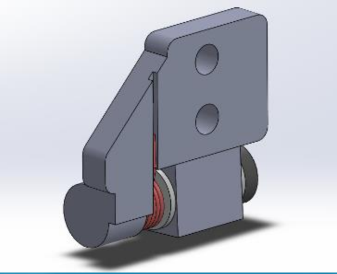


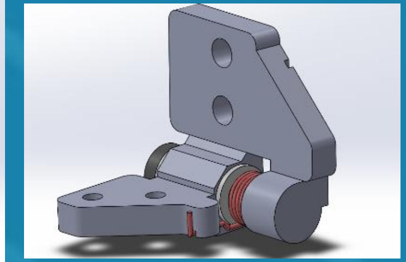


Design of solar panels

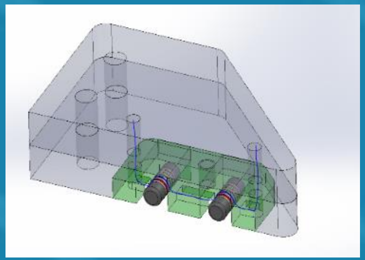
Mechanical design

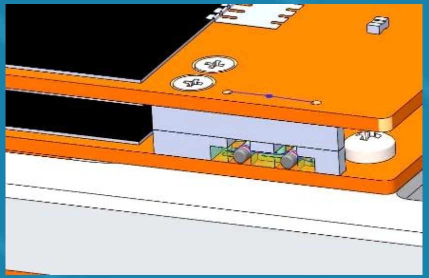
Hinges has two machined parts in aluminum with hard anodized with a torsion spring that it allows the movement of the deployable solar panel.





The **tie-holder** is a part made of aluminum and PTFE. It holds the resistors and wire to be cut. PTFE part allows a low friction with the wire when this is burned.

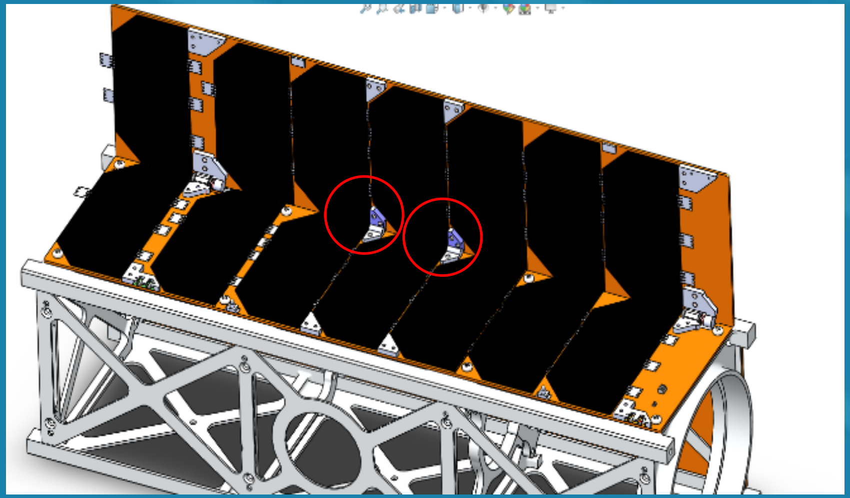


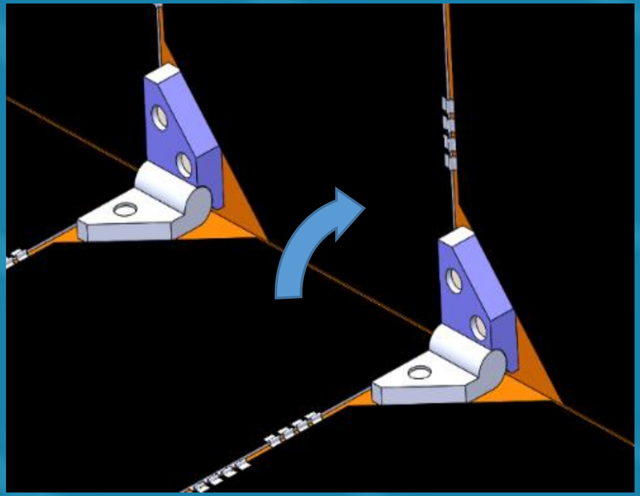


Design of solar panels

Mechanical design

Stopper two parts made of PTFE and placed in the outer edge to avoid they collapse them in a vibration environment.





