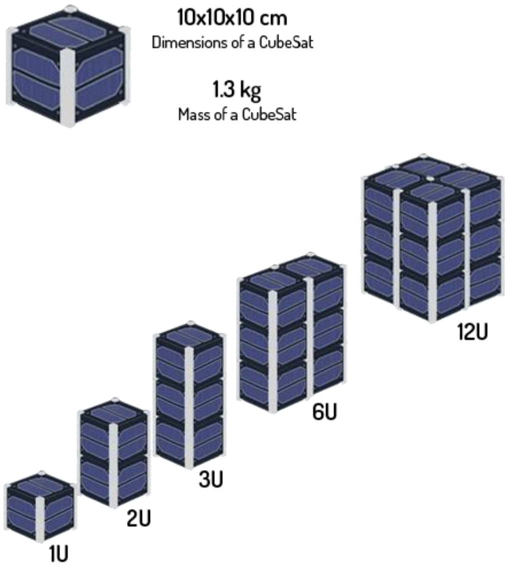
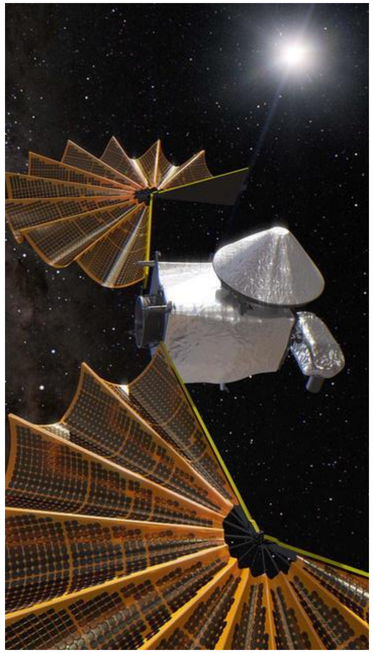
Solar panel deployer

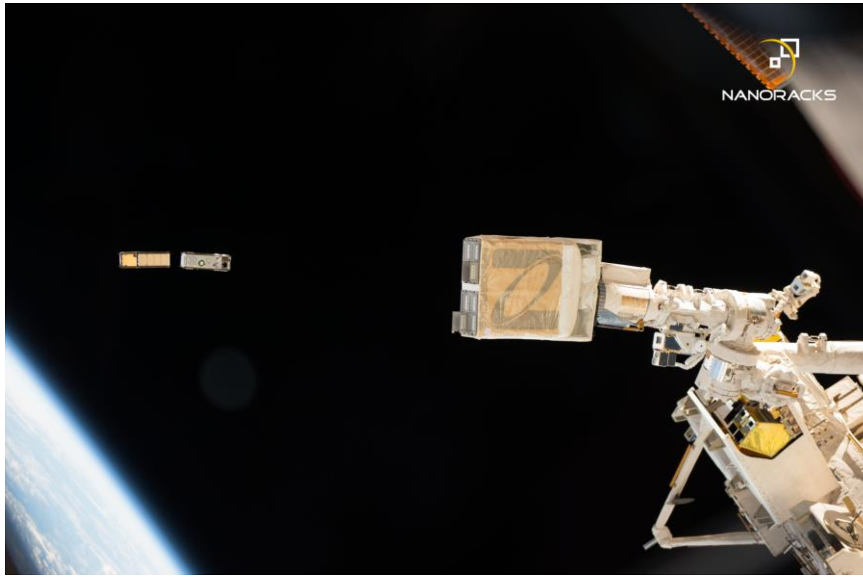
Cube Sats are small satellites that can be flown to the ISS and ejected from the Space Station using the robotic arm. They are being made by small and large companies, universities and even high schools. They can have a wide variety of uses and made in a lot of sizes.   Solar panels are often placed on the sides of the cube sats but in this case, they would interfere with the cooling of the internal electronics. The satellite will keep the same orientation as it orbits around the Earth which means that the solar panels will not always be pointing at the sun. The goal is to get as much power for the satellite as possible from the array since this satellite does not self orient so the solar panels are only expected to be collecting light 30% of the time.

Design, build and test the deployment of a 1U solar panel array for a 2U cube sat. that will:

- Fit within 1 U on the front of the 2U satellite
- Provide maximum of power available to satellite for the volume available (the more solar panels your team can deploy from the volume, the more power they should produce)
- Deploy within 2 minutes after being ejected from the deployer
- Should not induce a rotation or vibration of the satellite
- Panels can deploy in any direction
- Only has to deploy does not have to be able to retract.
- Solar cells can be rigid (more efficient) or flexible (less efficient)
- Solar cells can be expensive so I don’t expect you to demonstrate power but your prototype should be as mechanically accurate as possible—mimic wiring and panel thickness as it will affect deployment.
- This can be a powered deployment but it is not required and should use minimal power since it would be pulling from an internal battery.

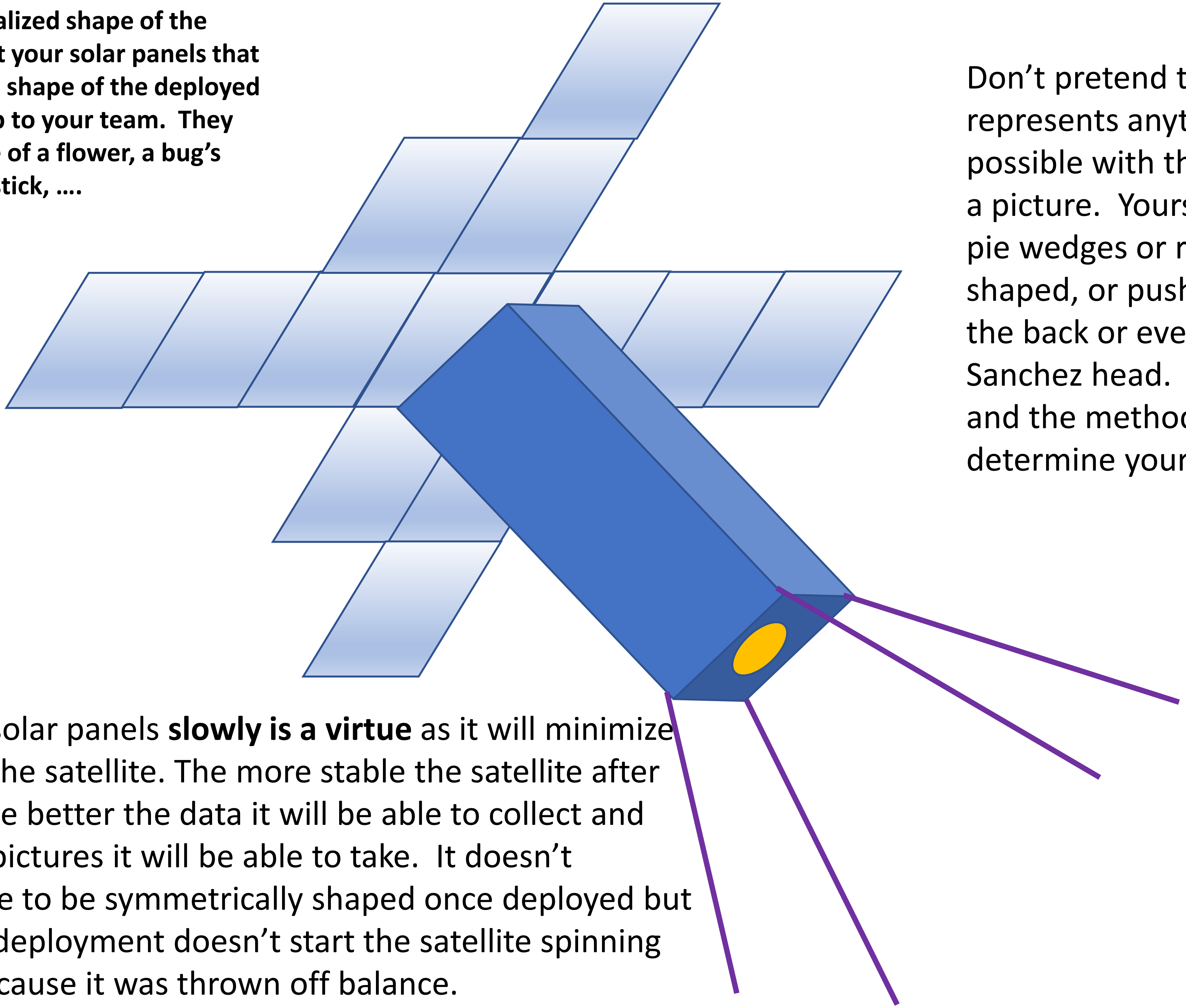






This is the generalized shape of the Cube Sat without your solar panels that will fit here. The shape of the deployed solar panels is up to your team. They can be the shape of a flower, a bug's wing, a straight stick, ….

Don't pretend that this picture represents anything good or smart or possible with the solar panels—its just a picture. Yours could be round with pie wedges or rectangular, or spiral shaped, or push out as a tube or line to the back or even shaped like a Rick Sanchez head. Efficiency of volume and the method of unfurling will determine your final shape.

