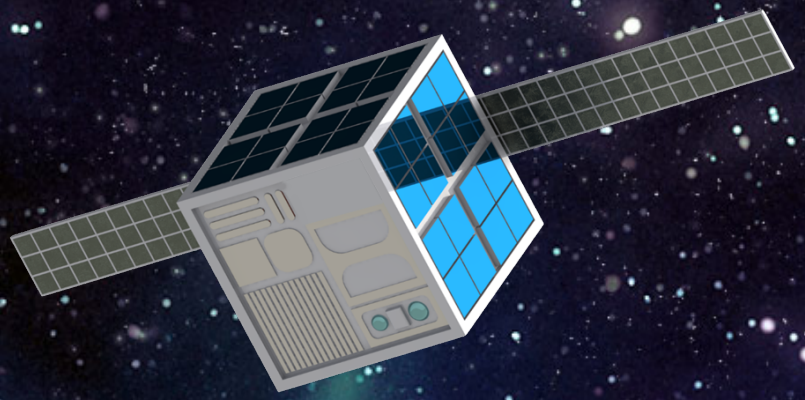


STEM Paper CubeSat Templates

Paper Prototype Build
Operational Control Planning Template
www.cubesatscrum.com

The CubeSat Challenge

http://cubesatscrum.com/

http://cubesatscrum.com/

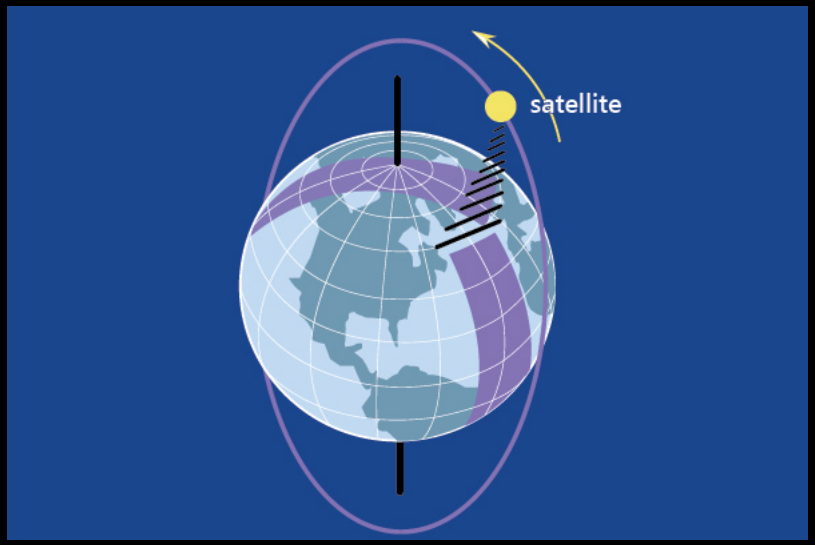
IceCap CubeSat Mission Objective

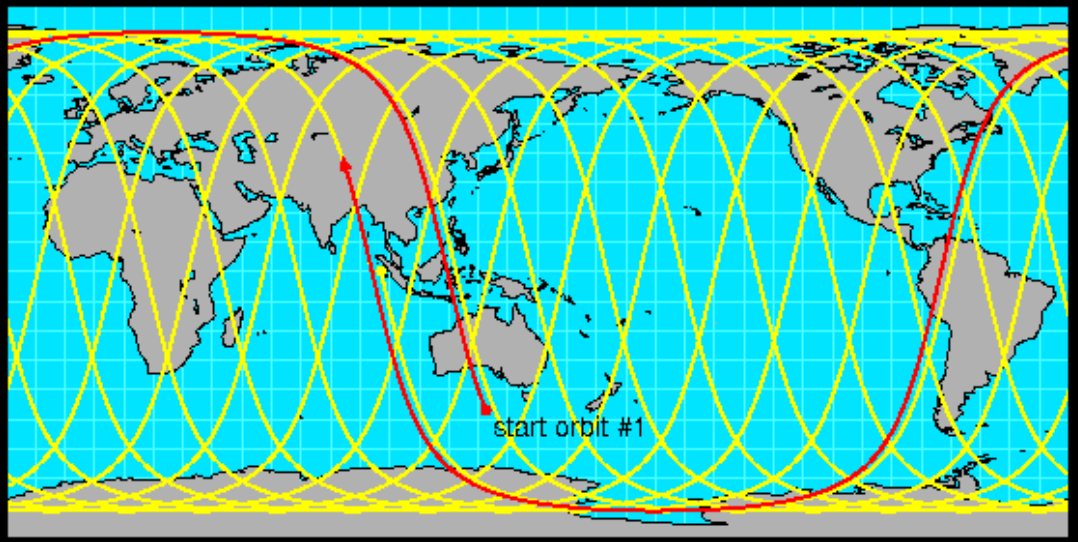
- Satellite used for measuring ice melt and solar reflection has been re tasked.
- There is a urgent need to fill this gap in coverage in support of the United Nations work on global warming.
- The IceCap CubeSat mission will fill this need with a polar orbit optical imaging and solar sensors.
- The mission must launch within 4 months to meet the desired window of coverage.

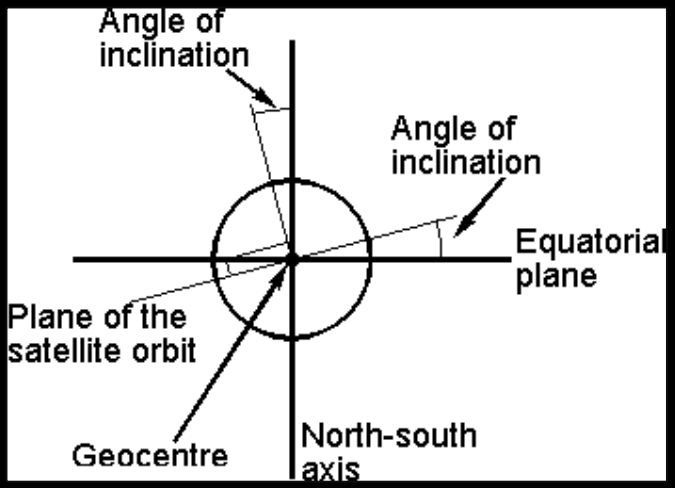
Low Earth Orbit (LEO)
Altitude: 200-2000 km
Satellites travel faster than Earth

Geo Synchronous Orbit (GEO)
Altitude: 35,786km
Satellite speed same as Earth – 24hrs

LOE Polar Orbit
90 Min Passes







Vision – *for your mission*

For the *NASA Science Mission Directorate*
Who *Needs to urgently understand sea water / polar ice interaction*
The *Ice Cap CubeSat*
Is a *Rapidly-Deployed Satellite*
That *observes polar reflection and sea-ice melt*
Unlike *the design and launch windows of traditional Satellites*
Our mission *meets tight launch windows, unlike long-lead, conventionally-built satellites.*

IN SCOPE (1) Mission objectives set forth in the agile cubesat workshop
(2) From directions / deck page 7

OUT OF SCOPE All mission objectives not approved – *consult P.O. for updates*

SUCCESS CRITERIA:

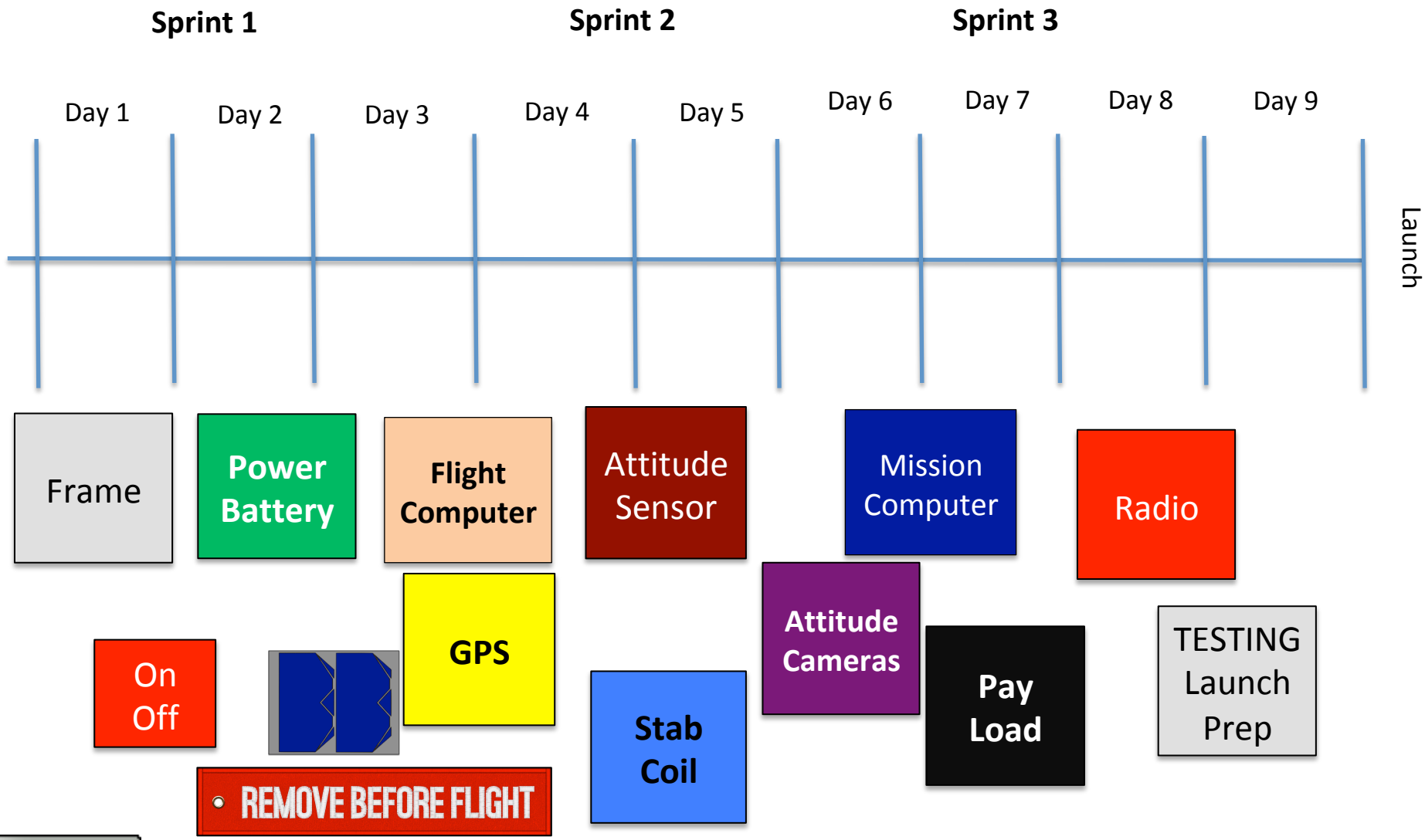
(1) Deliver the **Minimum Viable Product*** of mission objectives
(2) under cost and schedule.