Design of solar panels

Electrical design five solar panels. SP 2 and 3 solar cells in both sides.

Electrical Parameters @ AM0 (1367 W/m^2)					
PARAMETER	1 SPC	2 SPC	3 SPC	4 SPC	5 SPC
Solar Cell configuration	7S	7S2P	7S2P	7S	7S
Number of Solar Cells	7 SCA	14 SCA	14 SCA	7 SCA	7 SCA
Solar Cells technology	Triple-Junction	Triple-Junction	Triple-Junction	Triple-Junction	Triple-Junction
Average Open Circuit Voltage (V)	18.83	18.83	18.83	18.83	18.83
Average Short Circuit Current (A)	0.519	1.038	1.038	0.519	0.519
Voltage at max. Power (V)	16.86	16.86	16.863	16.86	16.86
Current at max. Power (A)	0.503	1.006	1.006	0.503	0.503
Max Power (W)	8.48	16.96	16.96	8.48	8.48
Installed power (W)	59.36				
Max System Power	25.44				

Test plan

Mechanical and vibration tests: (GSFC-STD-7000A standard, NASA GEVS levels.)

- **sinusoidal vibration**
- **random vibration**
- **shock loads**
- **resonance survey test**

Thermal and vacuum test: thermal cycling at low pressure conditions.

Visual inspection

Electric performance and over voltage test of the control electronic.

Test plan

Mechanical test – sinusoidal vibration

Mechanical test levels are designed under GSFC-STD-7000A

Test	Sinusoidal vibration		
Direction	X, Y, Z		
Sweep rate	2 oct / min / axis		
Profile	Frecuency range [Hz]	Qualification levels (0-peak) [g]	Acceptance levels (0-peak) [g]
	5 – 45	1,0	0,8
	45 – 110	1,25	1,0
	110 – 125	0,25	0,20

Test plan

Mechanical test – random vibration

Test	Random vibration	
Direction	X, Y, Z	
RMS acceleration (g_{RMS})	14,1	
Test duration	120 s / axis	
Profile	Frecuency [Hz]	ASD level [g^2/Hz] / Qualification
	20	0,026 g^2 / Hz
	20-50	+6dB / oct
	50-800	0,16 g^2 / Hz
	800-2000	-6dB / oct
	2000	0,026 g^2 / Hz

Test plan

Mechanical test – shock loads

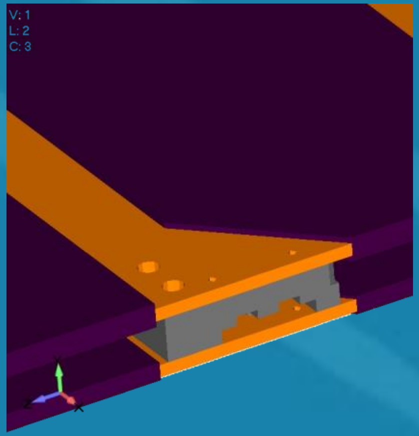
Test	Shock loads	
Direction	X, Y, Z	
Q factor	10	
Number of shocks	2 / axis	
Profile	Frequency (Hz)	Amplitude (g)
	100 - 1600	30 - 2000
	1600 - 10000	2000

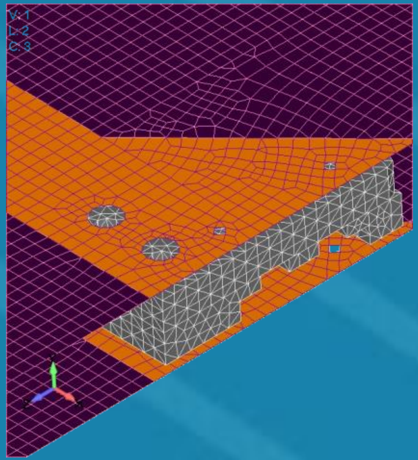
Mechanical test – resonance survey

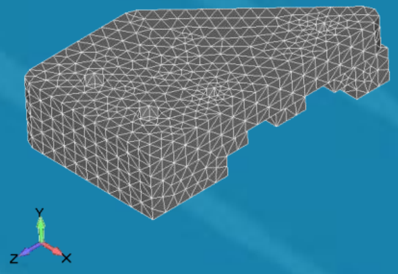
Test	Resonance survey	
Direction	X, Y, Z	
Type	Harmonic	
Sweep rate	2 oct / min / axis	
Profile	Frequency (Hz)	Amplitude (g)
	5-2000	0,4