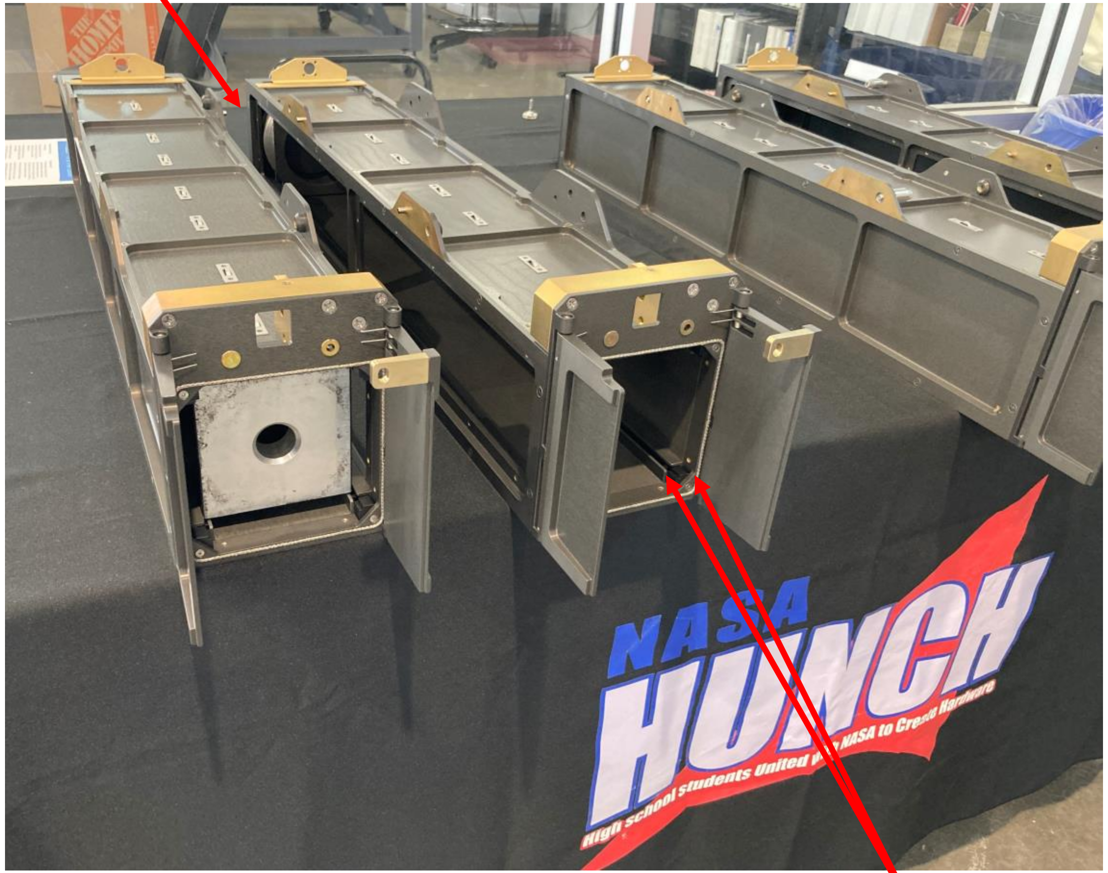


Deploying the solar panels **slowly is a virtue** as it will minimize the wobble of the satellite. The more stable the satellite after deployment, the better the data it will be able to collect and the better the pictures it will be able to take. It doesn't necessarily have to be symmetrically shaped once deployed but make sure the deployment doesn't start the satellite spinning or wobbling because it was thrown off balance.

The 4 antennas will be spring loaded in the deployer and will flip out from the body as the satellite is pushed by the ejection spring out past the doors.

These are cube sat deployers that are machined by HUNCH students and assembled by HUNCH for NanoRacks. These are being fit checked and readied for launch.

Compressed spring (slightly visible)for pushing satellite out of deployer

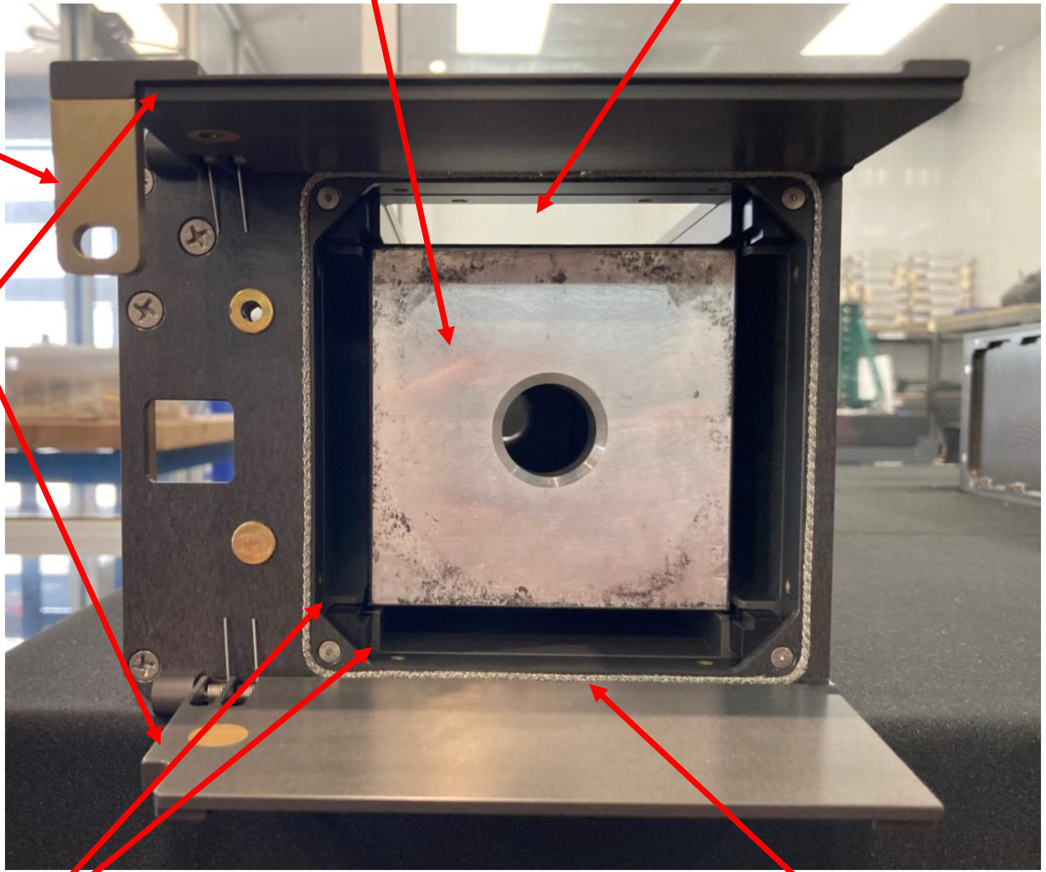


10 cm x 10cm x 30 cm cube sat mock up for testing

Outer panel removed for testing

Release latch

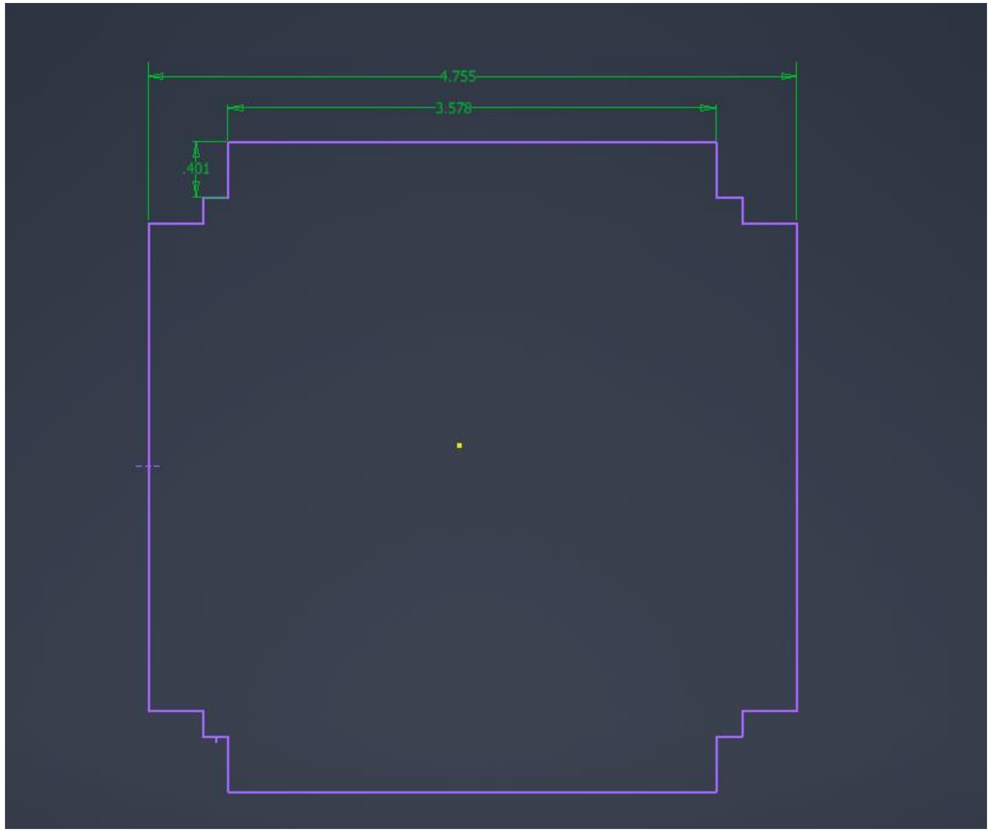
Doors



Rails (4x) keep the cube sat aligned and on a strait trajectory when it is pushed out by the spring

