



Space Power Workshop: Advanced Concepts

Self foldable lunar lander solar panel: design concept

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April 21 at 8:00 a.m.



- ***LEAPFROG PROJECT***
 - Generation-II: overview
- ***Origami Solar Panel (OSP)***
 - Pattern trade-off
 - Thickness troubleshooting
 - Gears design
 - System architecture
 - Test-bed description
 - Test-bed realization and manual test
 - Origami Solar Panel: PDCU
- ***CONCLUSIONS***

Innovative Design Focus

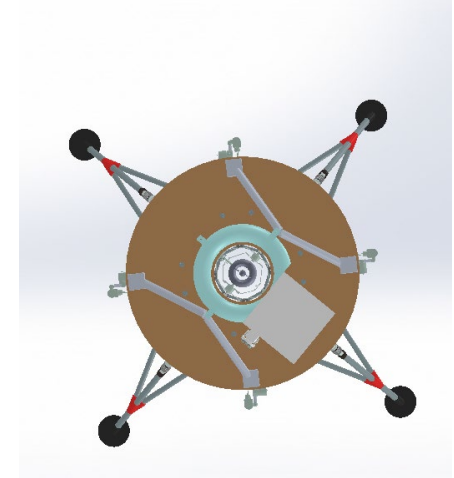
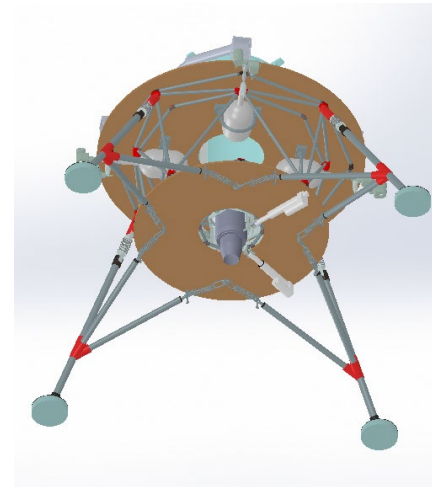
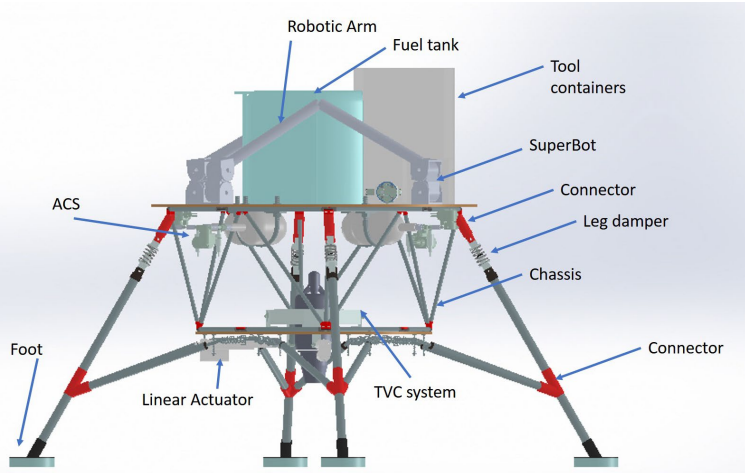
Re-think the function of a lander that can perform multiple activities: capable to change a single monolithic functioning lunar lander into a multi-functional platform that uses various techniques and new technologies to extend the use of the mass embedded in the makeup of the landing platform.

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

$$n\alpha + m\beta = 360^\circ$$

$$\beta = 120^\circ \quad \gamma = \alpha$$

$$n = 2$$

$$m = 2$$

- First OSP pattern proposal: $\alpha = 60^\circ$



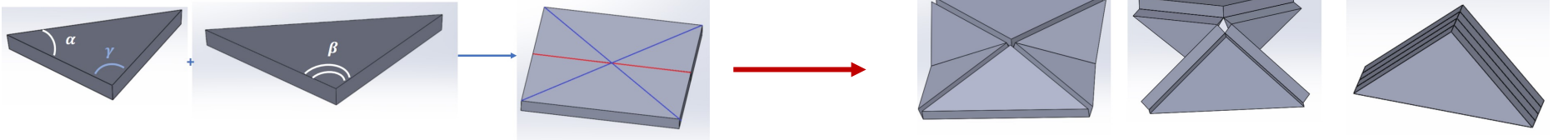
- Second OSP pattern proposal: $\alpha = 45^\circ$