HOME RUN "STRETCH" CRITERIA:

(3) Leave room for optional, additional high-priority objectives.

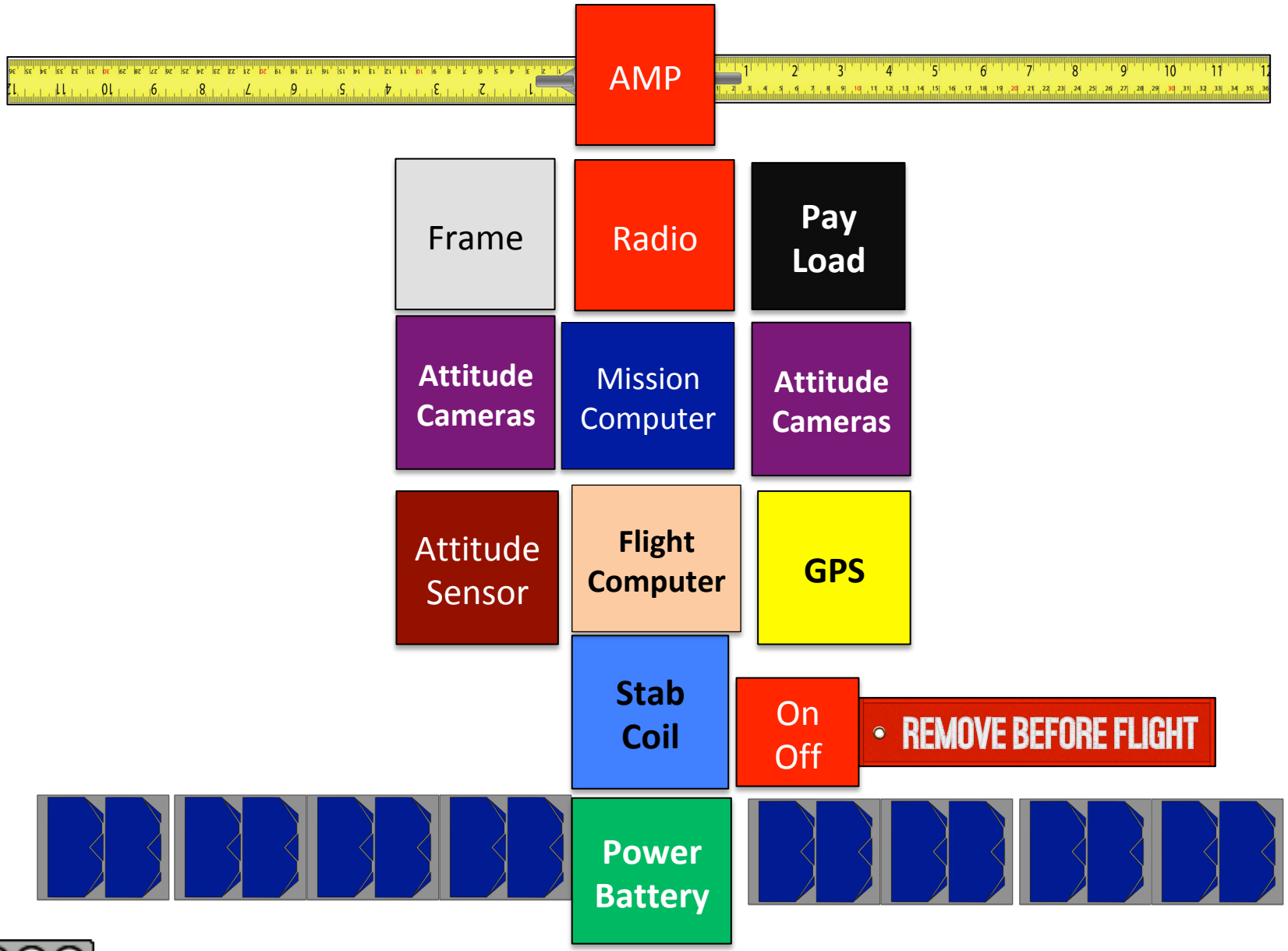
CONSTRAINT: **Need to build in <3 months for a launch in 4 months**

Mission Roadmap



http://cubesatscrum.com/

Systems Interface Diagram



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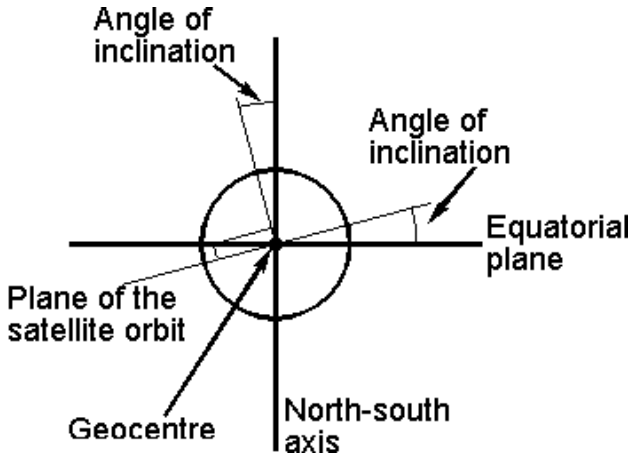
Select Your Launch Option

Vehicle	Orbit	Launch Date	Size Available	Cost
Delta II	High Polar Elliptical North South Axis 5 Deg	3 Months	1 U	$50,000
Atlas 5	Retrograde Equatorial Axis 10 Deg	3 Months	1 U	$40,000
SOAR	Polar North South Axis 7 Deg	1 Month	2 U	$75,000
Delta II	Polar North South Axis 7 Deg	1 Month	3 U	$110,000
Minotaur 1	Posigrade Equatorial Axis 10 Deg	5 Months	1 U	$30,000
Delta IV	Polar North South Axis 5 Deg	6 Months	1 U	$40,000
Lynx Mark III	Polar North South Axis 0 Deg	3 Months	2 U	$60,000
Pegasus XL	Polar North South Axis 15 Deg	1 Year	3 U	$100,000
Falcon 9	Retrograde Equatorial Axis 10 Deg	5 Months	1 U	$40,000
Delta IV	Polar North South Axis 7 Deg	4 Months	1 U	$35,000
Delta II	Posigrade Equatorial Axis 45Deg	2 Months	2 U	$50,000
Go Launcher 2	Polar North South Axis 5 Deg	5 Months	3 U	$90,000
Super Strypi	Retrograde Equatorial Axis 10 Deg	6 Months	1 U	$50,000
Pegasus XL	Polar North South Axis 0 Deg	3 Months	1 U	$25,000
Minotaur 1	Polar North South Axis 7 Deg	1 Year	2 U	$10,000
Delta IV	Retrograde Equatorial Axis 10 Deg	5 Months	3 U	$80,000
Pegasus XL	Posigrade Equatorial Axis 45Deg	4 Months	1 U	$45,000
Delta IV	Polar North South Axis 7 Deg	2 Months	1 U	$60,000
Delta II	Retrograde Equatorial Axis 10 Deg	1 Year	2 U	$75,000
as 5	Polar North South Axis 4 Deg	4 Months	2 U	$50,000

Orbital Path Map

Sketch your selected Orbital based on launch option here.



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Deliverables

Deliverable	Description / Additional Information
Mission Overview / Team Name	IceCap - CubeSat
Mission Success Criteria	
Systems Interface Diagram	
CubeSat Mockup	
Launch Vehicle Selection	
Time Line of Mission	
Power Management Matrix	
Mission Patch (Optional)	

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Mission Control Pre Launch Checklist

Component	Power Required	Cost Estimate	Weight
Frame / Structure			
Communication			
Antenna / Active or Passive			
Power /Generation /Storage			
Solar Array			
Attitude Determination			
Attitude Control			
Propulsion			
Computer			
Payload			
Remove Before Flight			

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Orbital Mission Power Management

	DAY					Night				
	10	20	30	40	50	60	70	80	90	100
CPU										
Stabilization										
Communication										
Payload										
Attitude										
Solar Cells										
Flight Comp										
Battery										

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In Orbit “House Keeping”

Component	Status	Notes
Spacecraft Clock		
Spacecraft position		
Attitude		
Temperature		
Voltage per instrument		
Power levels Battery reserve		
Solar charging cycle		
Data fill rates		
Last uplink		
Buffer capacity		
Smart instrument status Telemetry		

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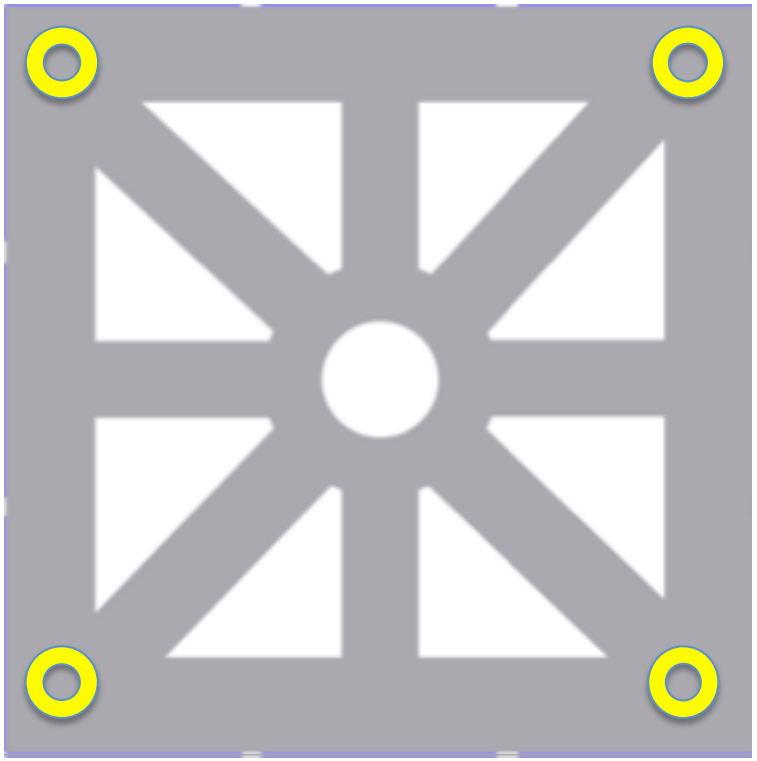