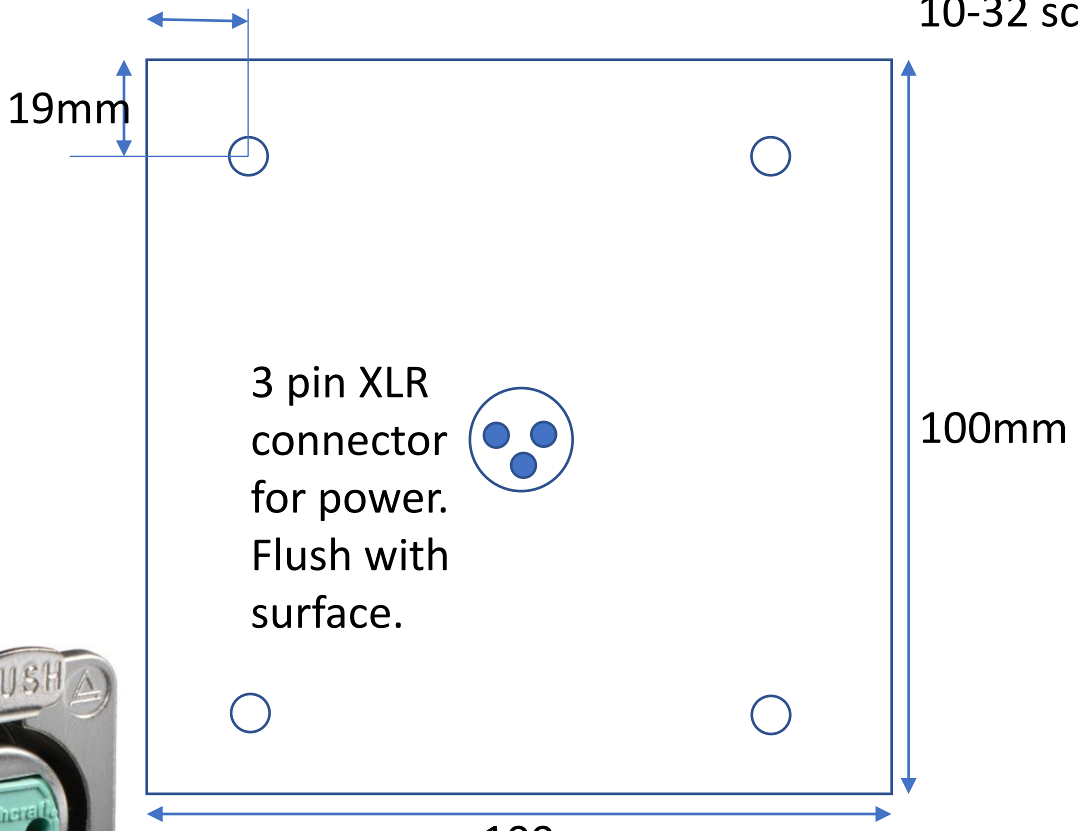
Solar panels can fit here (4)

Stainless steel mesh gasket

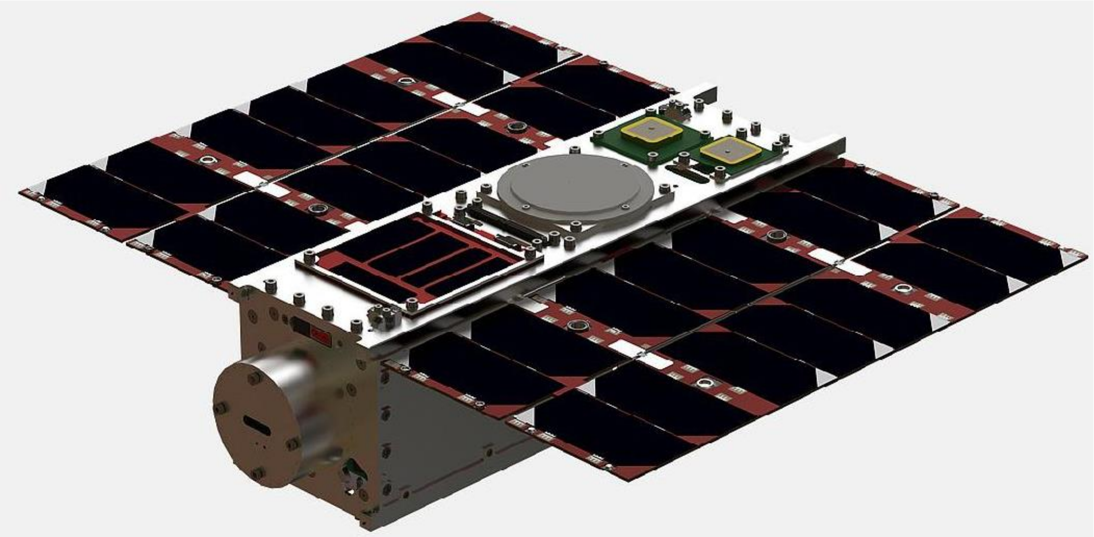


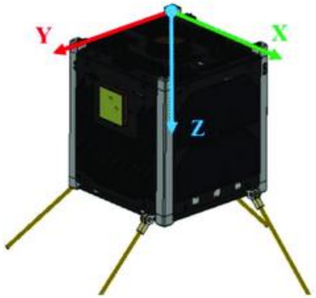
Dimensions in inches for the opening of the deployer.

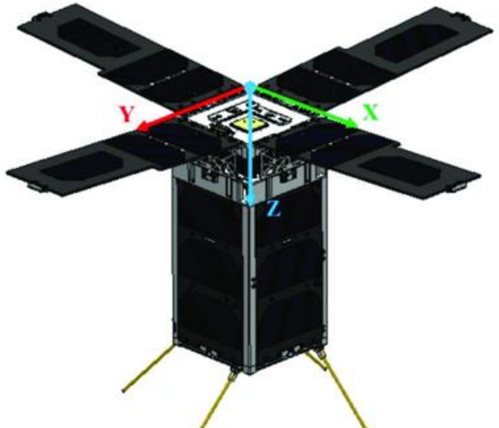
Attachment requirements for the solar panels to the front of 2U Cube Sat



Current cube sat solar arrays







Many satellites are able to deploy their solar panels from the sides or even leave the solar panels attached to the sides. That isn't possible for this cube sat. Because of the heat generated by the electronics, the sides are acting as heat sinks to dissipate the heat out into space.
On the side opposite the solar panels, there is a lens.

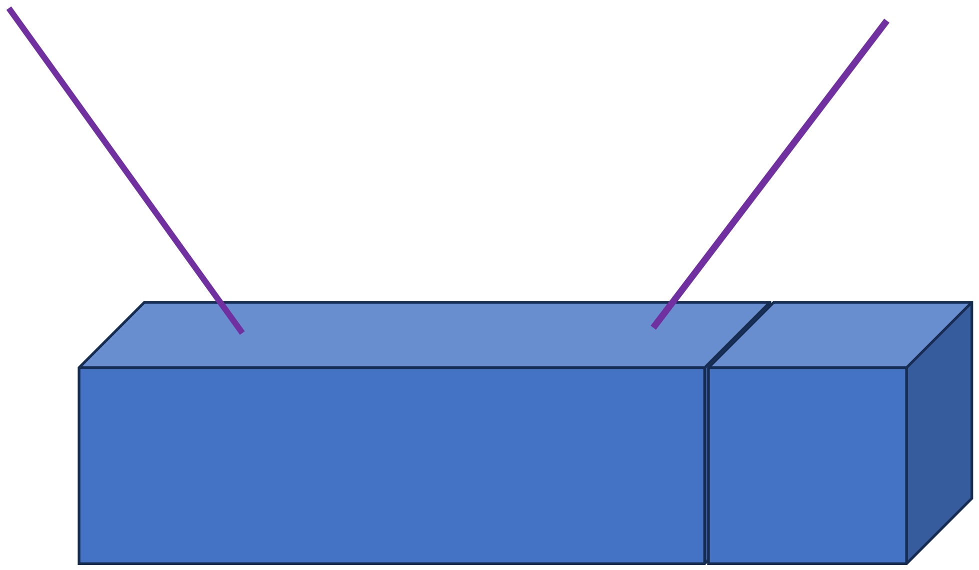
You can use rigid, silicon wafer solar panels that have a higher efficiency or you may use the flexible solar panels that have a lower efficiency but may be able to flex into smaller spaces. Your goal is to get 100W (or as much as possible) from your solar panels that are contained in your 1U volume. You can use hinges and springs to unfurl/unfold your array or you can use the elasticity of the some kind of plastic film to that will straighten out once it leaves the deployer but make sure it can handle the cold and heat of space-- +250F to -250F. How does it flex and move at different temperatures.

Testing

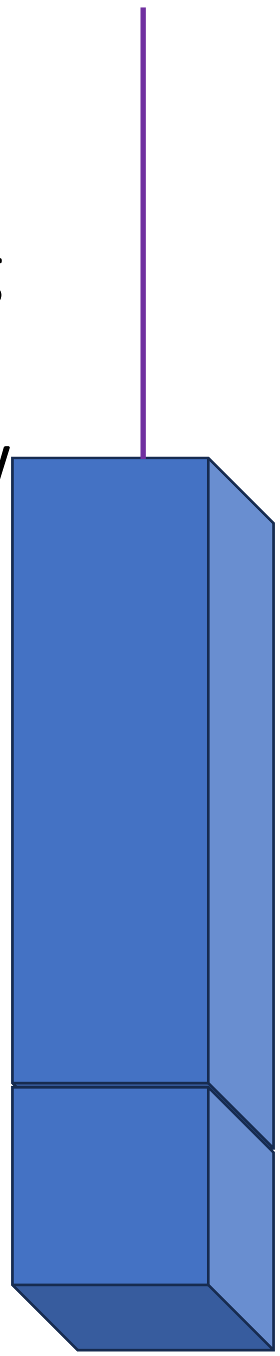
- Make a box with the internal dimensions of the deployer and pull it out to see how it behaves during deployment. You might hang it on a string to see how it bobs, wiggles or rotates as it deploys.
- You are not required to purchase solar panels and make them work. This project is about the deployment not a power test
- If you are not purchasing solar panels, choose materials that mimic the dimensions of the solar panels and their flexibility.
- Small solar panels are often sold with an epoxy coating over the solar panel—this is for protecting the solar panel from scratches and other damage and takes up valuable volume in your design. The epoxy can also cut down on the efficiency of the solar panels. Solar panels used for space do not use the epoxy material. If you choose to purchase solar panels and test the power, try to get solar panels without the epoxy coating.