Simulations

FEM – Finite Element Model







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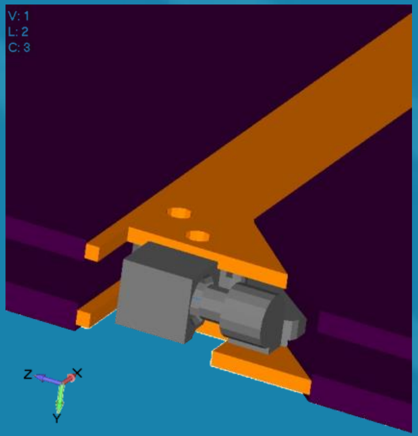
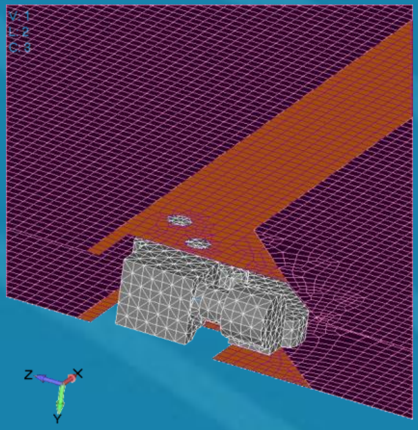
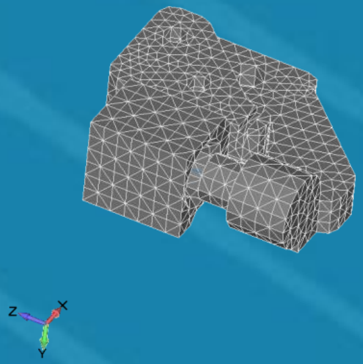




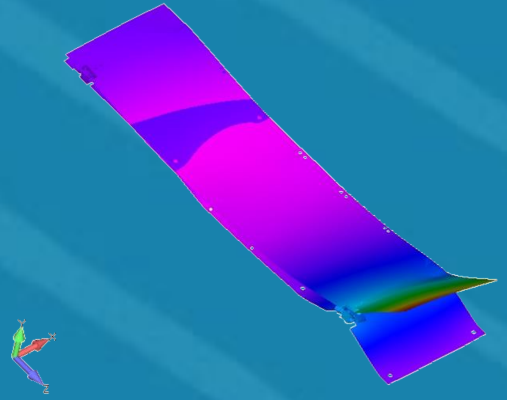


Simulations

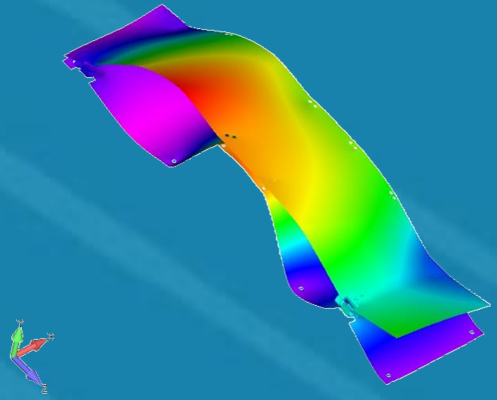
Modal analysis

Nº Mode	Frequency (Hz)
1	220
2	226
3	346
4	409
5	449
6	517
7	558
8	645
9	704
10	779