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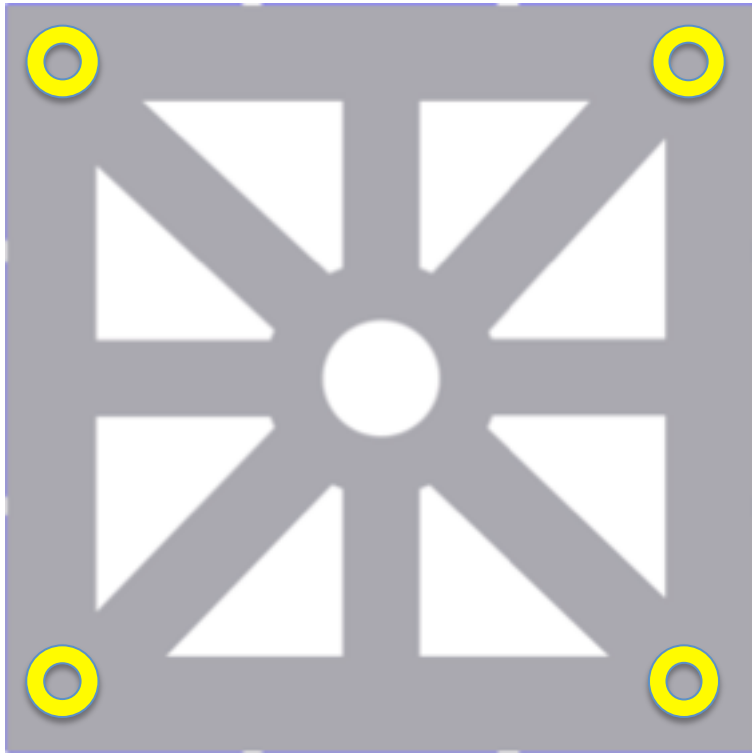

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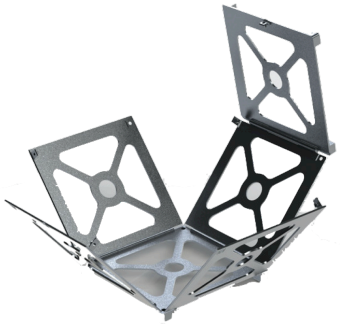
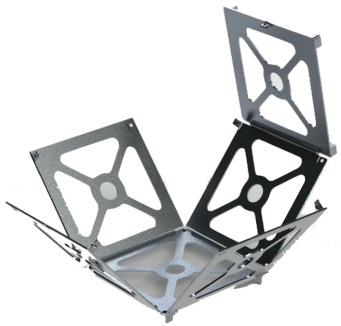


Frame

Weighbt25 Grams Each Side
Used with Other Frame Sides
Power Consumption None

Side

Side

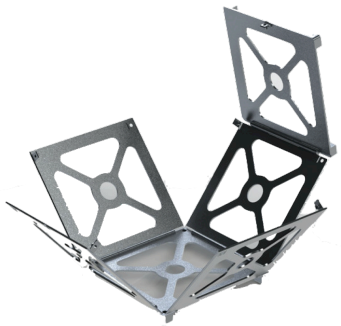


Frame

Weighbt25 Grams Each Side
Used with Other Frame Sides
Power Consumption None

Side

Side



Frame

Weighbt25 Grams Each Side
Used with Other Frame Sides
Power Consumption None

Bottom

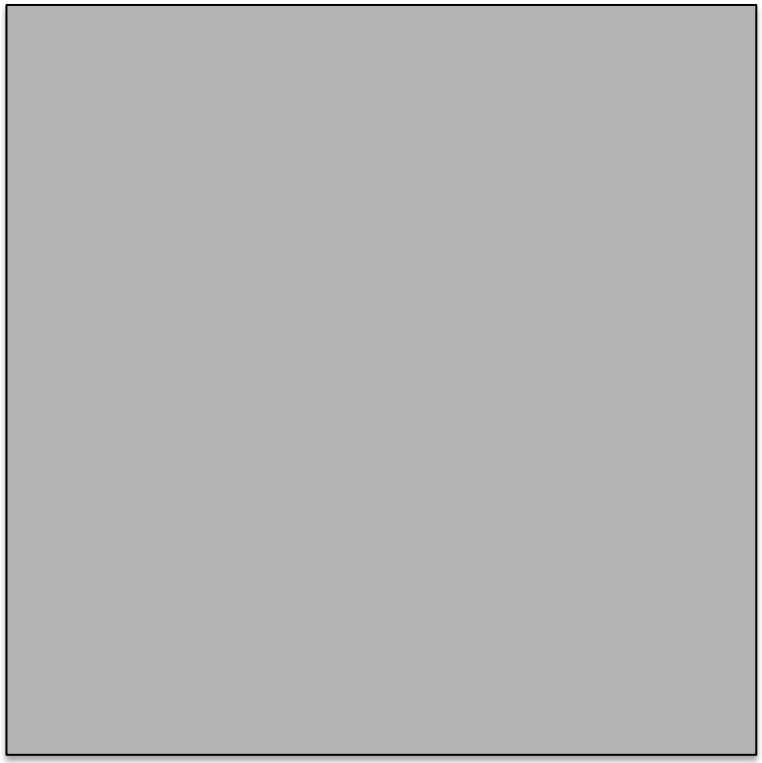
Side

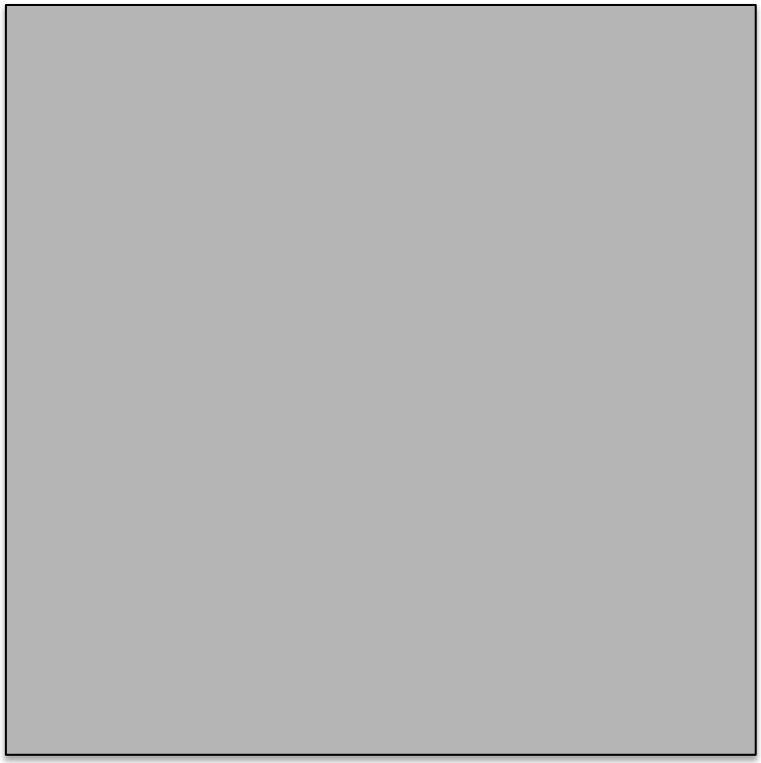
Ion Engine Frame

Weight 25 Grams
Used with Other Frame Sides
Power Consumption None

Camera Frame

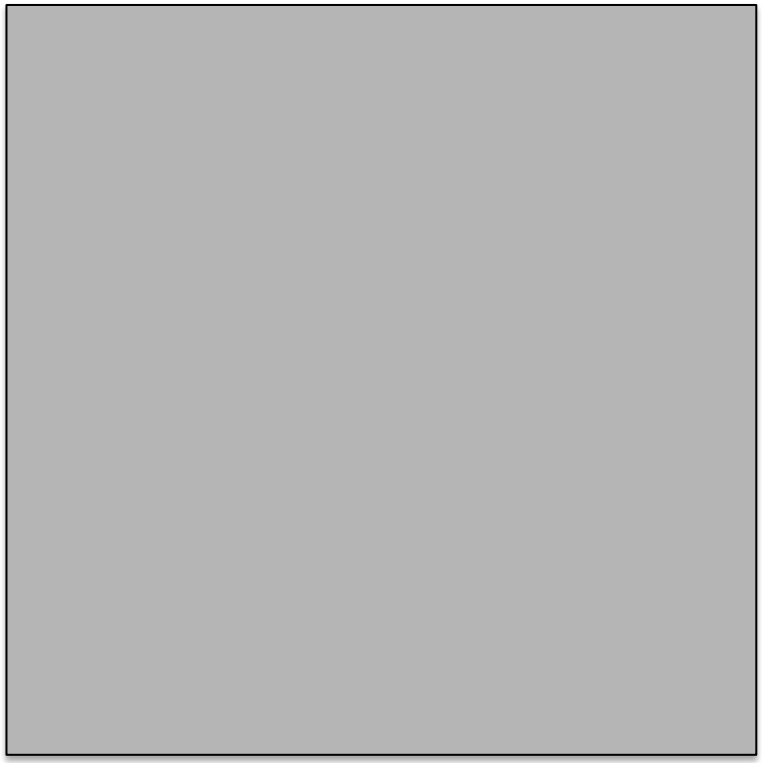
Weight 25 Grams
Used with Other Frame Sides
Power Consumption None