$$\beta = 90^\circ$$

$$\gamma = 45^\circ$$

$$n = 4$$

$$m = 2$$



- Third OSP pattern proposal: $\alpha = 60^\circ$
 $m = 2$

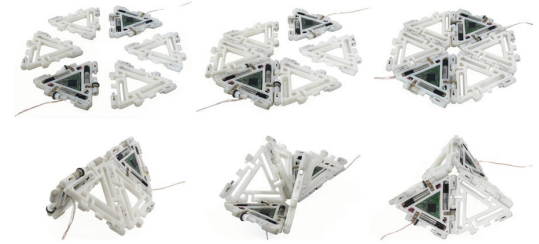
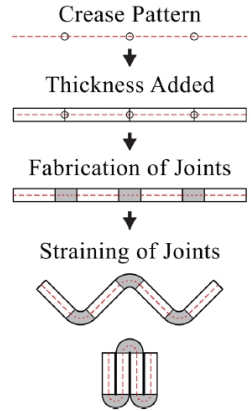
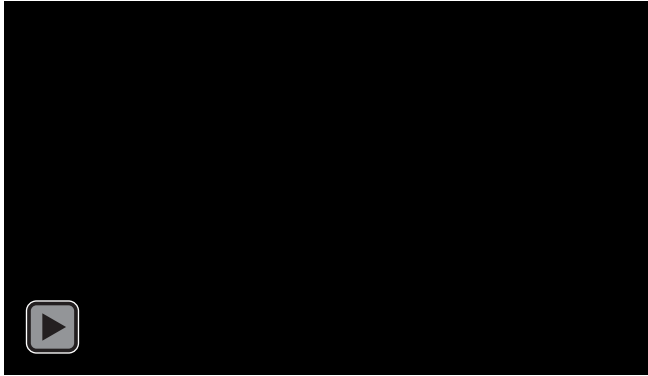
$$\beta = 60^\circ$$

$$\gamma = 45^\circ$$

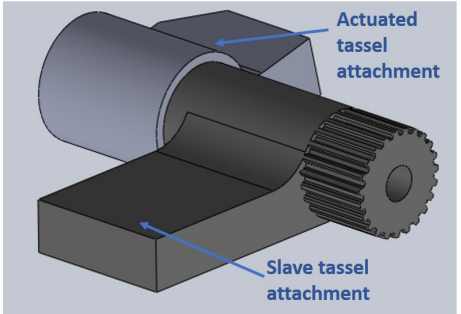
$$n = 4$$



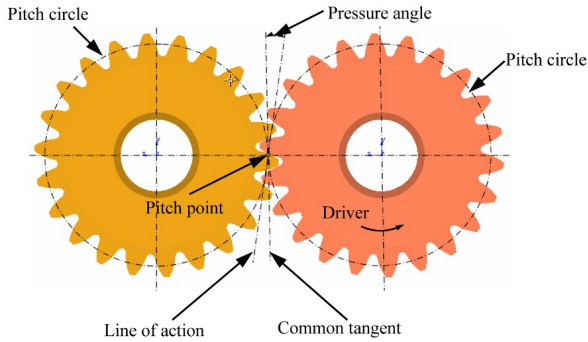
Origami Solar Panel: thickness troubleshooting



