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Information Sciences Institute & Space Engineering Research Center (SERC)

Space Power Workshop: Advanced Concepts

Self foldable lunar lander solar panel: design concept

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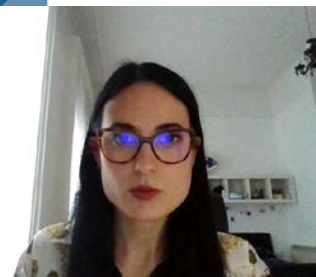
April 21 at 8:00 a.m.



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- ***LEAPFROG PROJECT***
  - Generation-II: overview
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  - Thickness troubleshooting
  - Gears design
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LEAPFROG Project: Generation-II

Innovative Design Focus

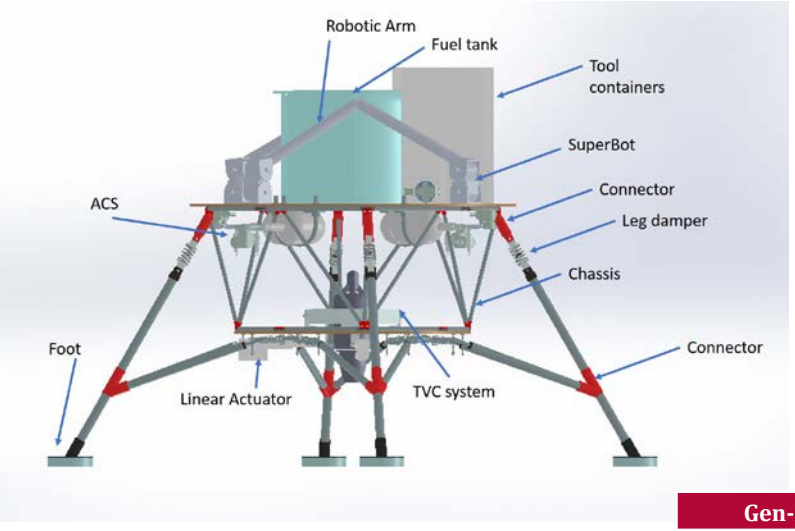
Re-think the function of a lander that can perform multiple activities: capable to change a single monolithic functioning lunar lander into a multi-functional platform that uses various techniques and new technologies to extend the use of the mass embedded in the makeup of the landing platform.

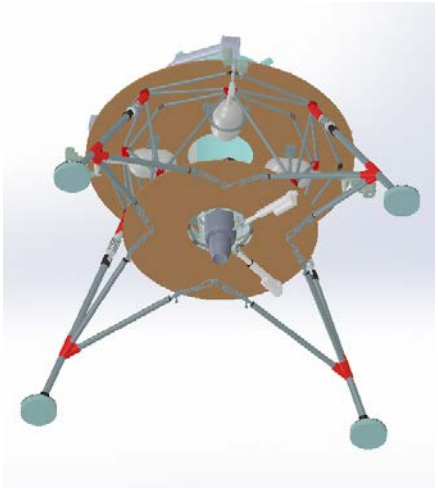
Increased Performance and Functionality

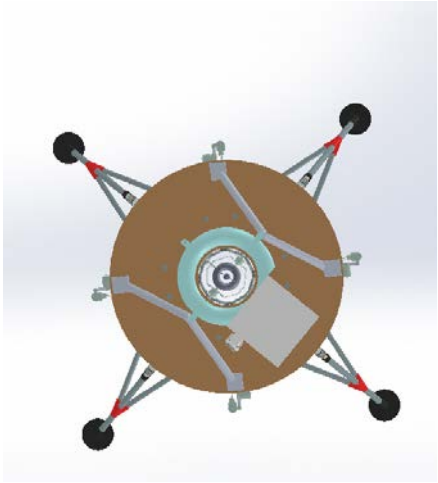
A lander should be able to:

- ***Have increased flight performance***
- *Maintain total autonomy*
- *Transform to perform different activities after landing (i.e. structure becomes active, unfolds, changes shape etc.)*
- ***Prove multi-functionality using new techniques***