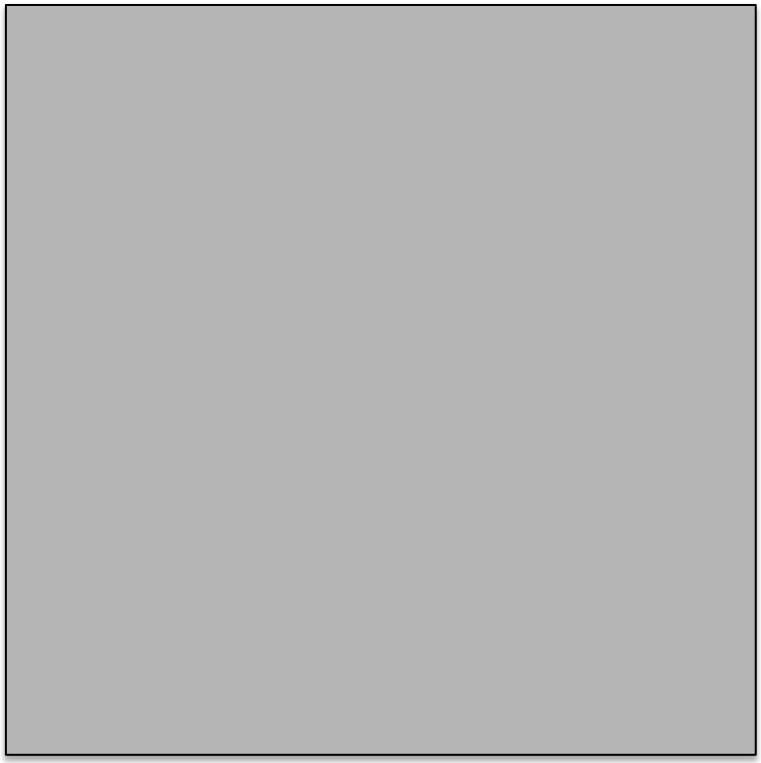




Frame Cover

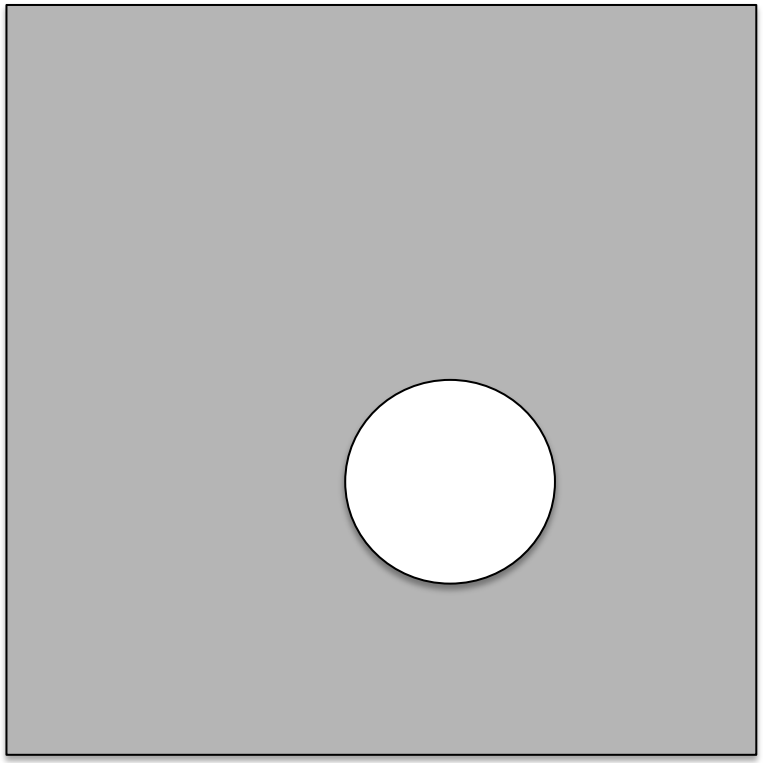
Weight 10 Grams
Used with Other Frame Sides
Power Consumption None



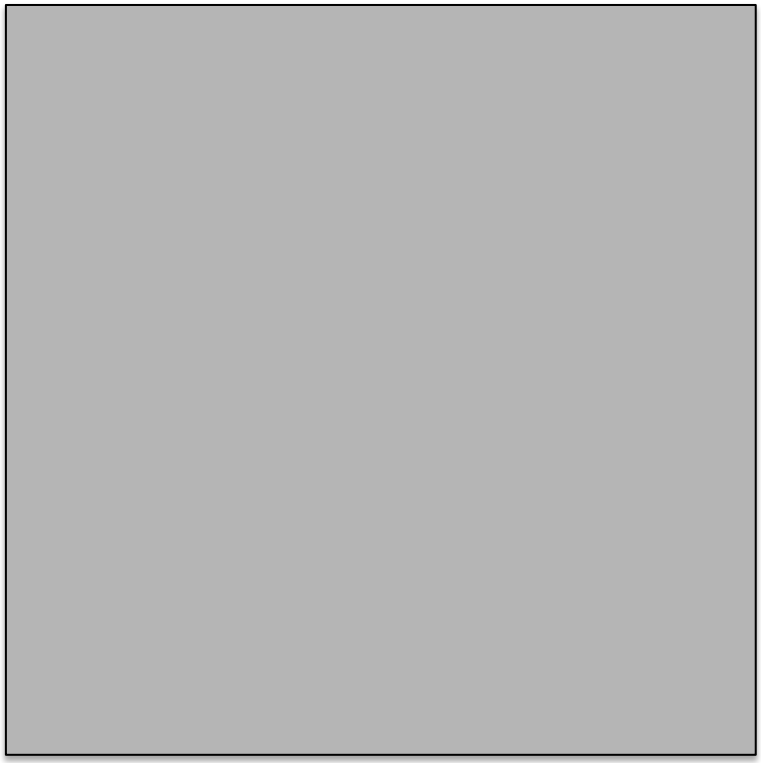


Frame Cover

Weight 10 Grams
Used with Other Frame Sides
Power Consumption None



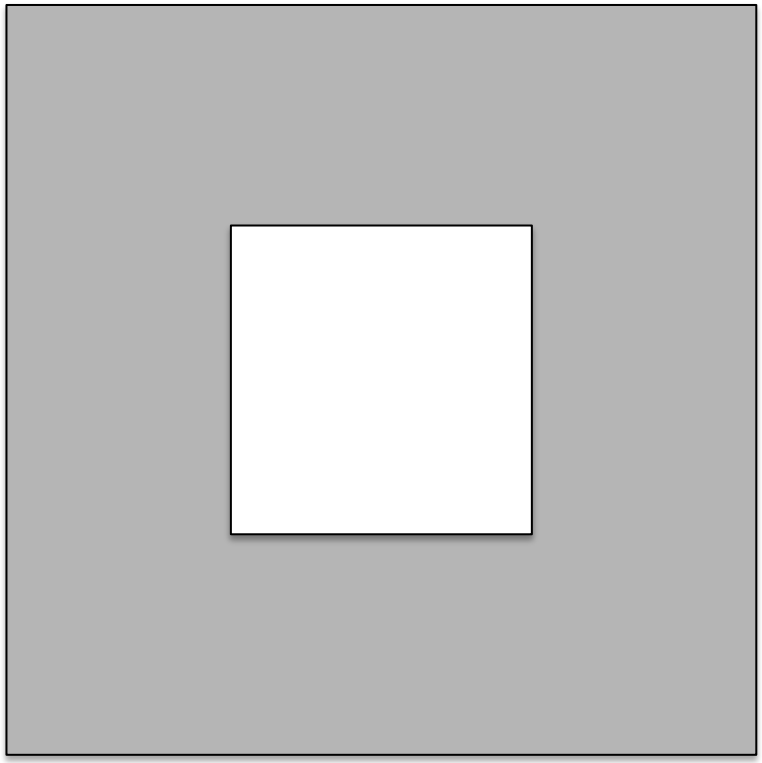
Camera Side



Side

Camera Frame Cover

Weight 10 Grams
Used with Other Frame Sides
Power Consumption None



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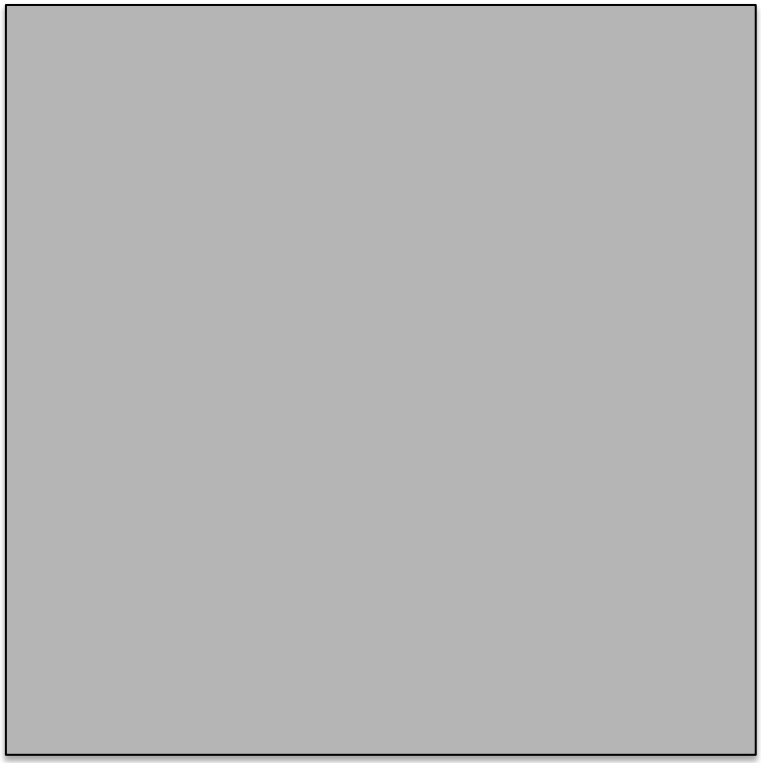
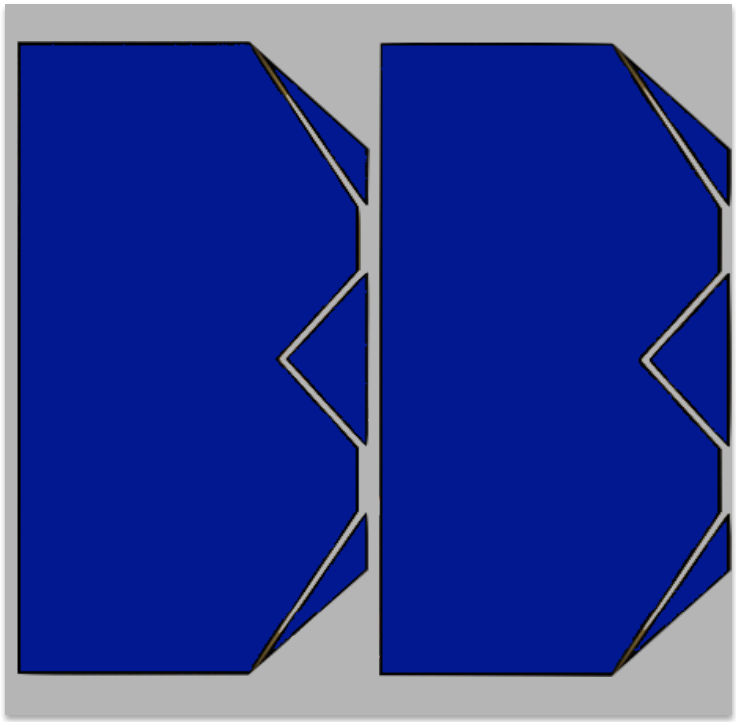
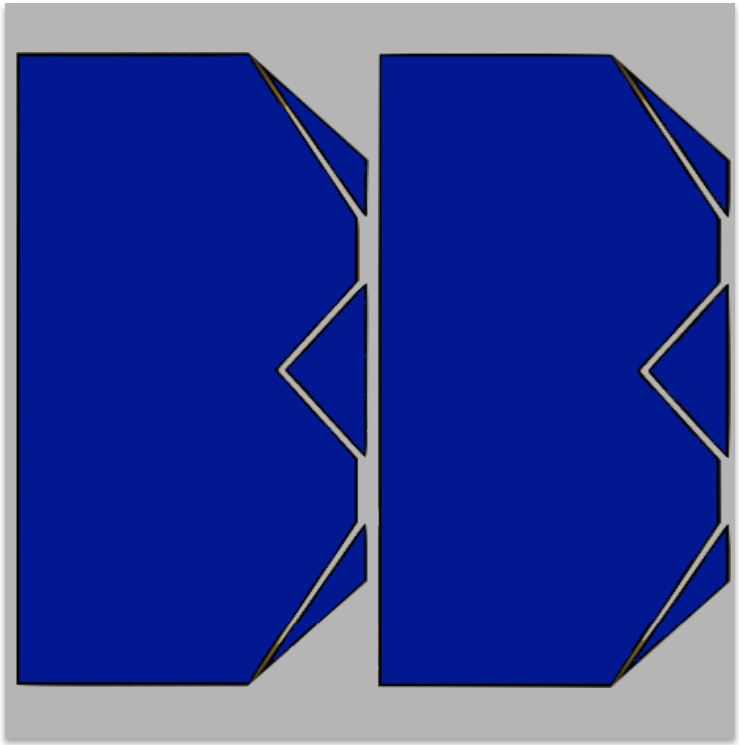