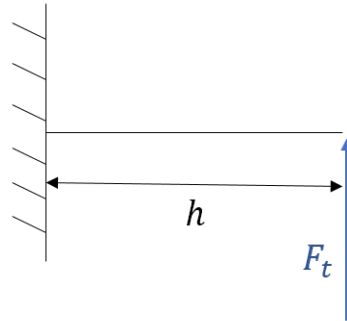
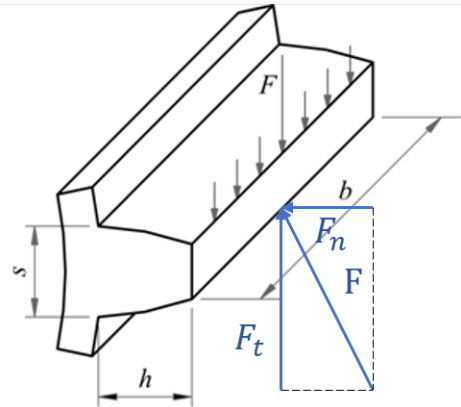
Credits: MORI A modular origami robot



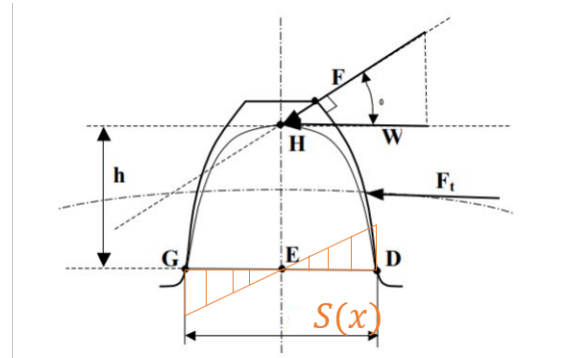
Origami Solar Panel: gears design

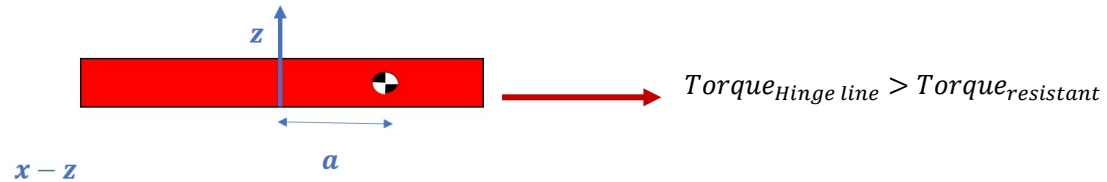
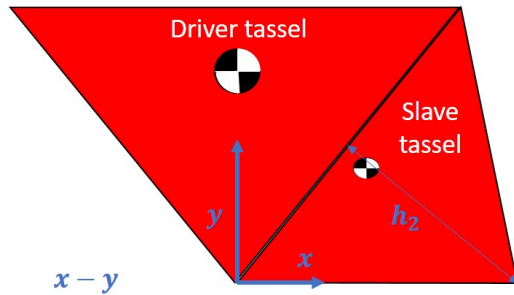


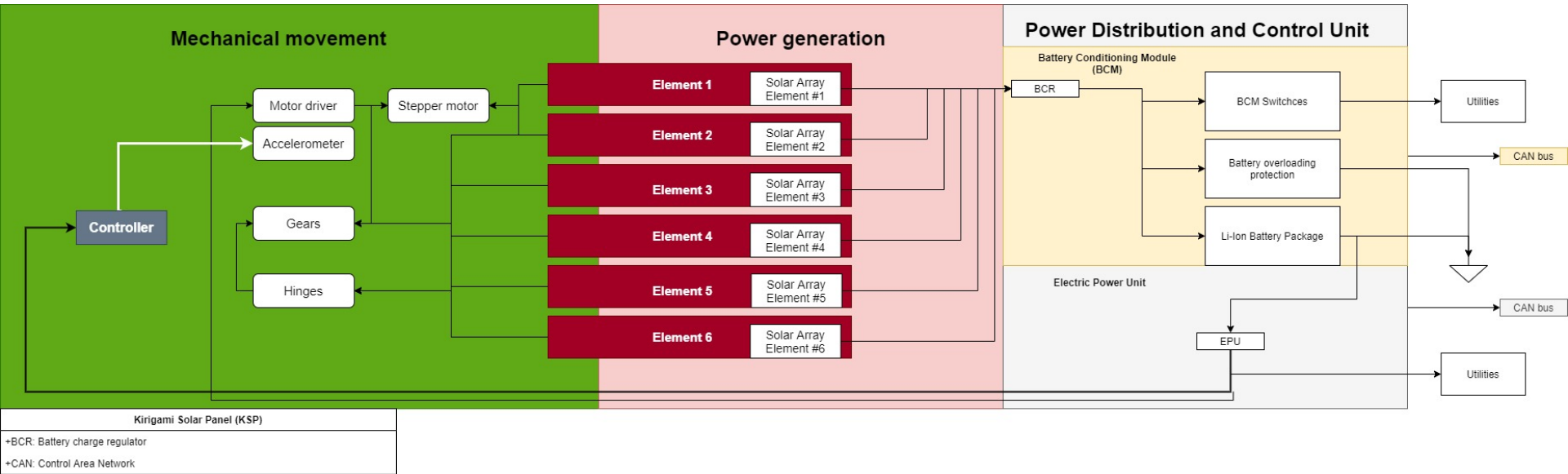
- Spur gears
- Teeth evolving profile
- Static and flexural solicitation design: Lewis method