LEAPFROG Project: Generation-II







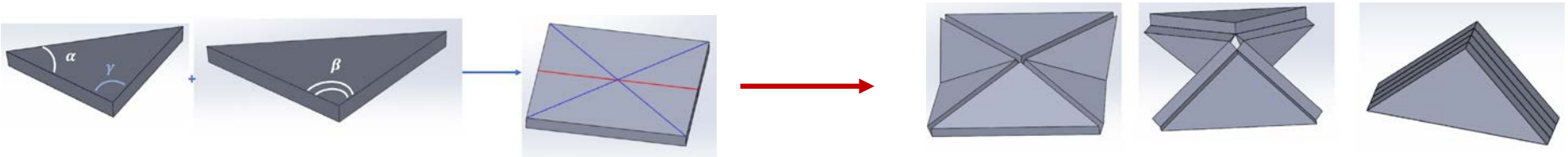
Gen-II Component	Mass [Kg]
Main structure	8
Engine P-300Pro JetCat	2.7
Fuel	3.9
Gimbal systems	1.486
Linear actuators	2.16
Electronics	3.5
TOTAL	**21.746**

Origami Solar Panel: pattern trade-off

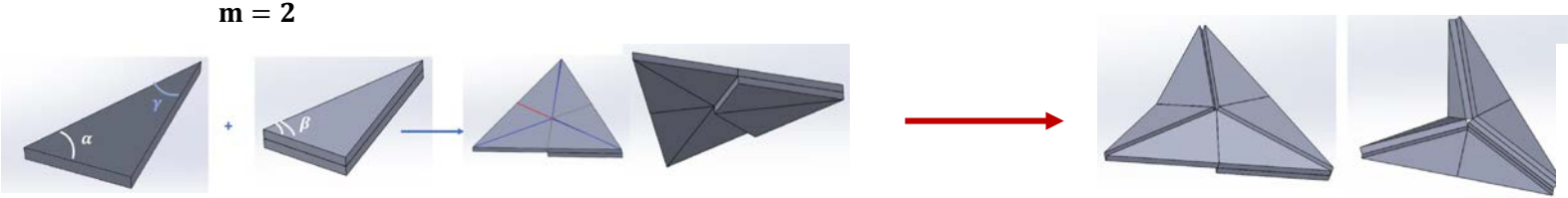
$$n\alpha + m\beta = 360°$$

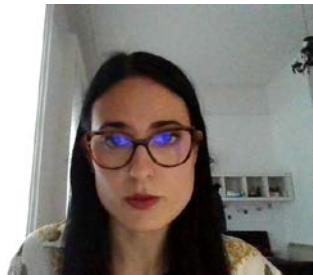
- **First OSP pattern proposal:** $\alpha = 60°$ $\beta = 120°$ $\gamma = \alpha$ $n = 2$ $m = 2$

- **Second OSP pattern proposal:** $\alpha = 45°$ $\beta = 90°$ $\gamma = 45°$ $n = 4$ $m = 2$

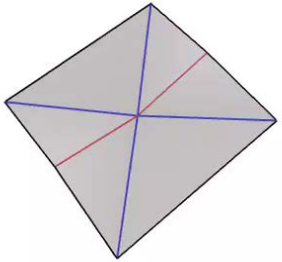


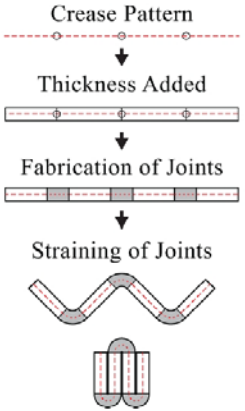
- **Third OSP pattern proposal:** $\alpha = 60°$ $\beta = 60°$ $\gamma = 45°$ $n = 4$ $m = 2$



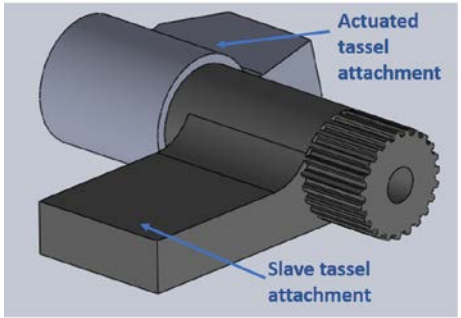


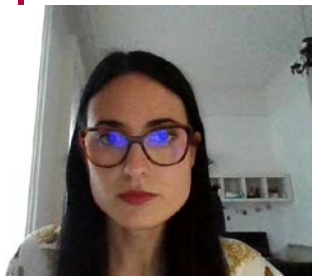
Origami Solar Panel: thickness troubleshooting