Side

Frame Cover

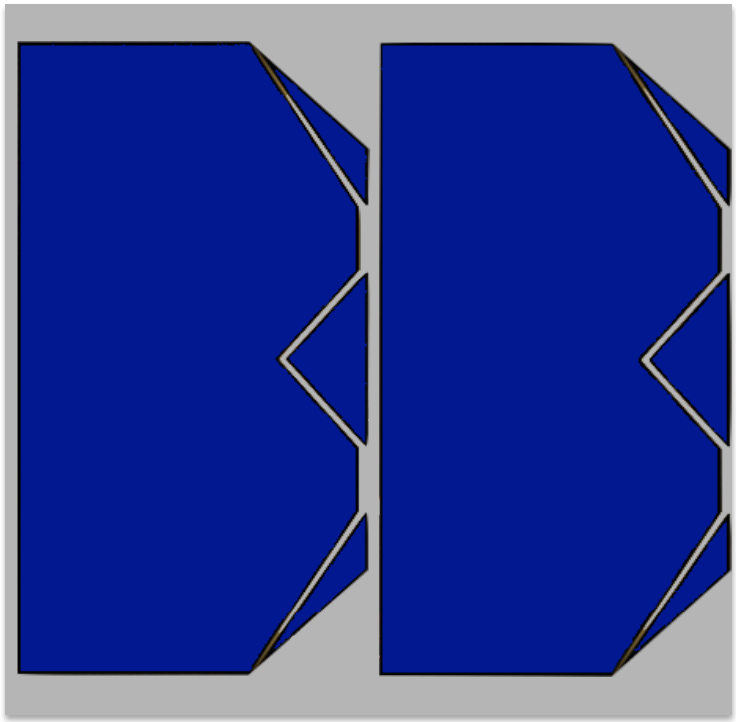
Weight 10 Grams
Used with Other Frame Sides
Power Consumption None

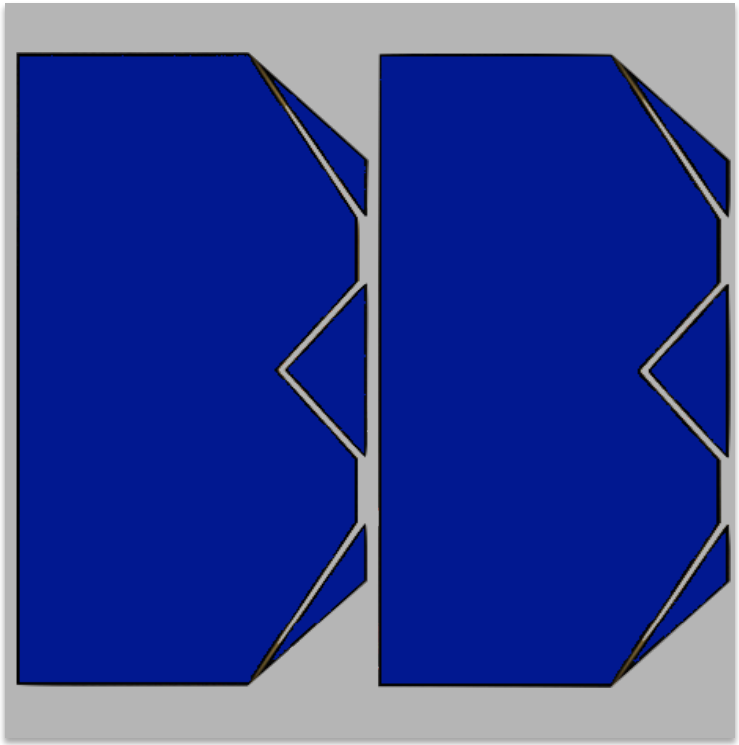




Solar Cells

Weight 25 Grams Each
Makes 2 Power





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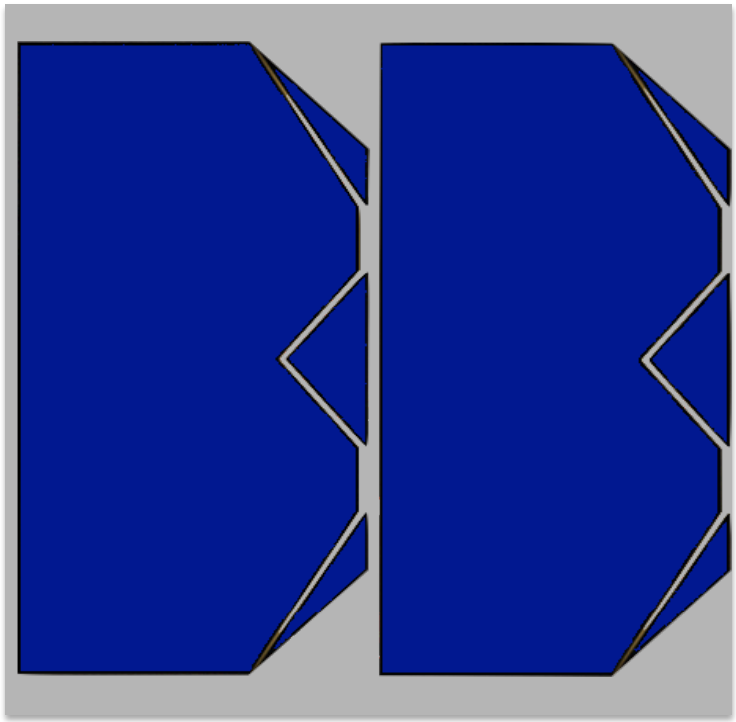

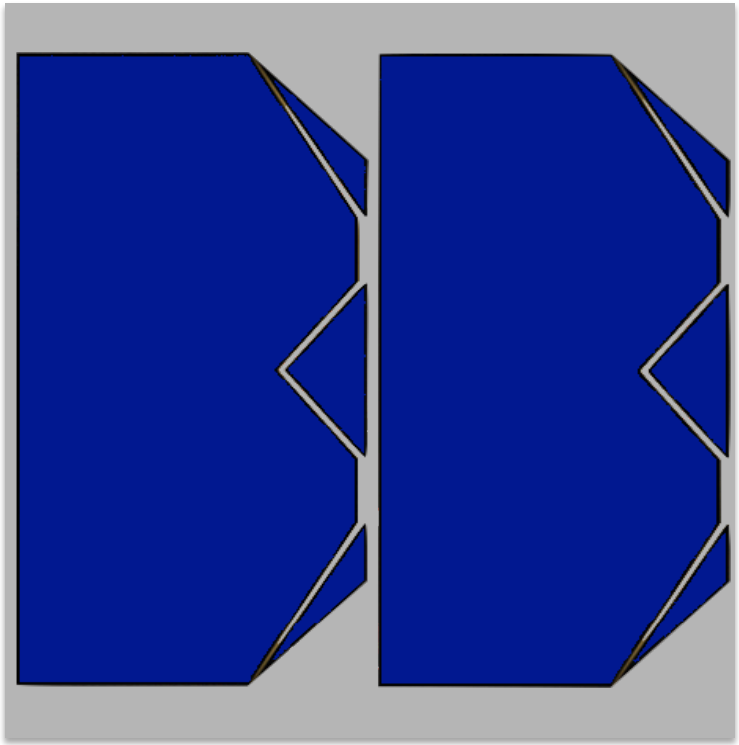

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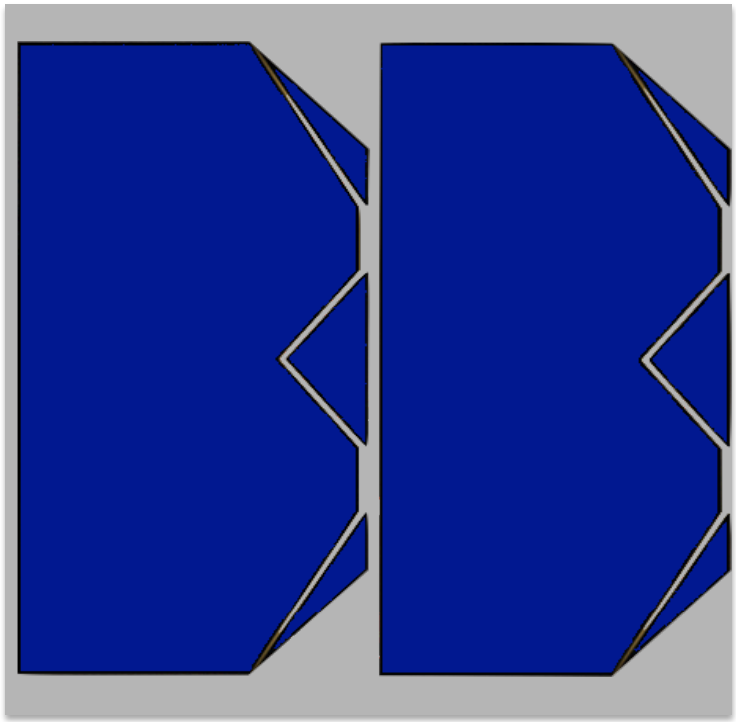