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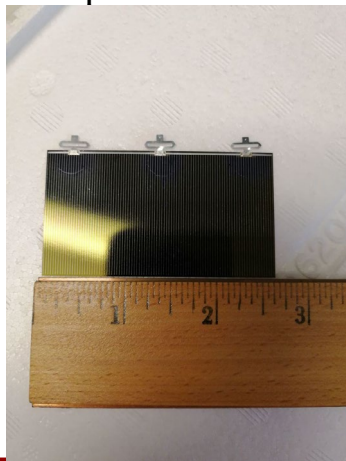






HARDWARE

- **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

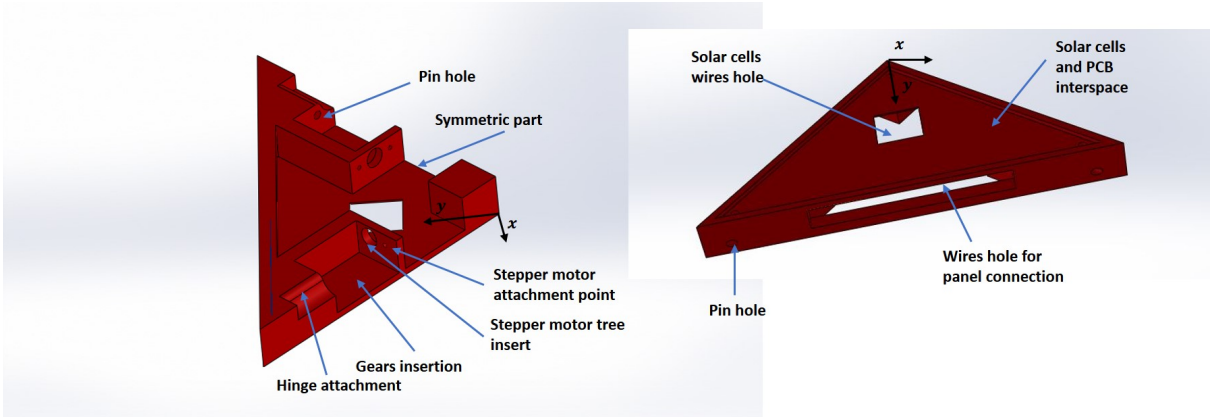


PRINTING MATERIALS

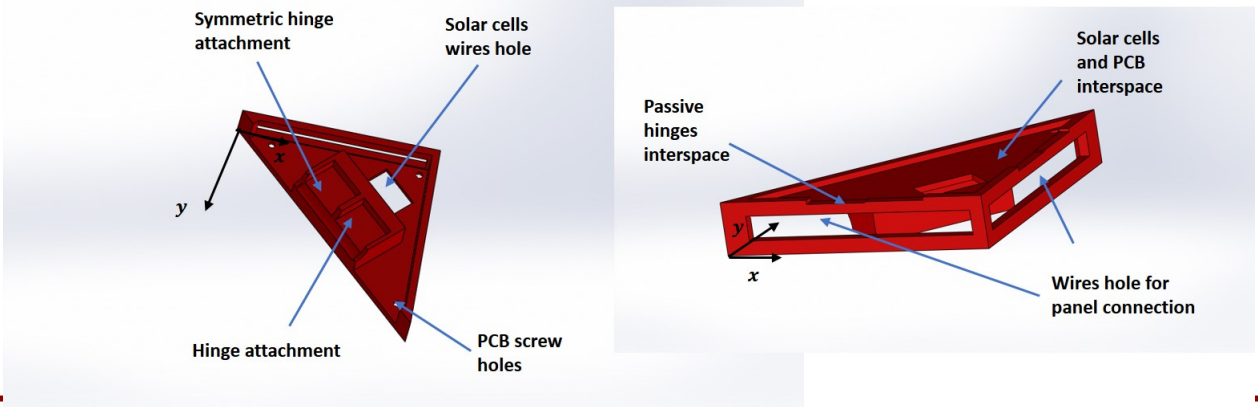
- Stratasys ABSplus-P430 Cartridge White for the tassels