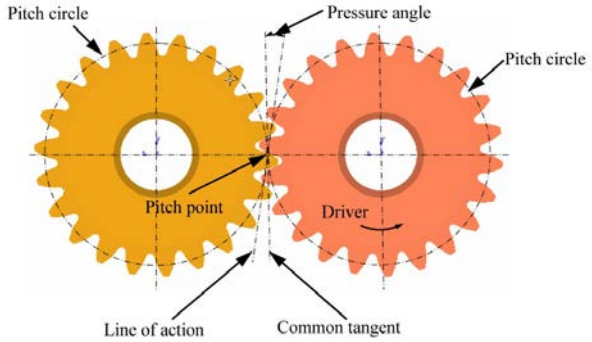


Credits: MORI A modular origami robot

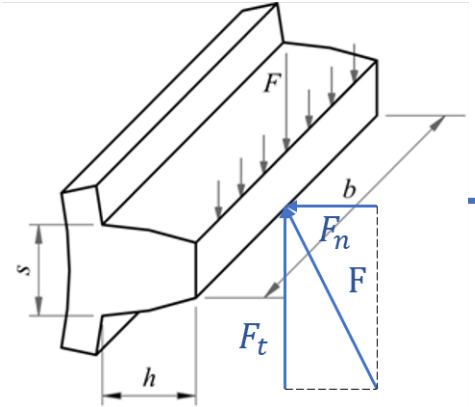


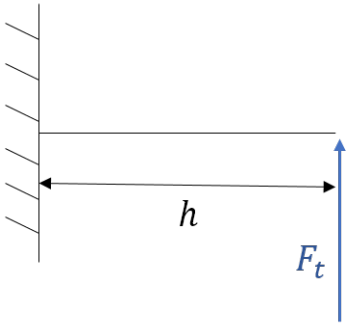


Origami Solar Panel: gears design



- Spur gears
- Teeth evolving profile
- Static and flexural solicitation design: Lewis method





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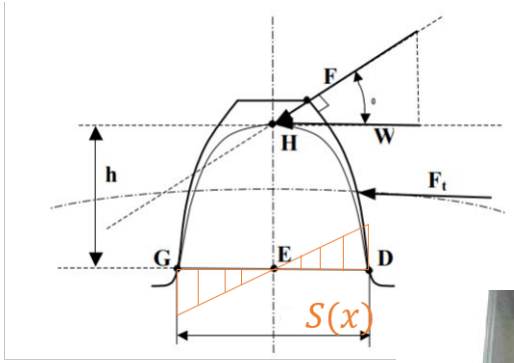
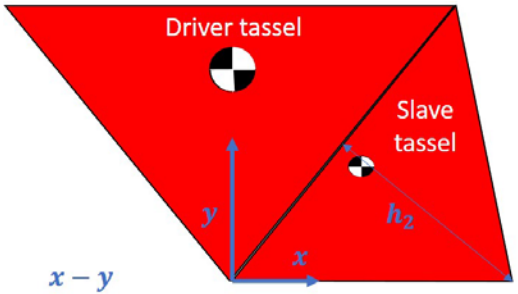
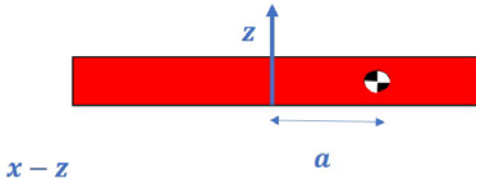