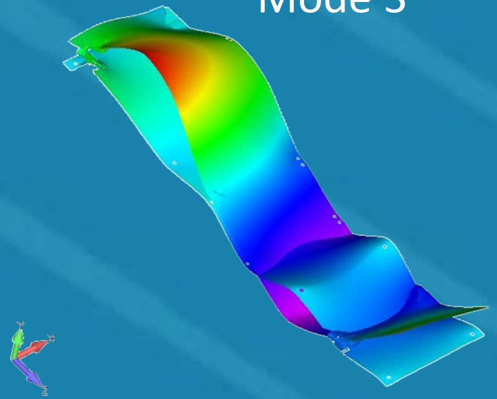
Mode 1



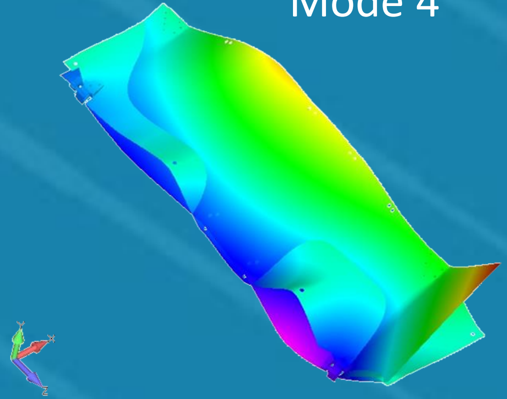
Mode 2



Mode 3

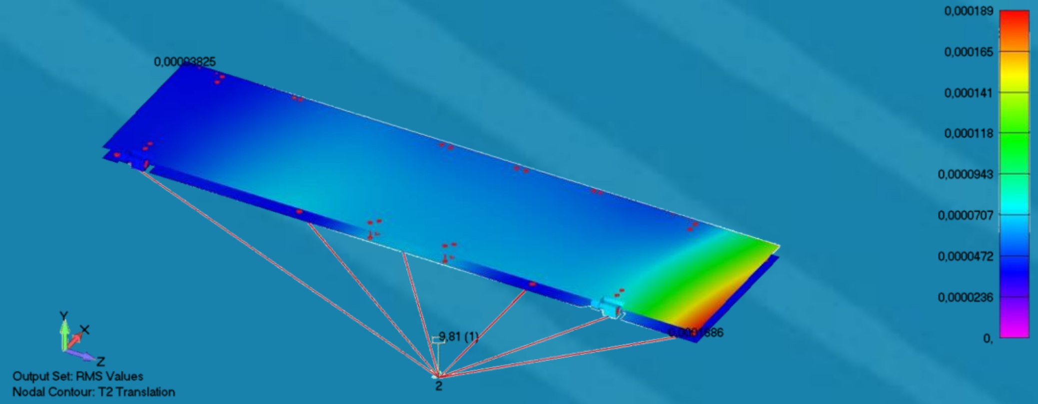


Mode 4



Simulations

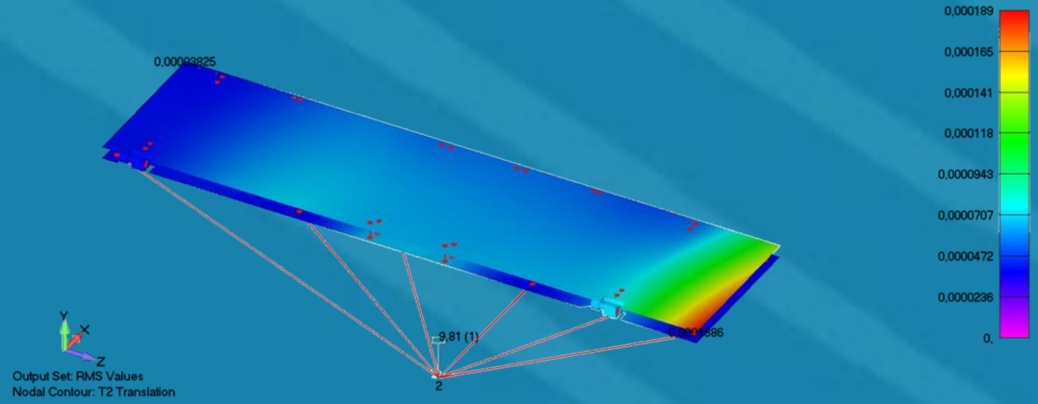
Random vibration response



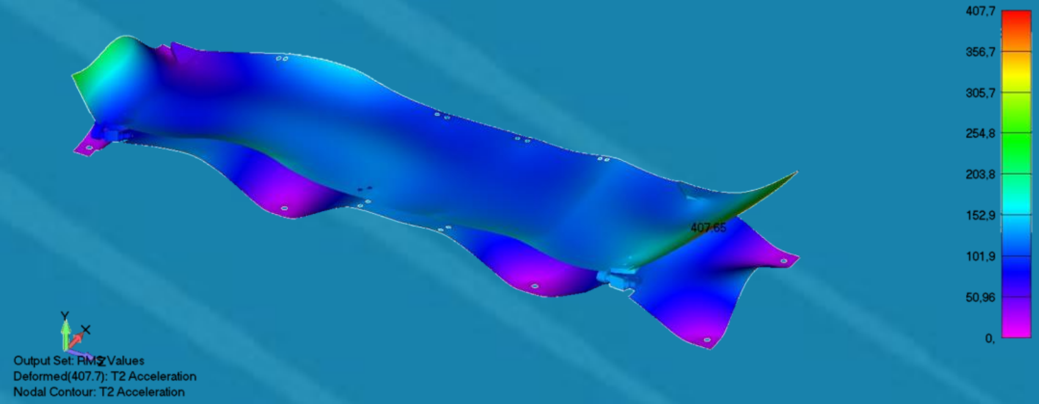
Translation