Testing of deployment

- Hanging your 1U solar panel from some string and allowing it to open should give you some information about if it causes twisting or vibrations to the rest of the satellite.
- You may want to hang it in a few different orientations to see how it behaves when the panels deploy.



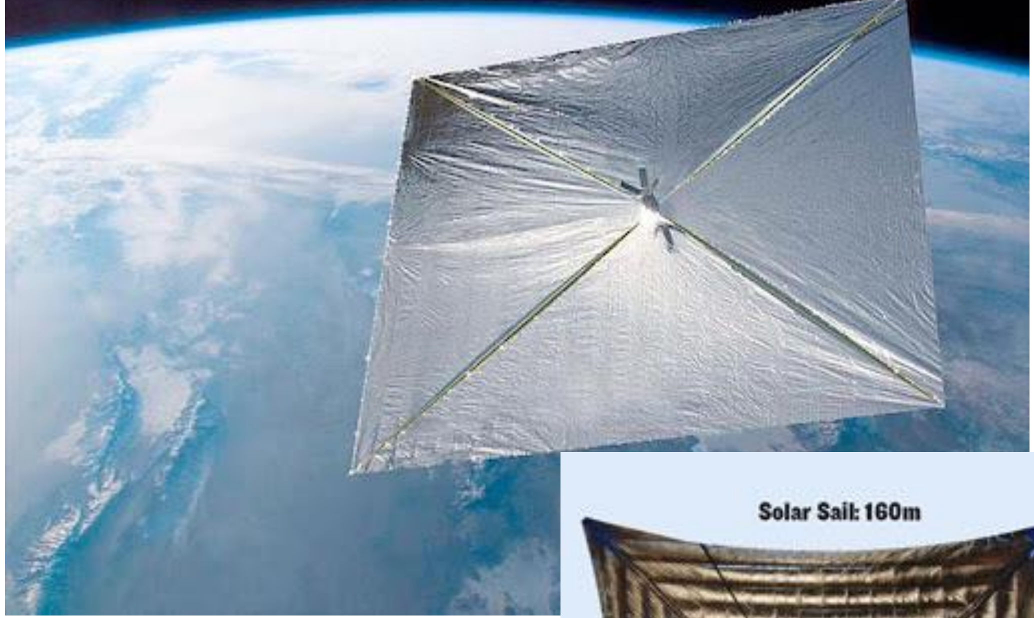
Strings attached to some kind of overhead bracket will allow you to see how the mass shifts when the panels deploy.

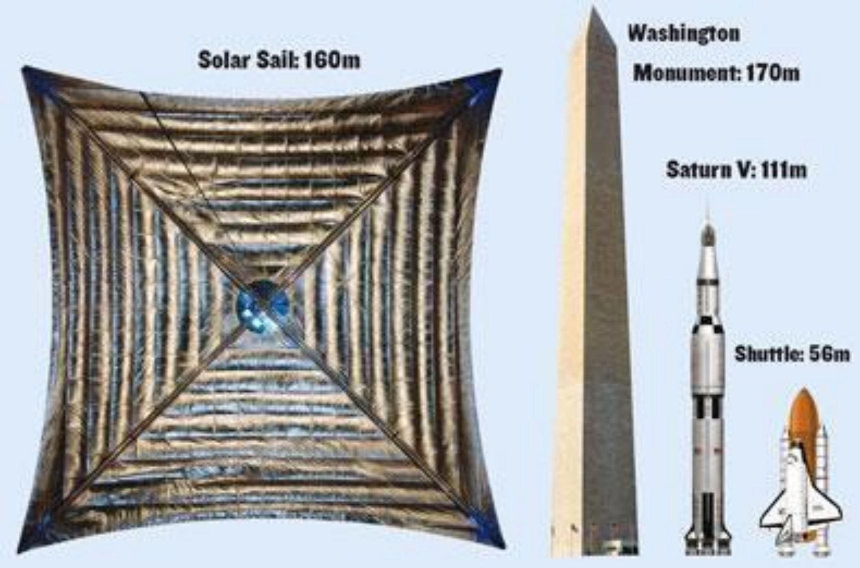


Solar Sails vs. solar panels

Solar sails are very thin, low mass, reflective material (often mylar) that allow the suns rays to push a satellite similar to how the wind pushes a boat's sails (but much less force). The solar sails have to reflect the sun light to receive the push from the sun or bright light.

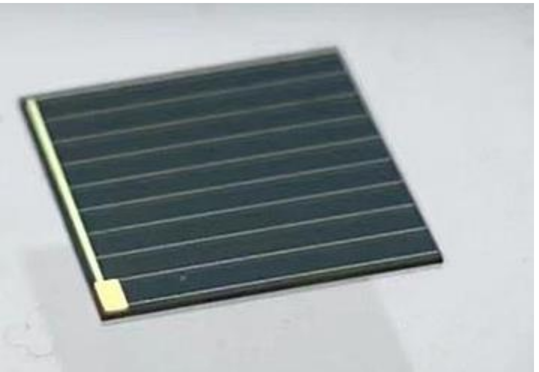
This is not what we are doing.





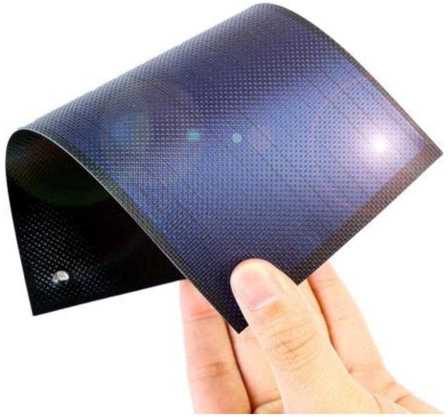
Your choice for type of solar panels.

Solar panels are silicon materials (or sometimes a flexible material) that absorb the sun light and turns it into electricity. Although solar panels have been shown to act as solar sails (slightly) when positioned correctly over long periods of time, because they are absorbing most of the light and turning it into electricity, the solar panels are very poor solar sails.



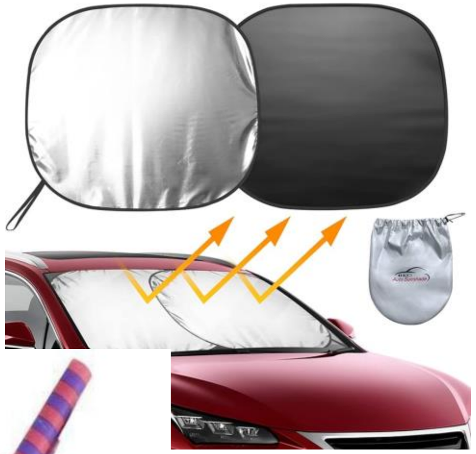
Rigid but more power

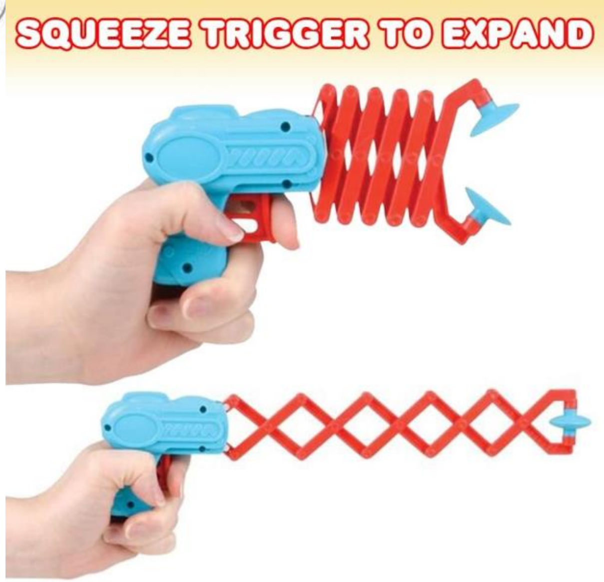
Range in size from 5x5 mm to 166x166mm and probably more sizes and shapes



Flexible but less efficient

Potential options to consider





How does nature deploy large structures from small packages?