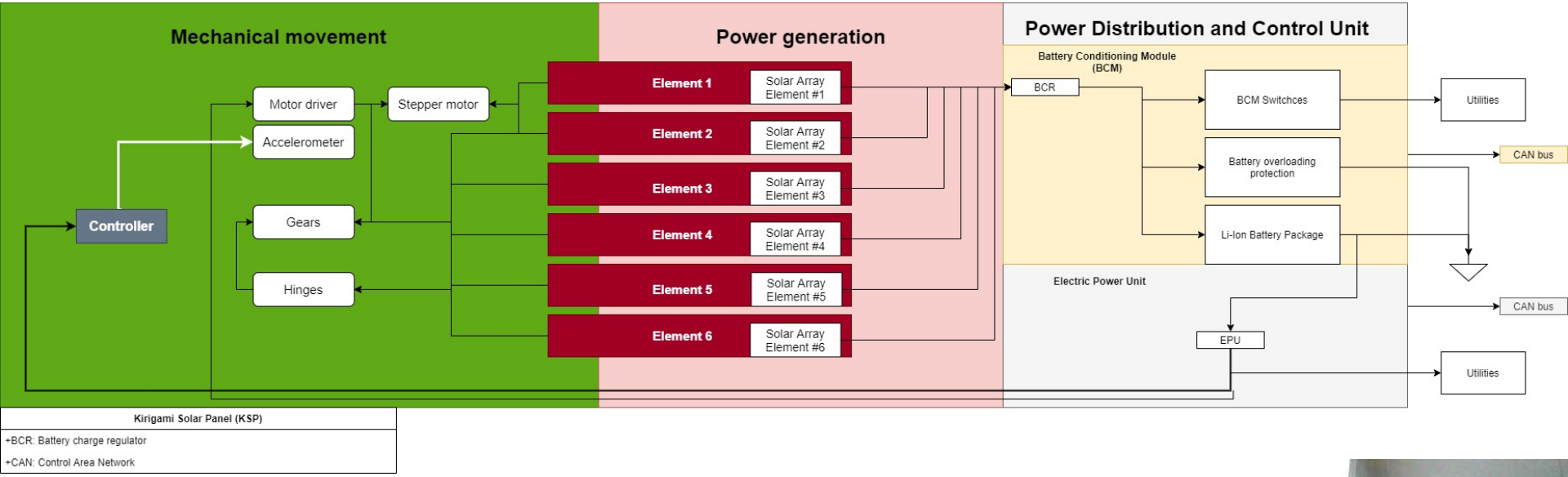
Origami Solar Panel: gears design trade-off





$$Torque_{Hinge\ line} > Torque_{resistant}$$

Origami Solar Panel: system architecture

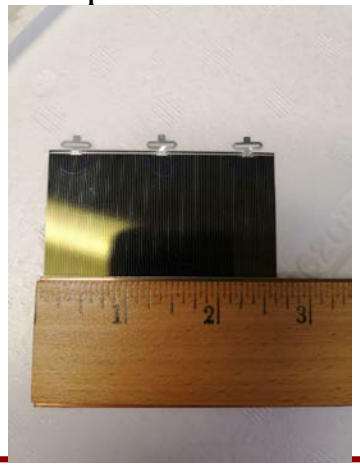


Kirigami Solar Panel (KSP)
+BCR: Battery charge regulator
+CAN: Control Area Network

Origami Solar Panel: test-bed description

HARDWARE

- **Stepper motor**: PG20L-D20-HHC0
- **Motor driver**: The DRV8835 Dual Motor Driver
- **Controller**: Arduino Mega
- **PCB Circuit Board**: Uxcell Single-Sided Copper Clad Laminate
- **Solar cells:** Already available in SERC from Spectrolab

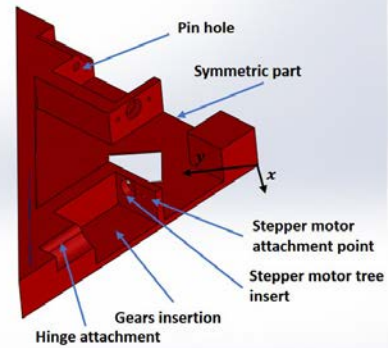


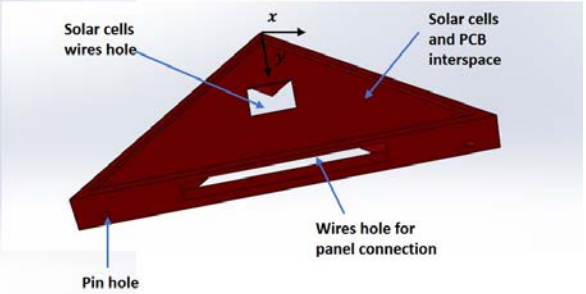
PRINTING MATERIALS

- Stratasys ABSplus-P430 Cartridge White for the tassels
- P400-SC Soluble Concentrate for the support printing material
- Red MAKERBOT PLA for the hinges, pins and gears