Simulations

Random vibration response



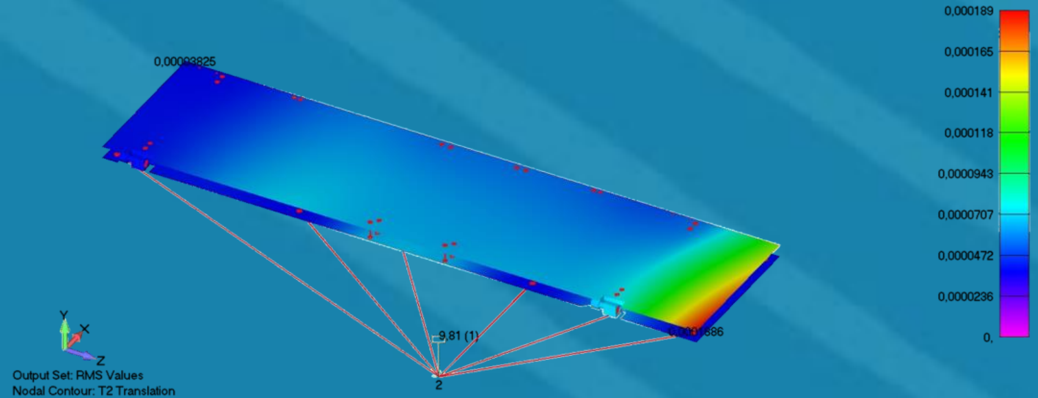
Translation



Acceleration

Simulations

Random vibration response



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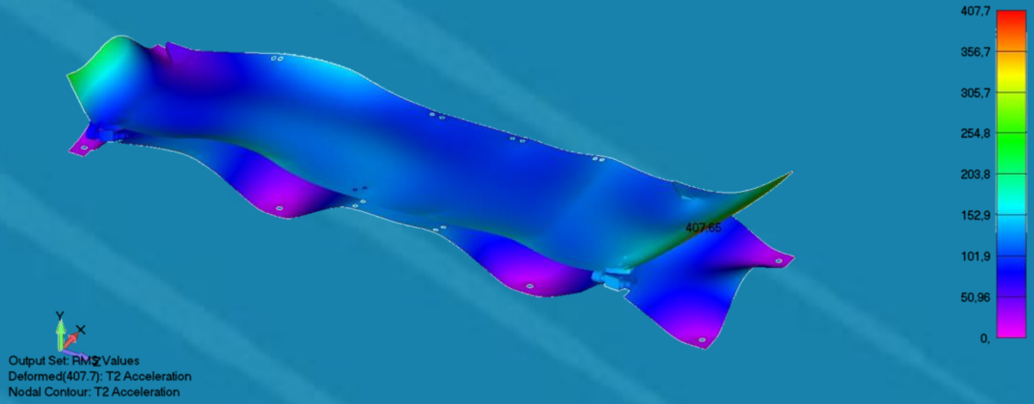
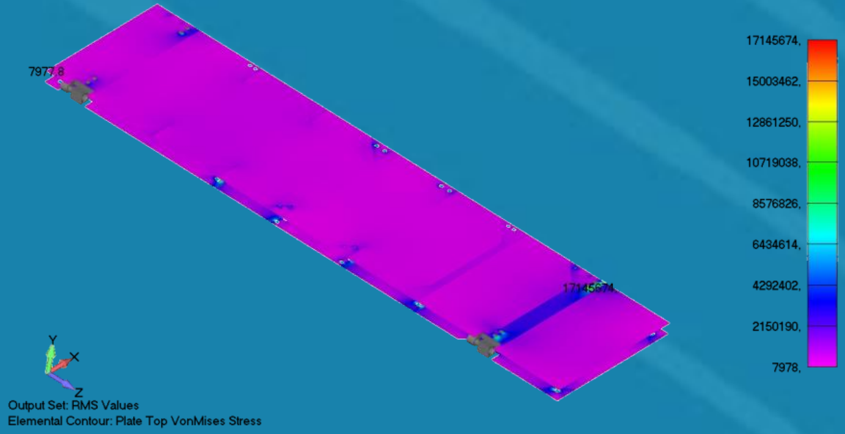