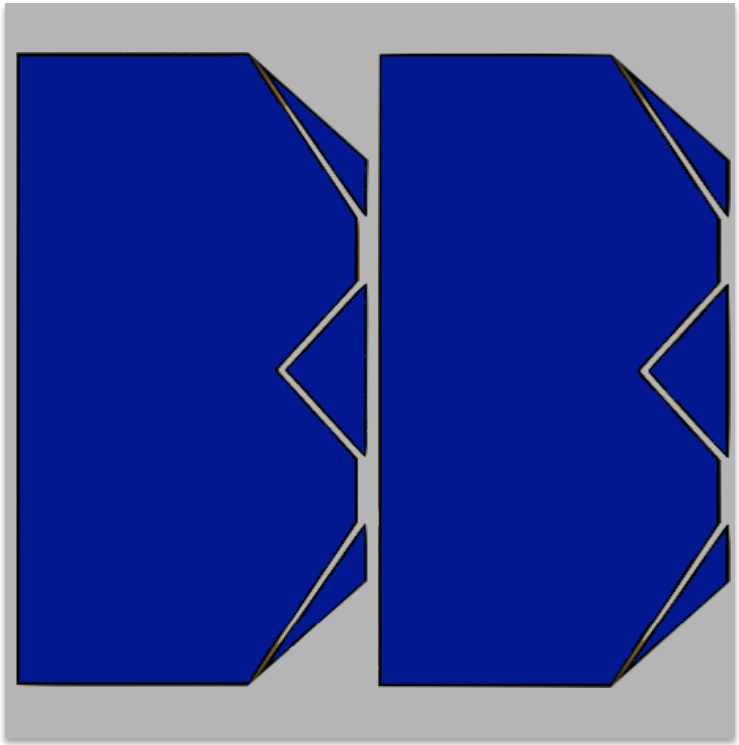

Solar Cells

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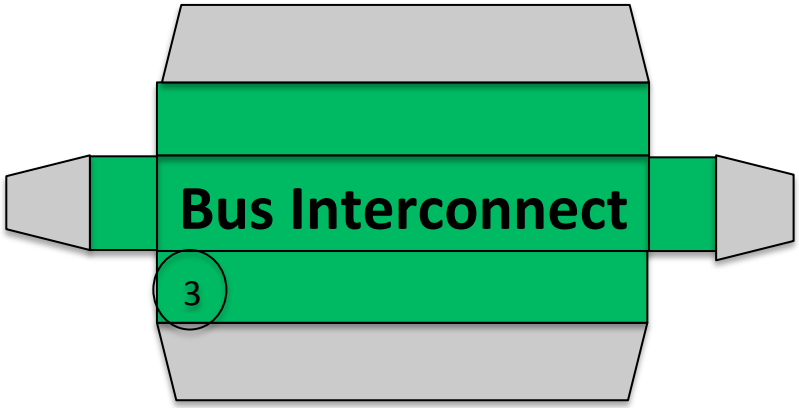
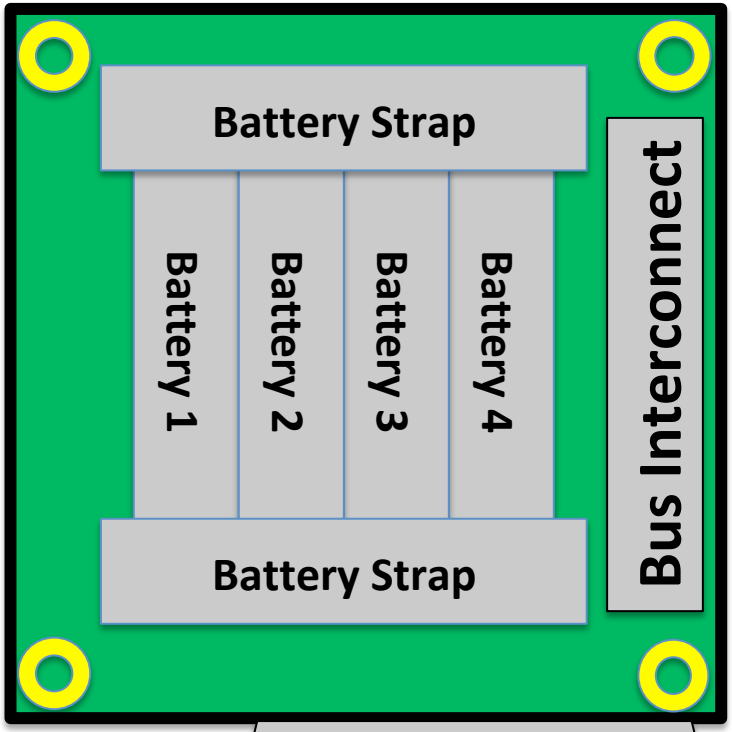
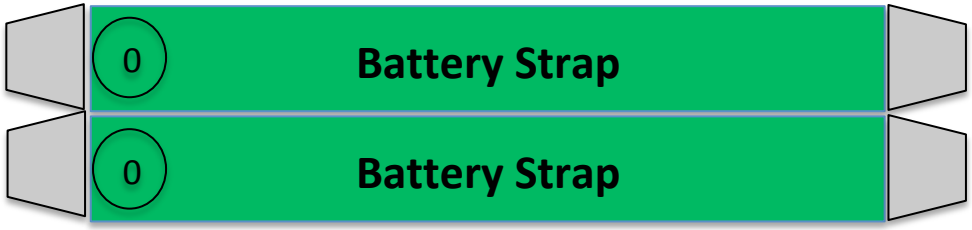
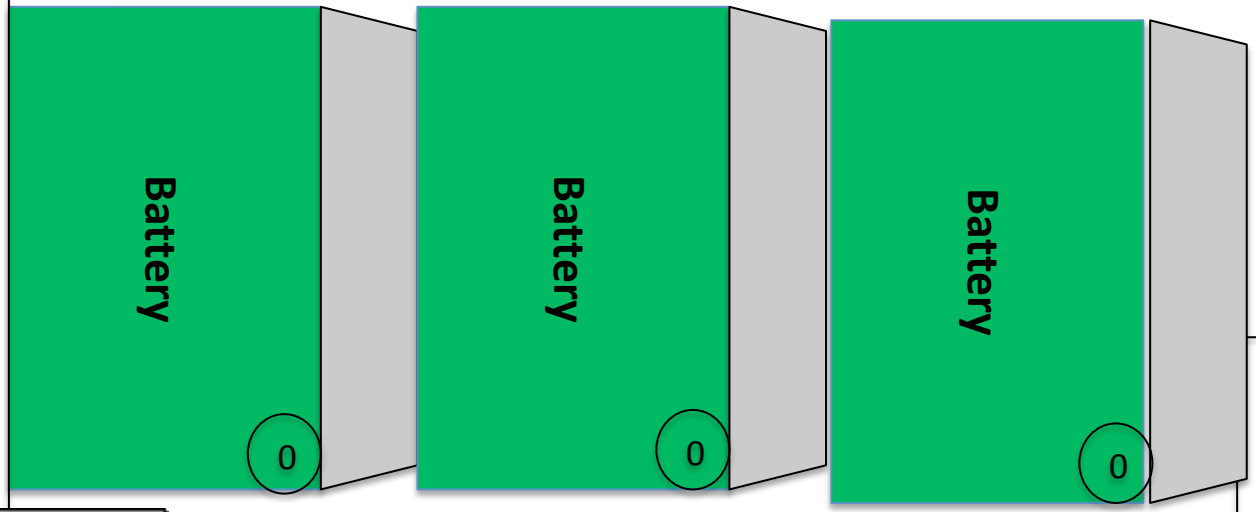
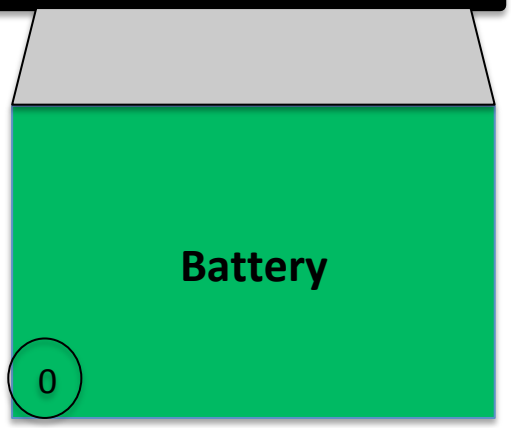