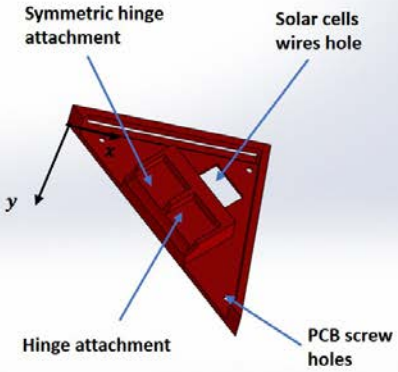
Origami Solar Panel: test-bed description

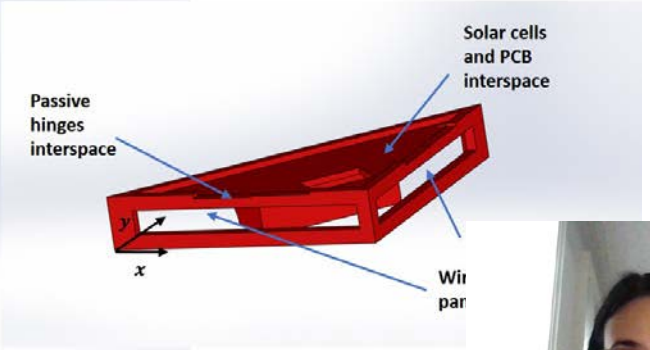
- Bigger tassels

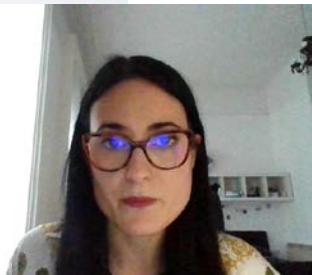




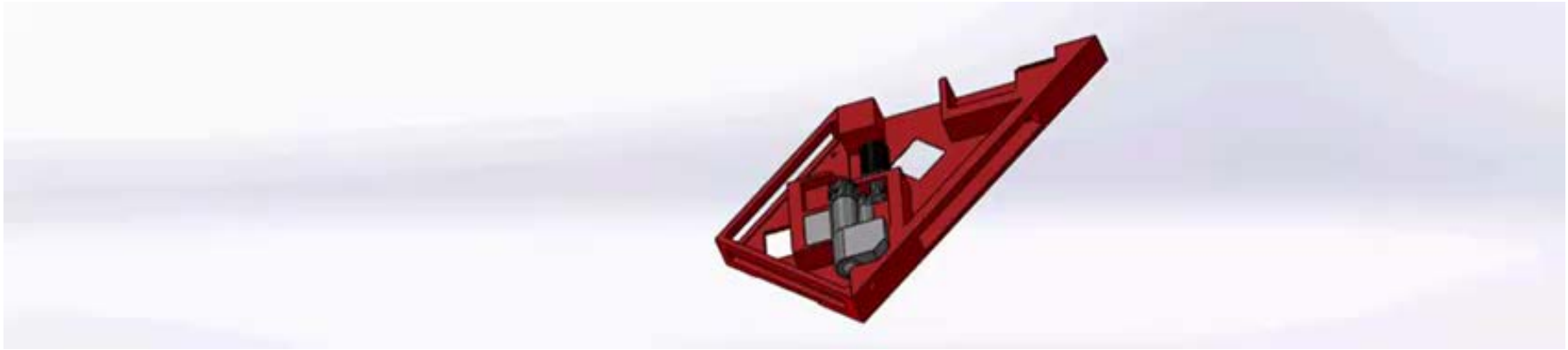
- Smaller tassels



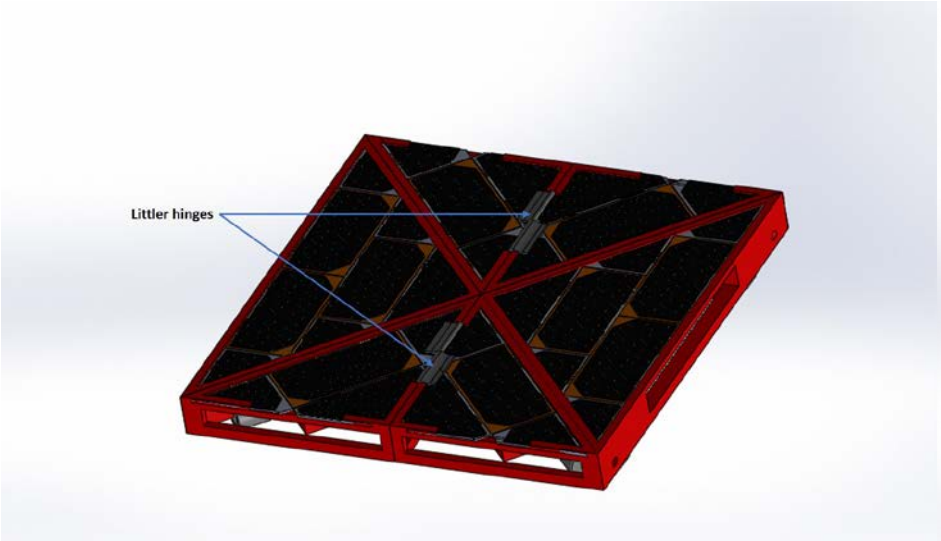


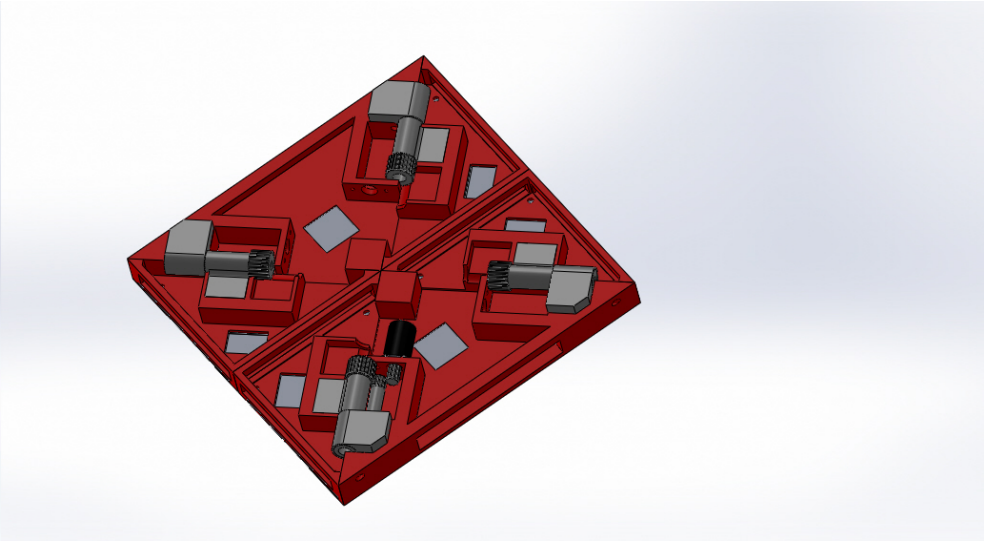


Origami Solar Panel: test-bed actuation

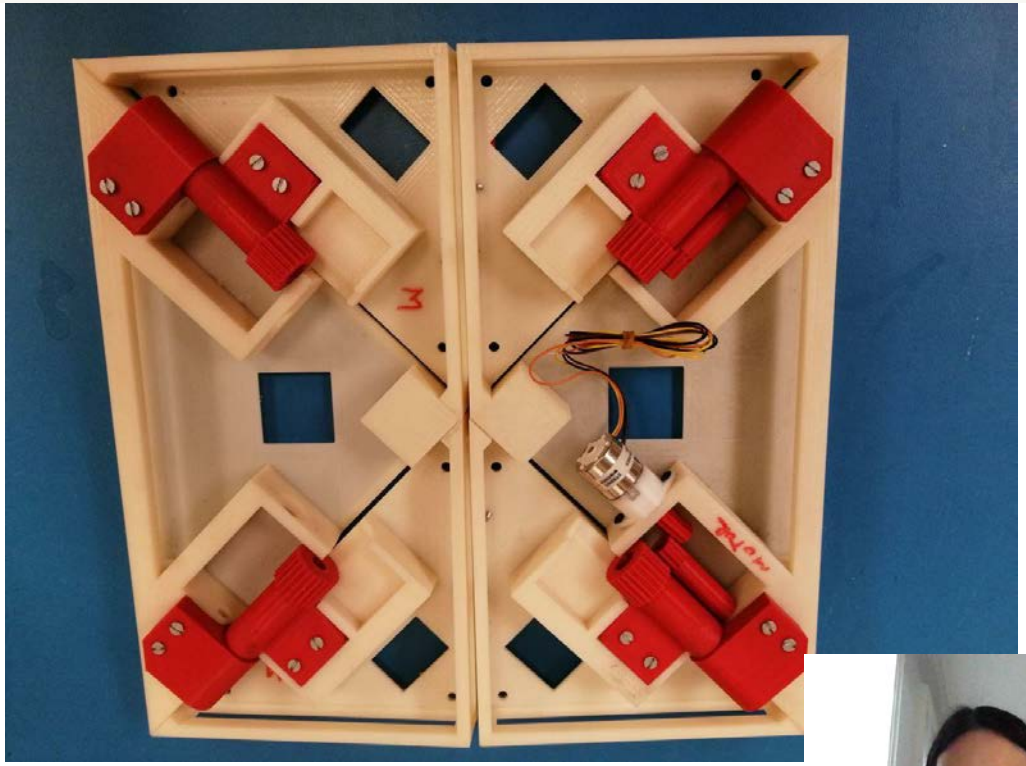


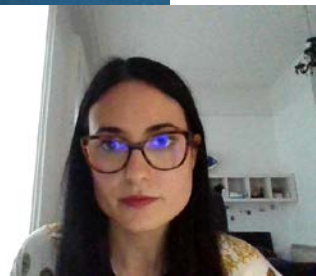