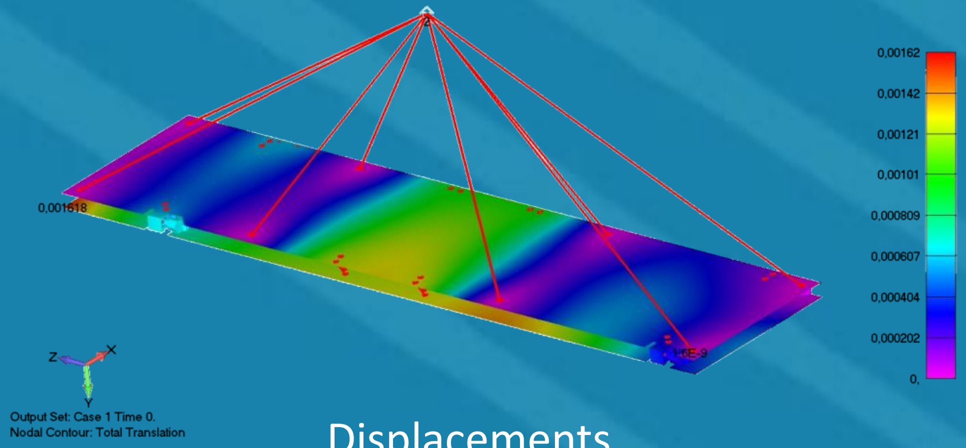
Acceleration



Stress

Simulations

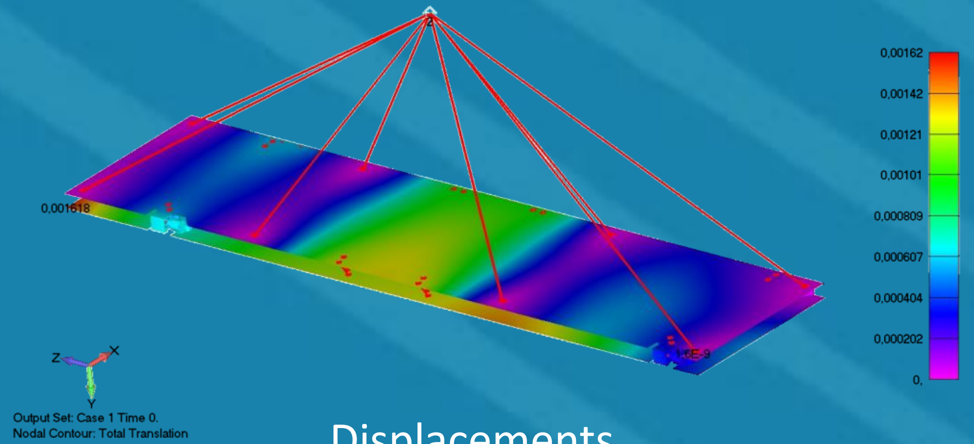
Shock response



Displacements

Simulations

Shock response



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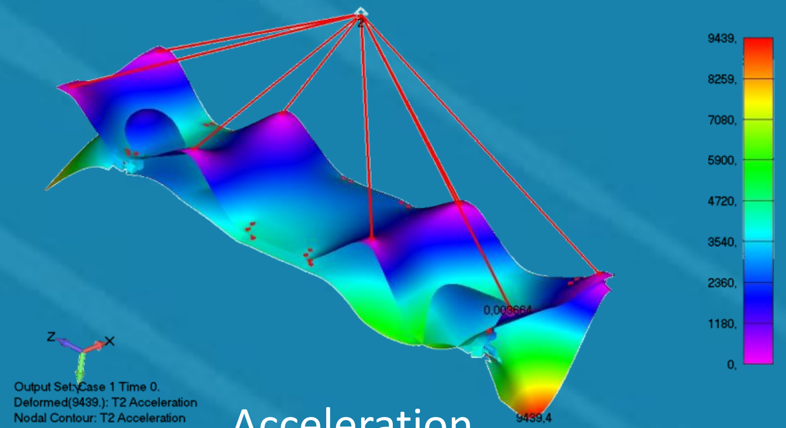
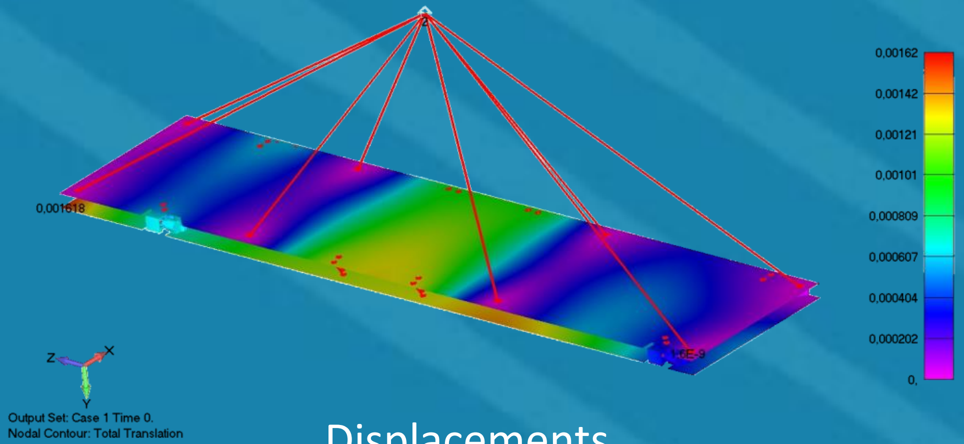


Acceleration

Simulations

Shock response



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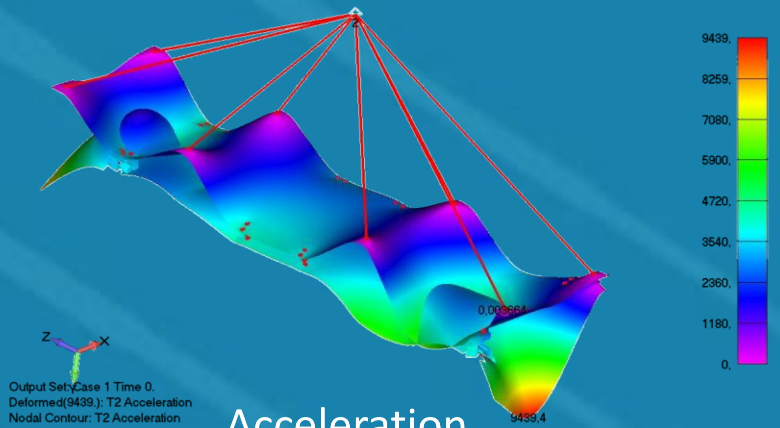
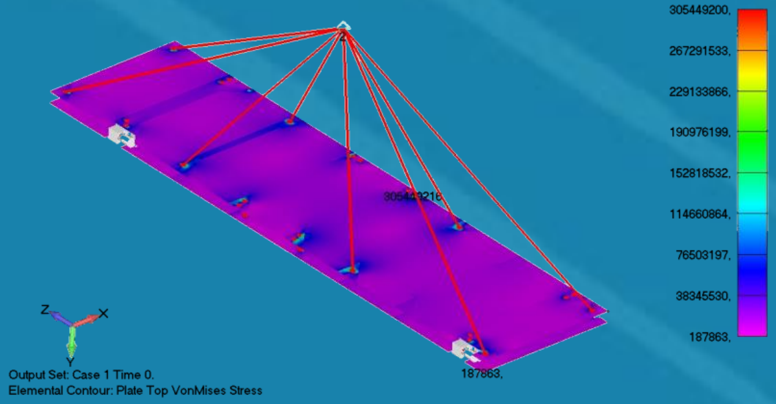


Acceleration



Stress

Conclusions

Solar panels for TRISAT mission has been designed.

Two 3U long size simple deployable and three body mounted solar arrays.

Test plan has been presented.

FEM and mechanical simulation has been presented.

Engineering model is manufacturing. During May all tests will be developed.

In June the flight solar panels will be manufactured.

Acknowledgment

Ministerio de Economia y Competitividad (Spanish Government)

DEEPSAT project
File: RTC-2016-4644-3
Call "RETOS COLABORACION 2016"

Thanks so much for your kind attention

Contact detail:

Miguel A. Vazquez
Managing Director & Co-Founder
www.dhvtechnology.com
m.vazquez@dhvtechnology.com
+34 619 053 924