- P400-SC Soluble Concentrate for the support printing material
- Red MAKERBOT PLA for the hinges, pins and gears

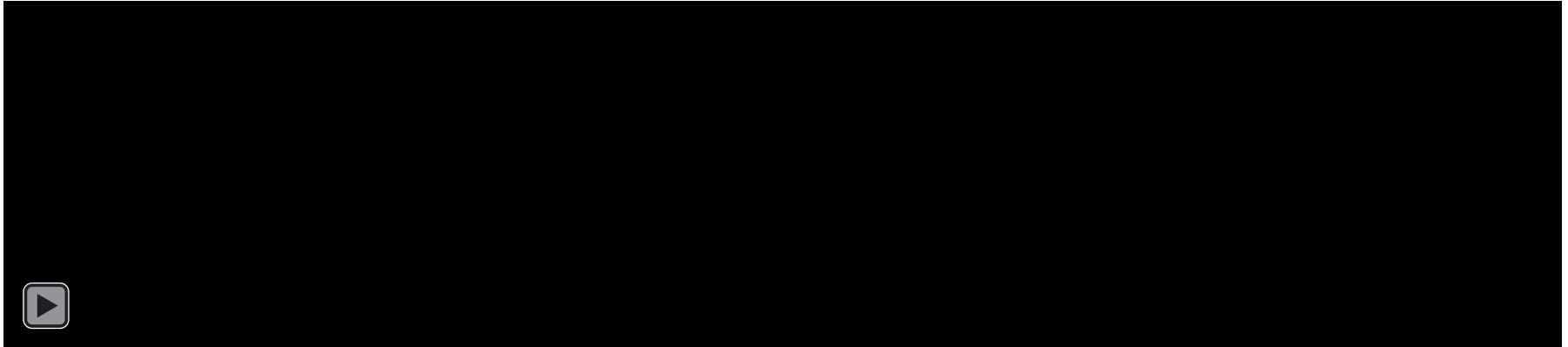


- Bigger tassels



- Smaller tassels

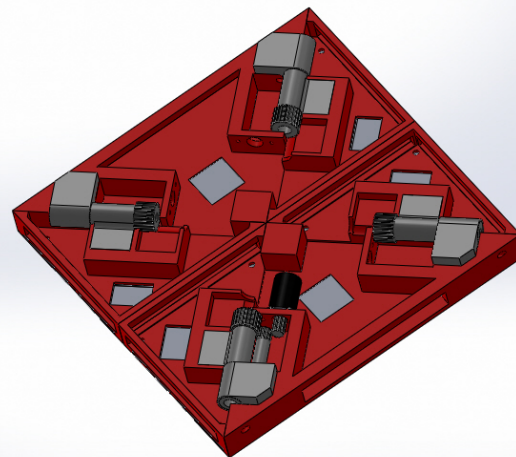
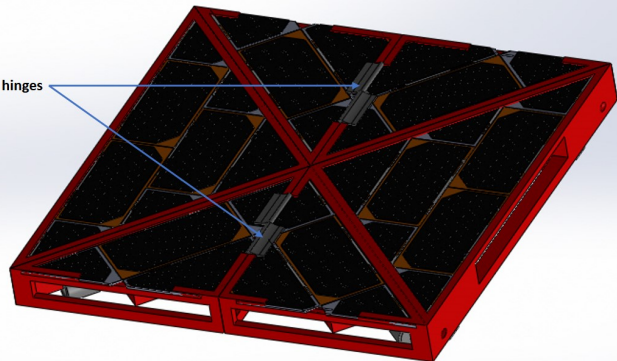