https://www.google.com/search?sca_esv=03047b03c4b9cd9d&rlz=1C1GCEA_enUS110
4US1104&q=cicada+coming+out+of+skin&tbm=vid&source=lnms&prmd=ivsnbmt&sa=
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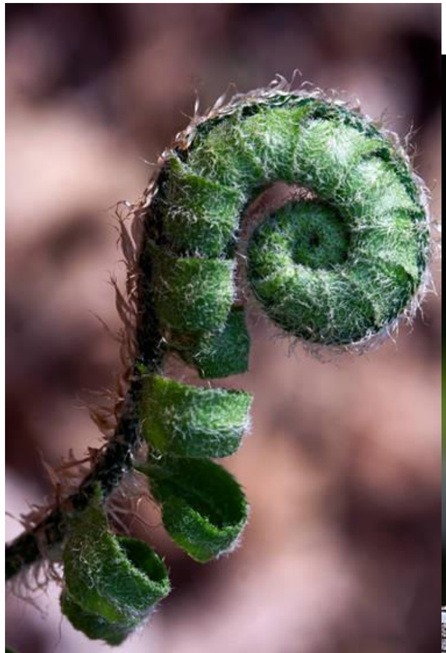
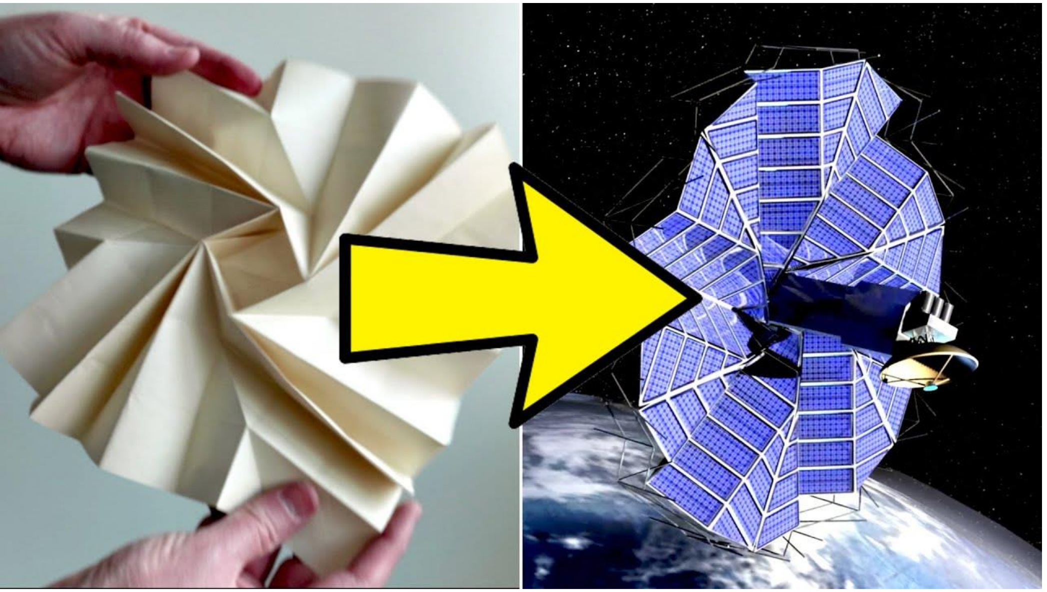
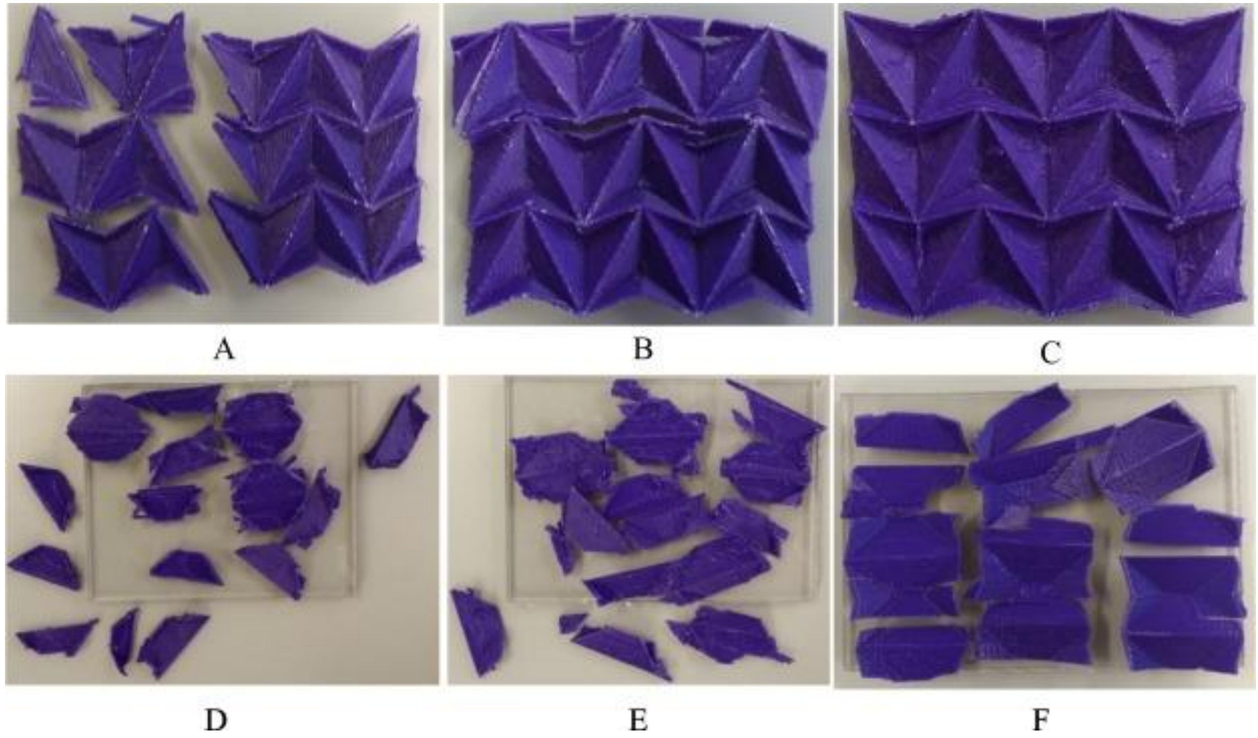
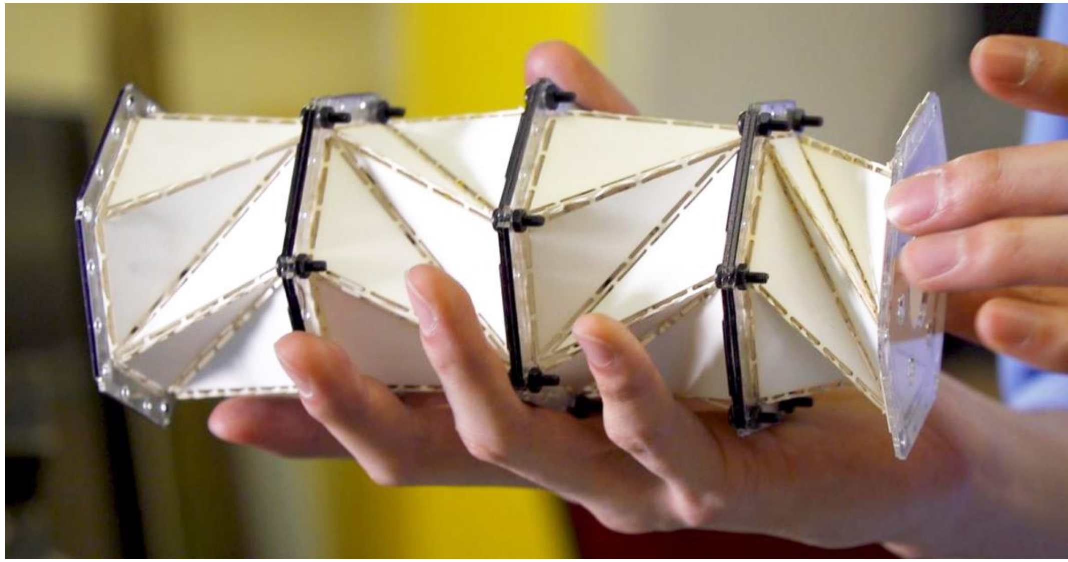


Can nature inspire your technology?

Origami thoughts?