Origami Solar Panel: test-bed assembly



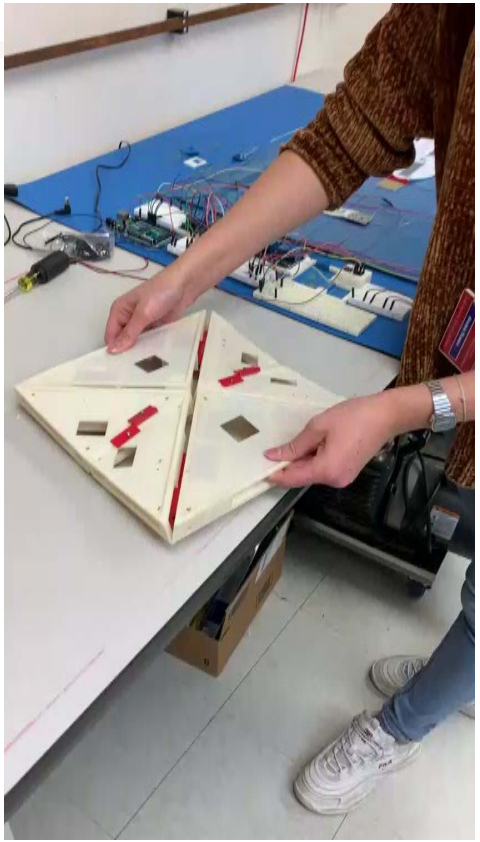


Origami Solar Panel: realization and trouble shooting

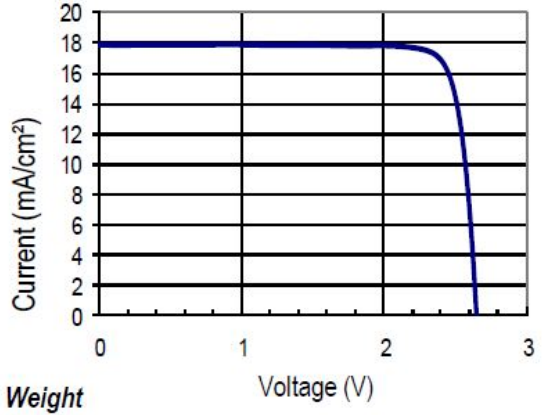




Origami Solar Panel: deployment manual test



Origami Solar Panel: PDCU



Credits: Spectrolab

- ***29.5% NeXt Triple Junction (XTJ)***
- ***26,6 cm^2***
- ***29.62W***

Conclusions and future improvements

- ***Origami Solar Panel (OSP)***

  - The test-bed evidences good applications for compact systems
  - Hardware test should be done with solar cells surface oriented upward
  - The Power Management Distribution Unit has to be tested, as well as the solar cell array

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Thanks for the attention!

- Structural and mechanical design:

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- Power distribution and control system design

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