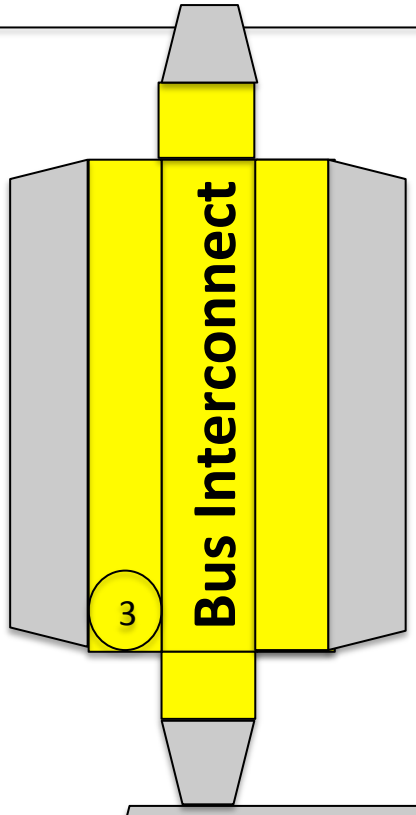


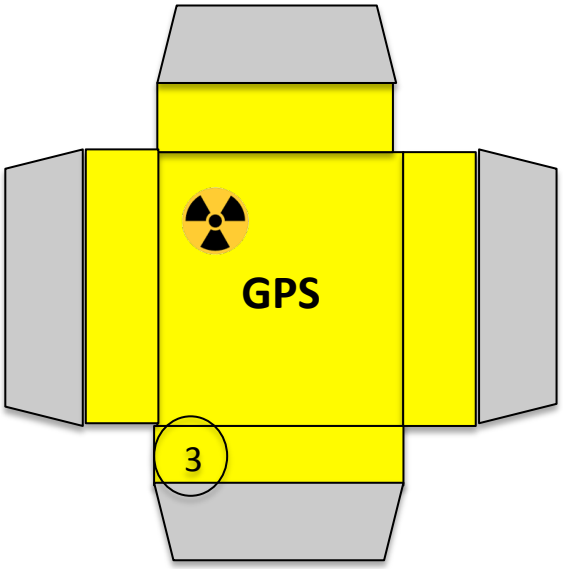


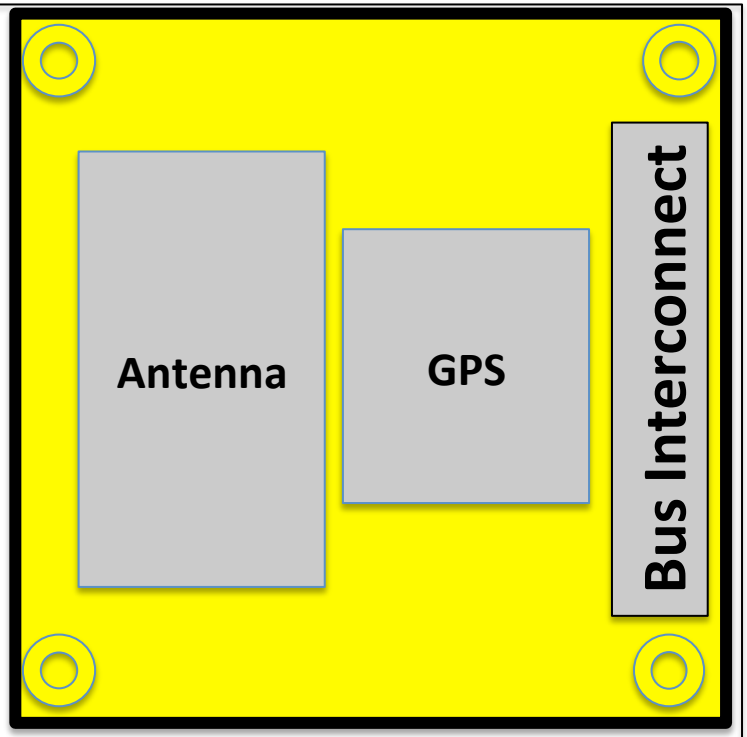
Power Supply / Storage

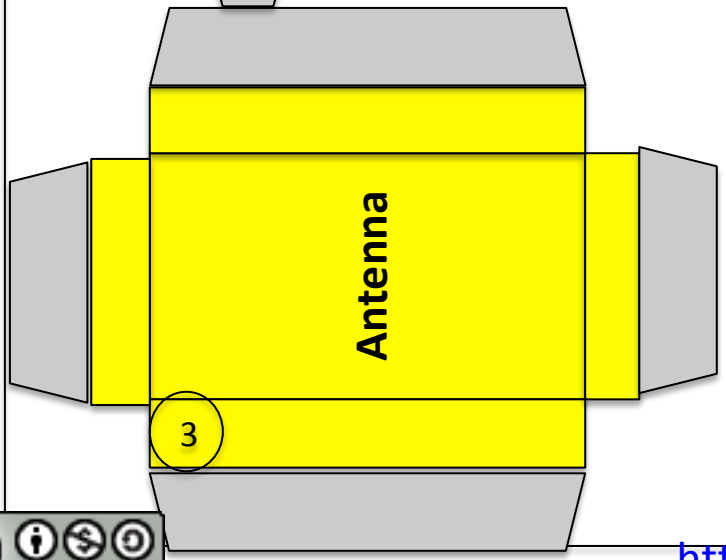
Weight 300 Grams
1 Power / Can supply 10 and store 50

GPS



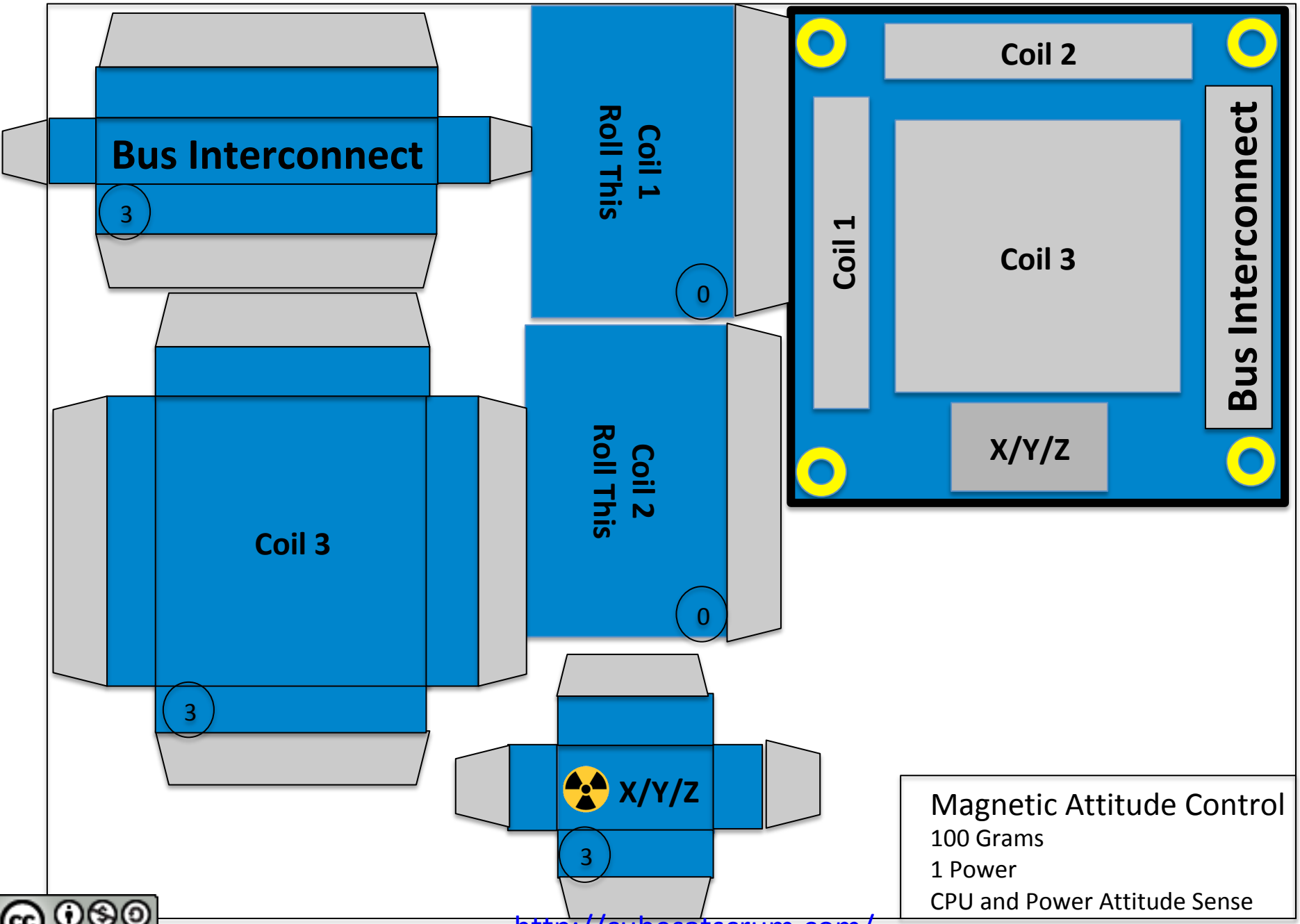




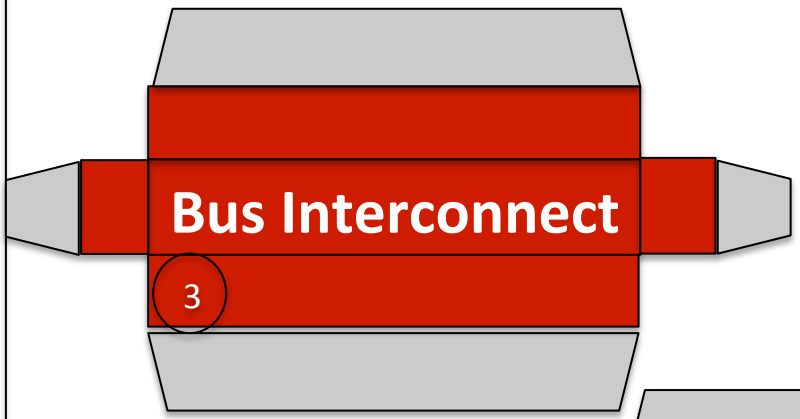


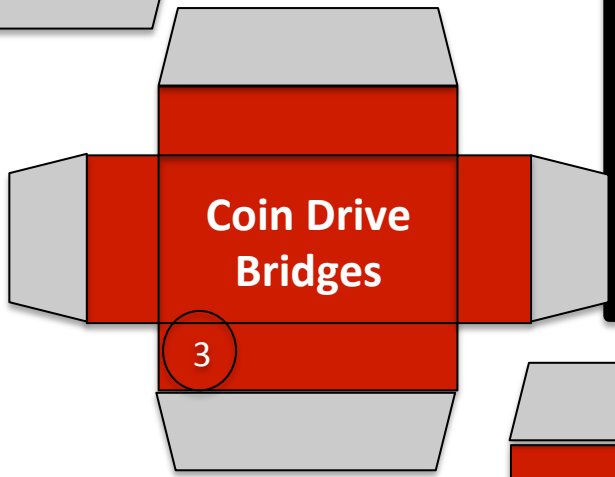
GPS Antenna / Positioning

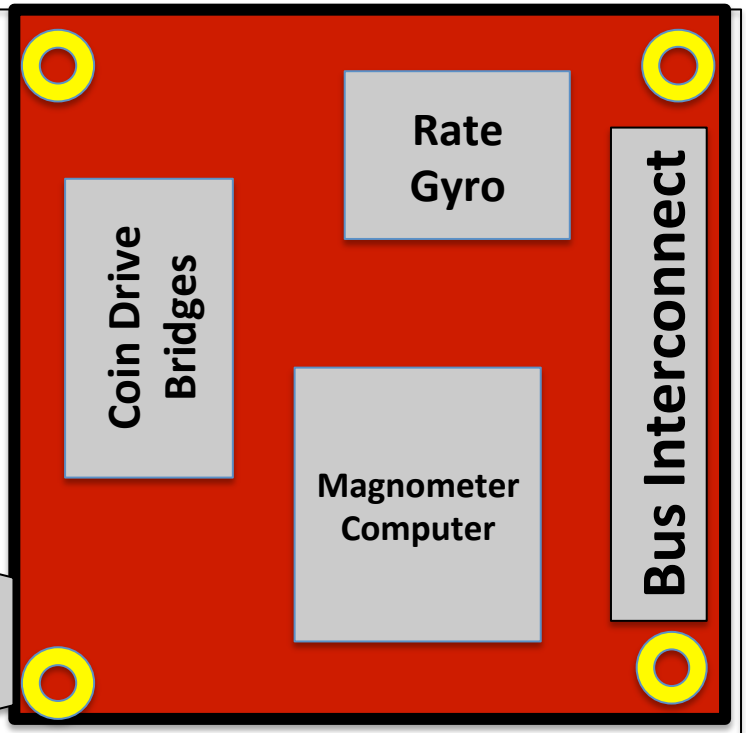
100 grams
1 Power
CPU Attitude determination star sensor