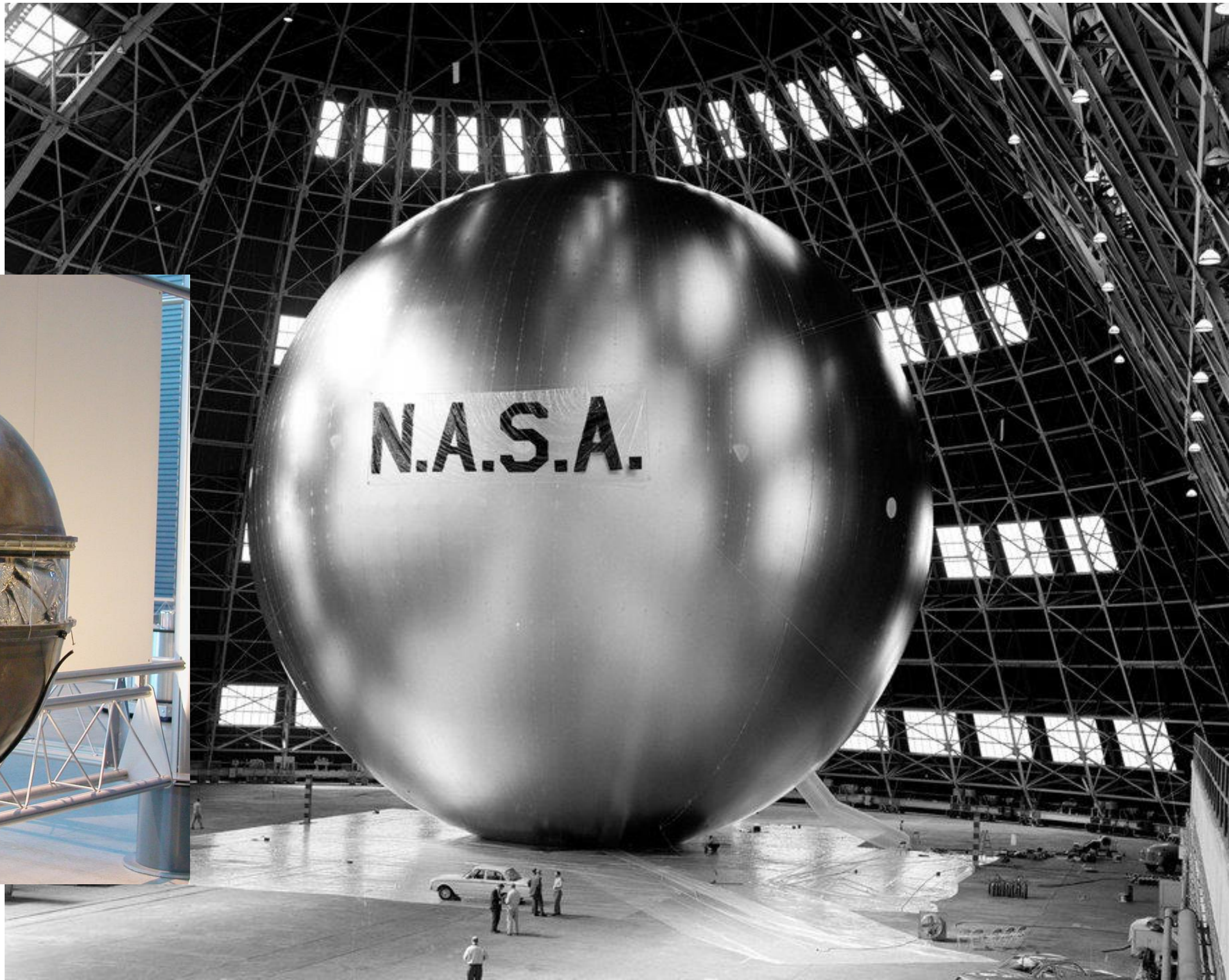






Echo 2

Deploying a satellite has changed over the years.

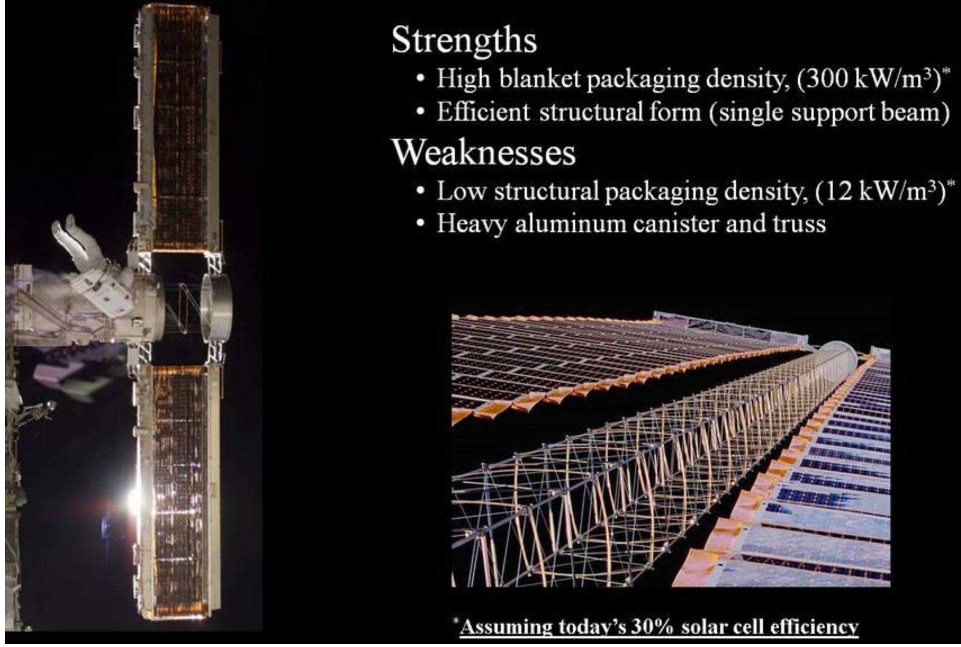


Project Echo, NASA's first passive communications satellite experiment, demonstrated the potential of satellite communications. The 135-ft (41.1 m) Echo 2 had a thin skin of mylar and aluminum and inflated with a small explosive once in orbit. Radio waves could be bounced off the satellite and reflected back to the ground to be picked up and heard by other radio receivers.

Flies up the size of a large beach ball

Original ISS Solar Panels

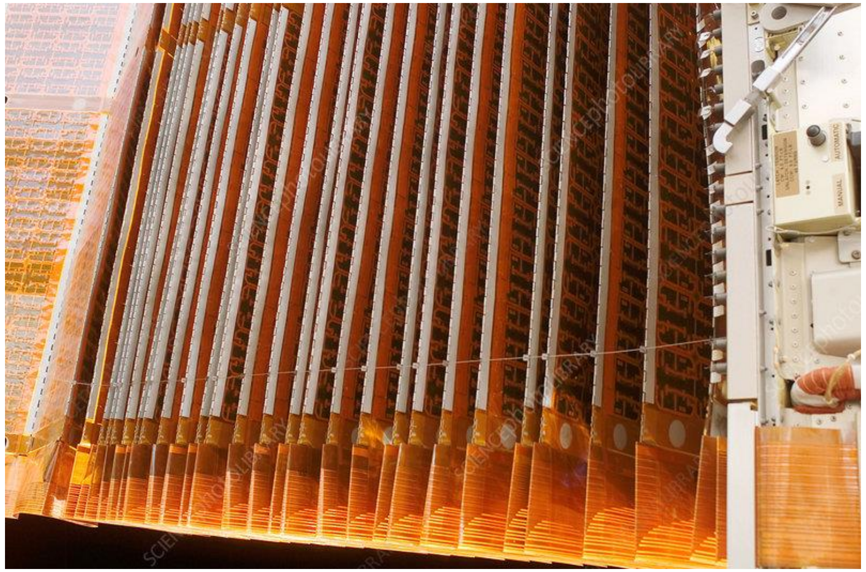
Astronaut unlatching the boxes containing the solar panels



Astronaut releasing the fiberglass rods with drill

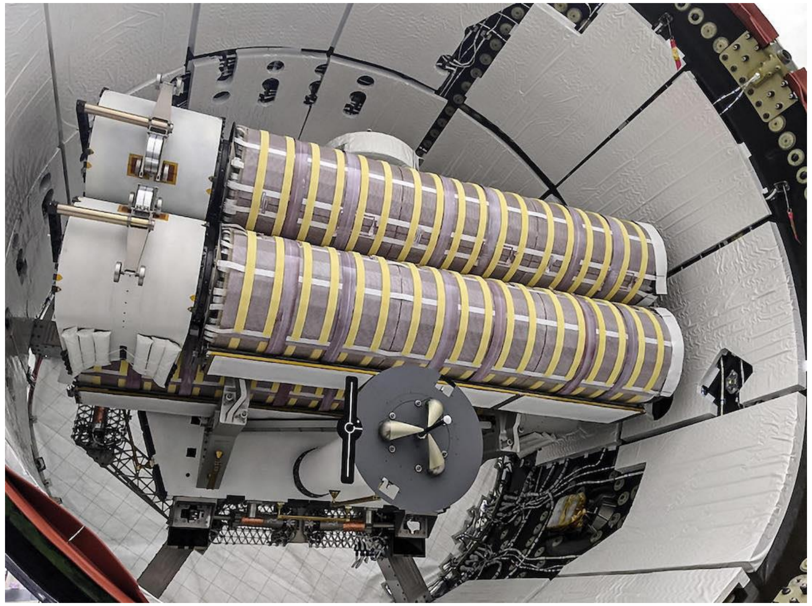
Solar panel stretched out by the fiberglass beam

The original ISS solar panels arrived in long boxes in the Space Shuttle cargo bay and were pulled out of the boxes by a light weight expanding beam. The beam is made of fiber glass rods that were flexed (kind of like a bow for archery) when in the large cylindrical can. The astronaut used the drill to release the flexed rods of the beam. As the fiber glass rods straightened out, they pulled the solar panels out of the boxes.