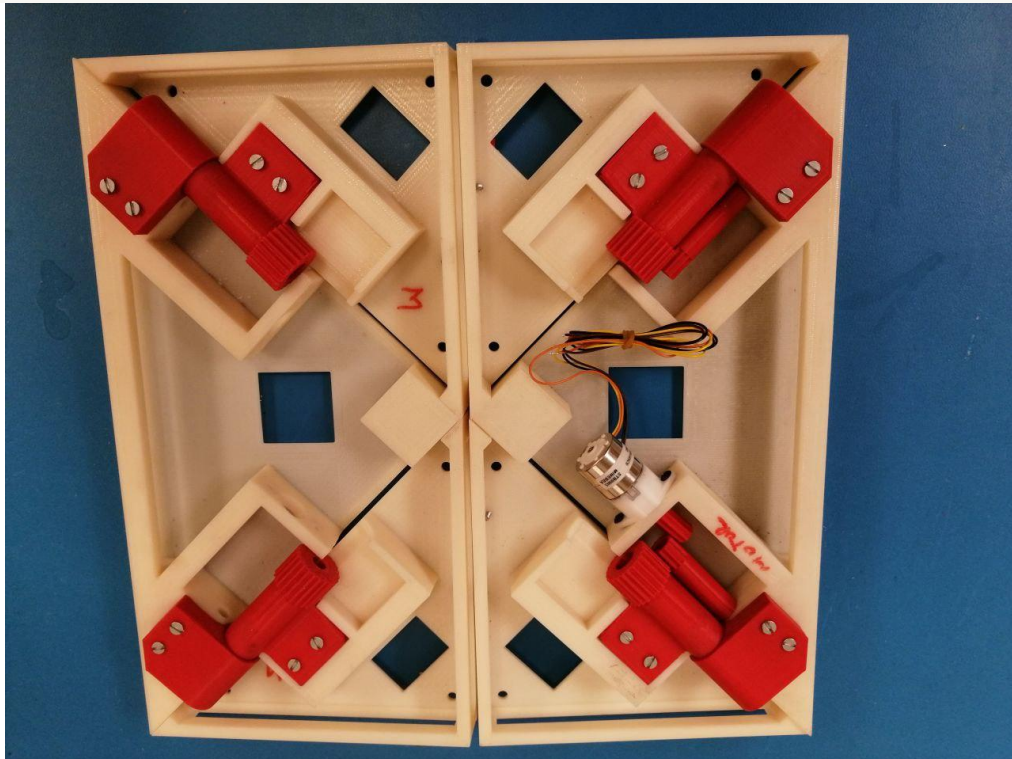


Origami Solar Panel: test-bed assembly

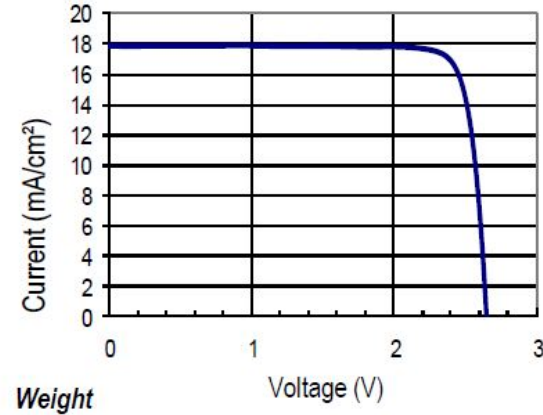


Little hinges









Credits: Spectrolab

- **29.5% NeXt Triple Junction (XTJ)**
- **26,6 cm²**
- **29.62W**



- ***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

Thanks for the attention!

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mechanical design:



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➤ Power distribution and
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