Solar panels being pulled out of the boxes

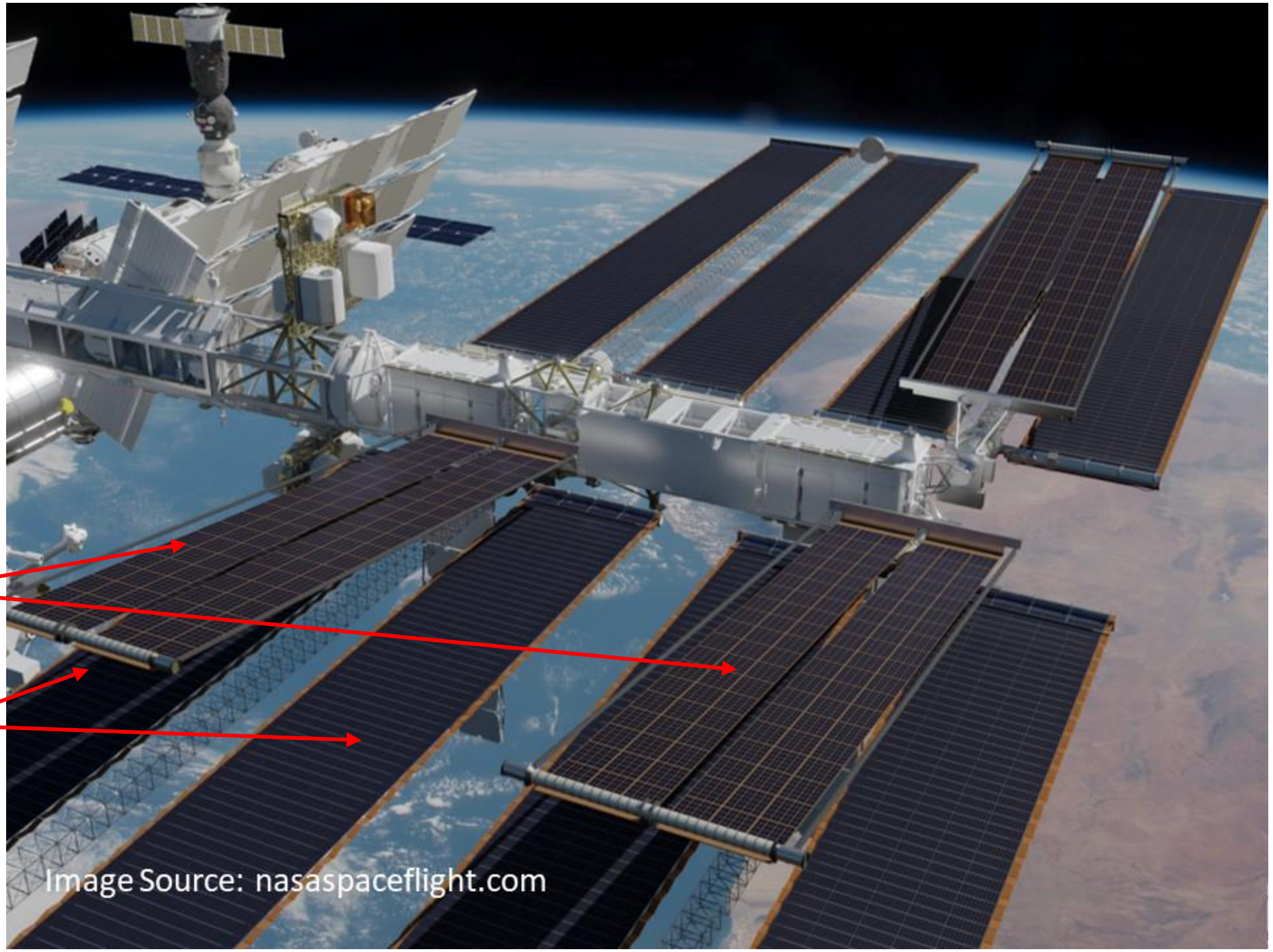
New ISS Roll Out Solar Panels

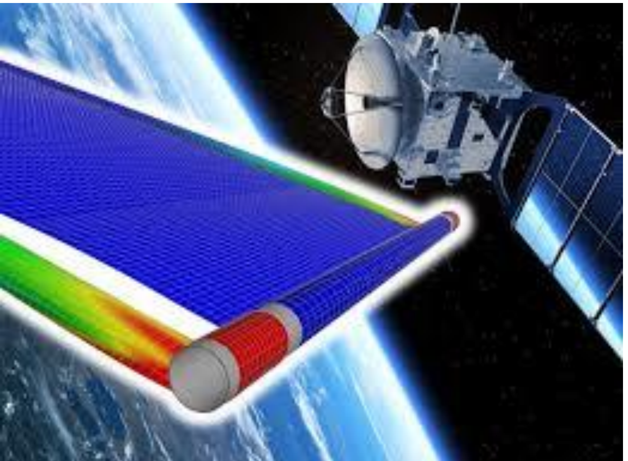


Rolled up flexible solar panels in the trunk of the Space X Dragon Supply Ship.

Roll Out Solar Panels

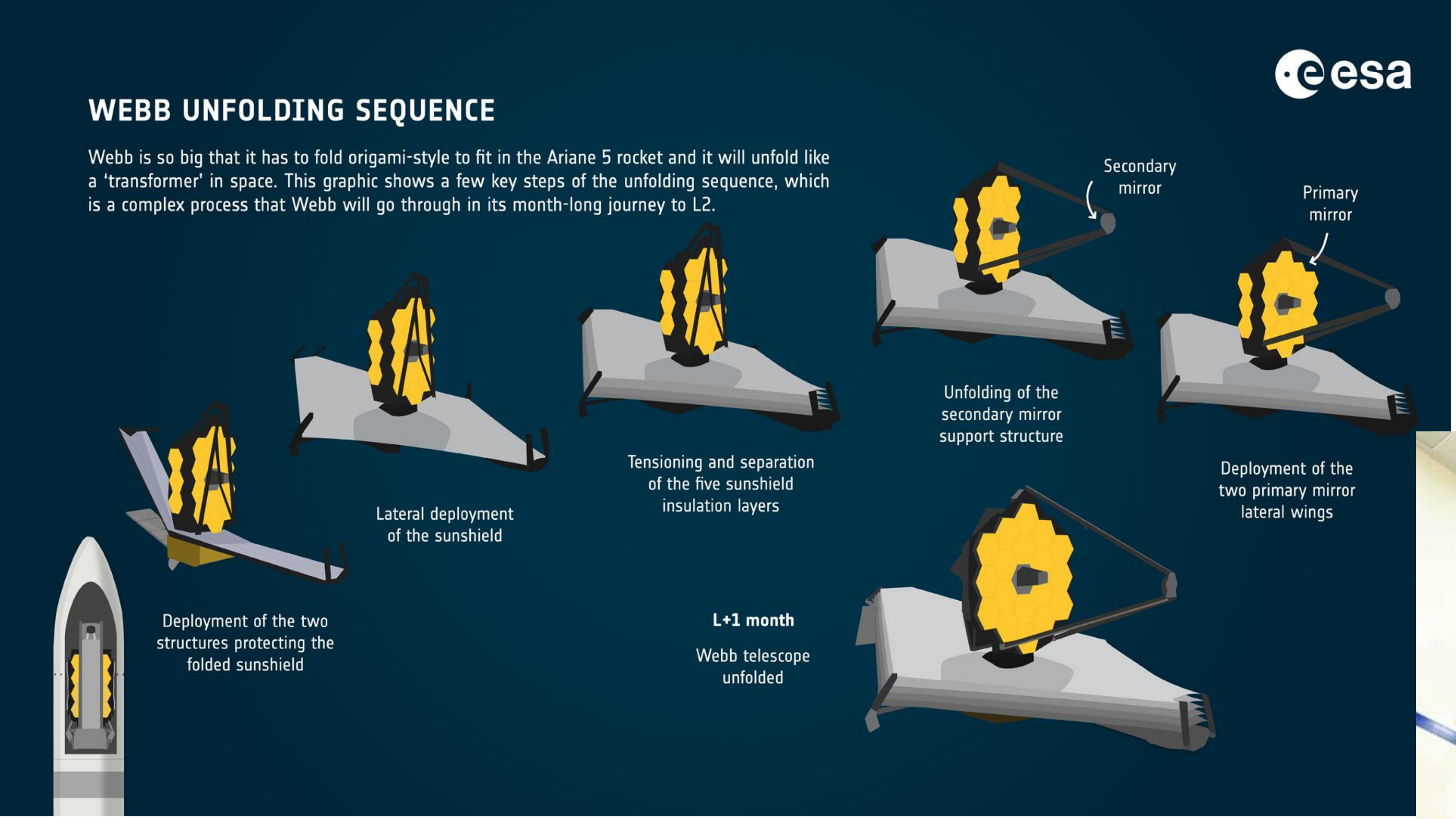
Original solar panels



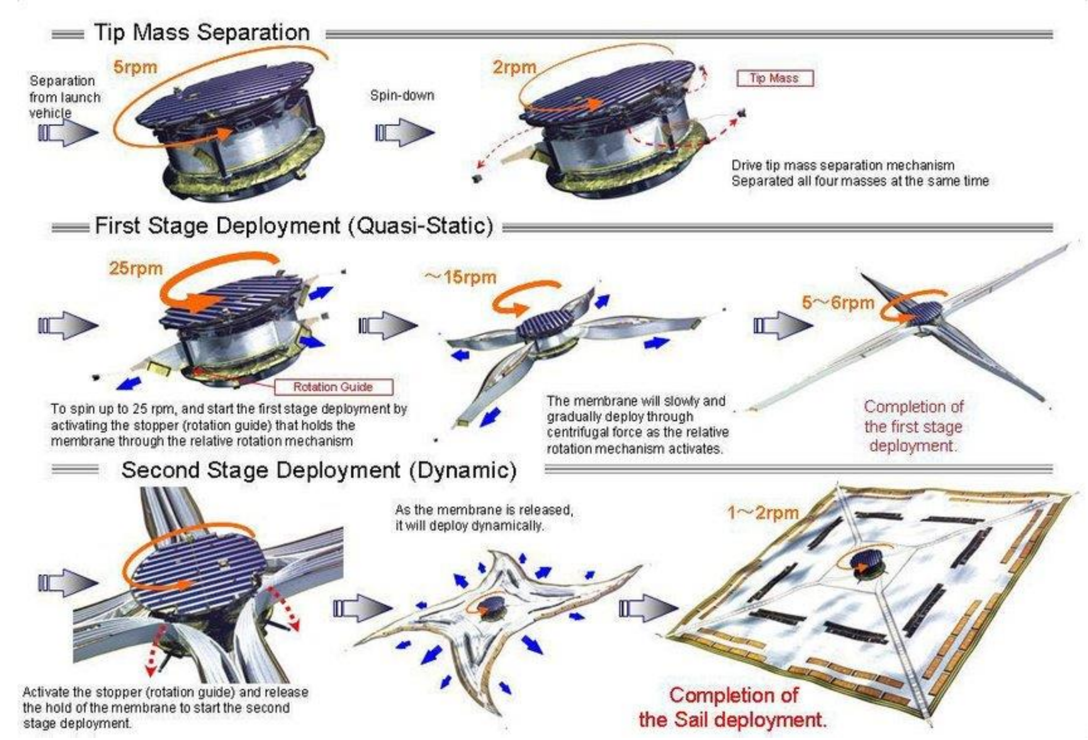


This is kind of like wrapping a soda straw around your finger. As you wrap it around your finger, it flattens out and you are storing energy in the straw. When you release your hold on the straw, it unwinds from your finger as the plastic returns to its round shape.

James Webb Space Telescope



The James Webb Telescope was folded up for launch and had to unfold once in orbit. The bottom gray portion in the picture above are insulation blankets that prevents the telescope from getting warmed by the sun. The main mirror is composed of 18 smaller mirrors that had to be folded into position and then be focused. Each of the 18 mirrors is coated with a very thin layer of gold that needed to remain dirt and scratch free.

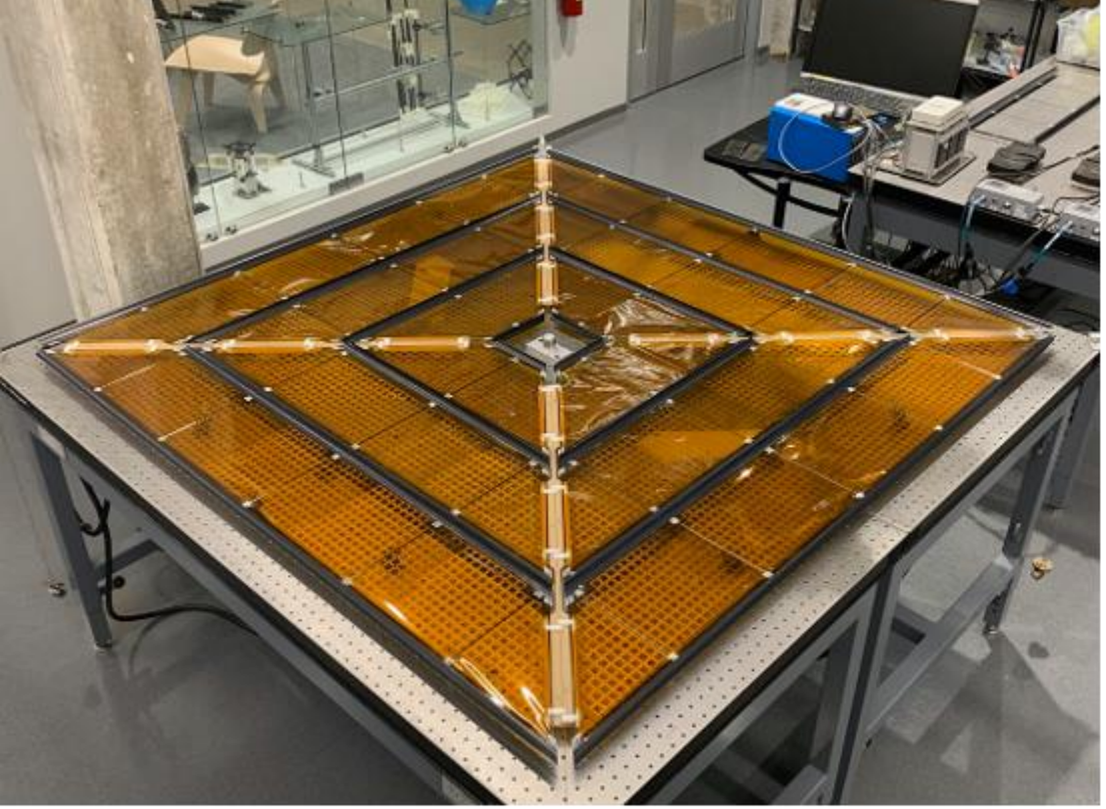


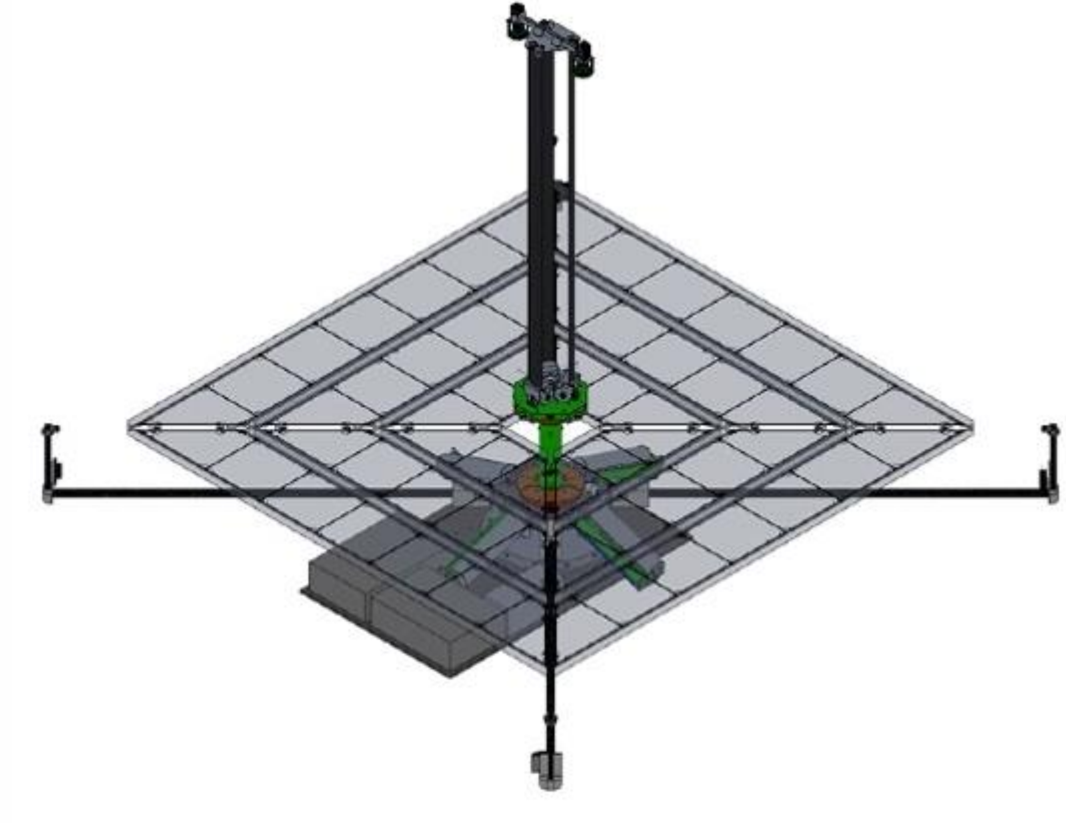
Bill Nye

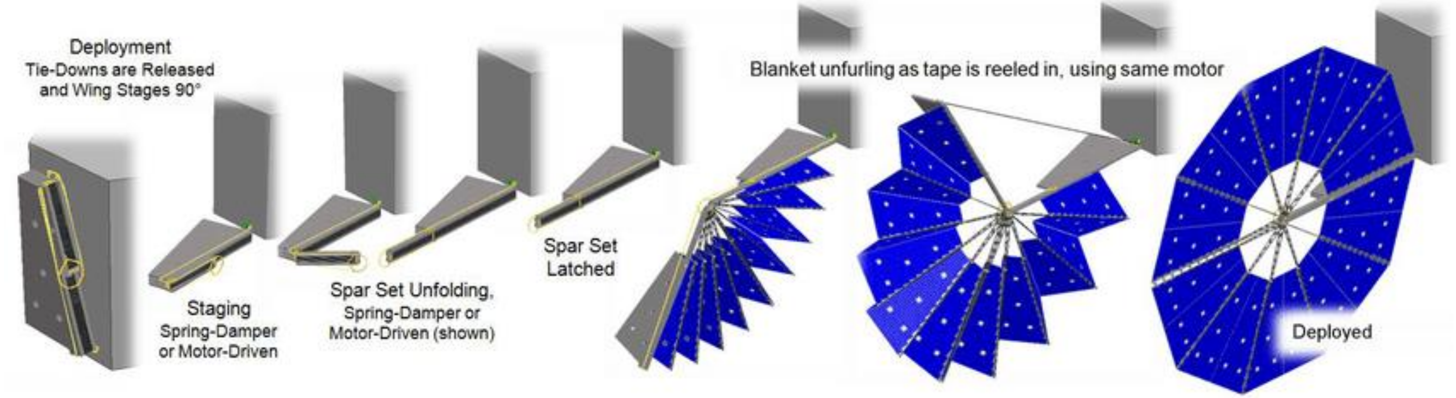
https://www.youtube.com/watch?v=-ZDSvnzpRNI

https://www.youtube.com/watch?v=K7UBWz2mvro

https://www.planetary.org/video/raw-video-lightsail-sail-deployment






Deployment
Tie-Downs are Released
and Wing Stages 90°
Staging
Spring-Damper
or Motor-Driven
Spar Set Unfolding,
Spring-Damper or
Motor-Driven (shown)
Spar Set
Latched
Blanket unfurling as tape is reeled in, using same motor
Deployed

- https://www.nasa.gov/centers-and-facilities/langley/deployable-composite-booms-dcb/
- https://ntrs.nasa.gov/api/citations/20170003919/downloads/20170003919.pdf

- https://mmadesignllc.com/products/deployables/

- ISS solar panels deploying.
- https://www.quora.com/How-did-the-ISS-solar-panels-get-to-space-without-breaking-All-the-shaking-from-launch-would-have-broken-them-right