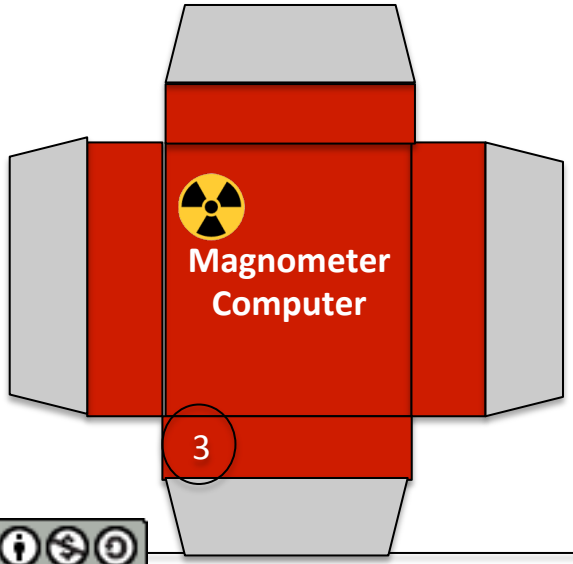


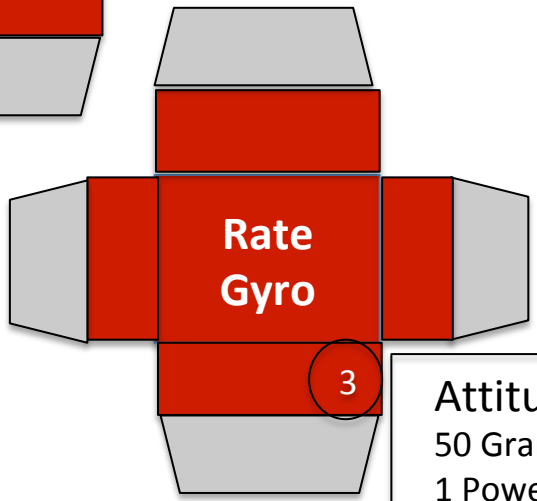
Magnetic Attitude Control
100 Grams
1 Power
CPU and Power Attitude Sense





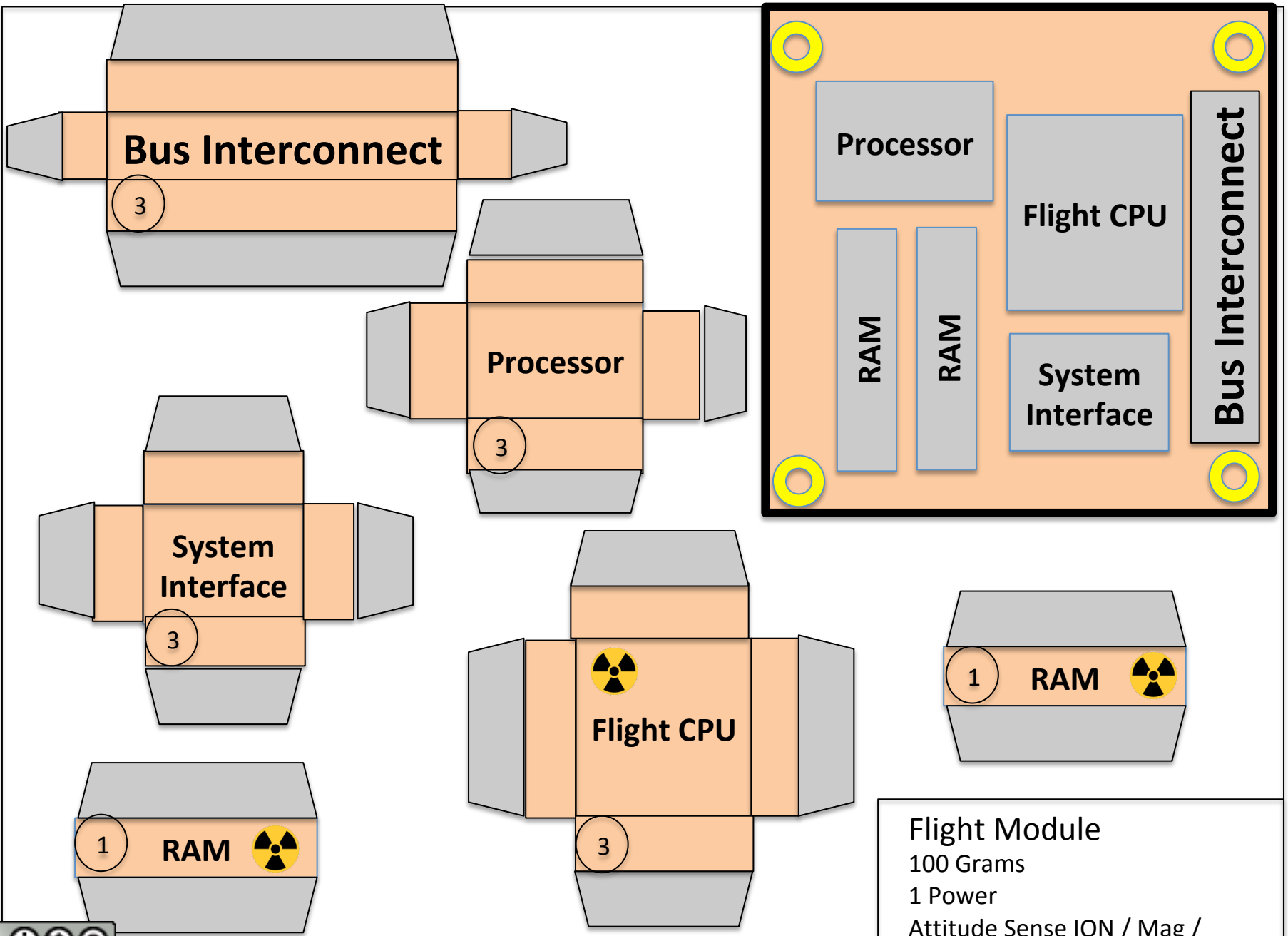






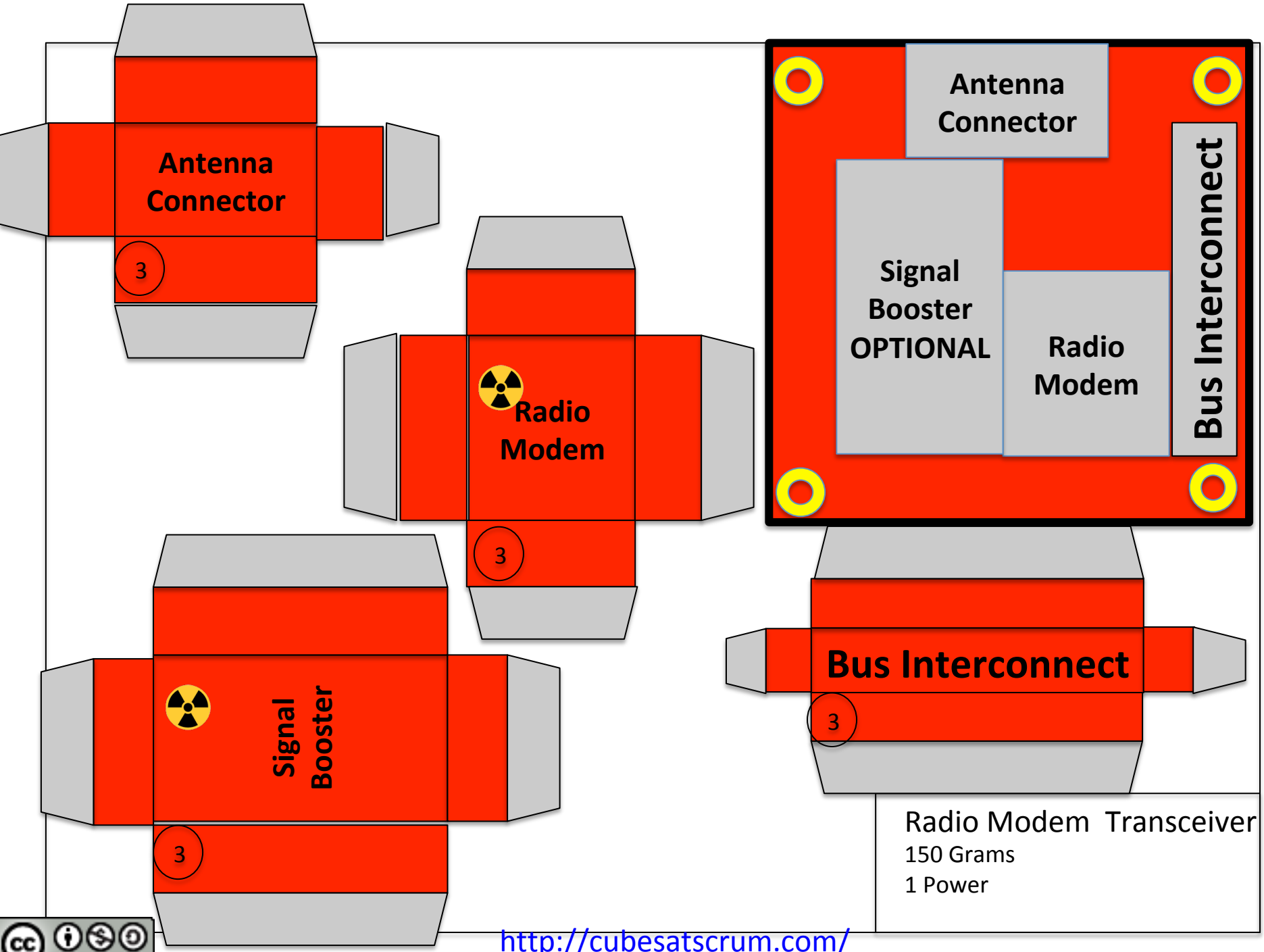
Attitude Determination
50 Grams
1 Power
CPU and Power Attitude Sense

http://cubesatscrum.com/



Flight Module
100 Grams
1 Power
Attitude Sense ION / Mag / Wheels

http://cubesatscrum.com/



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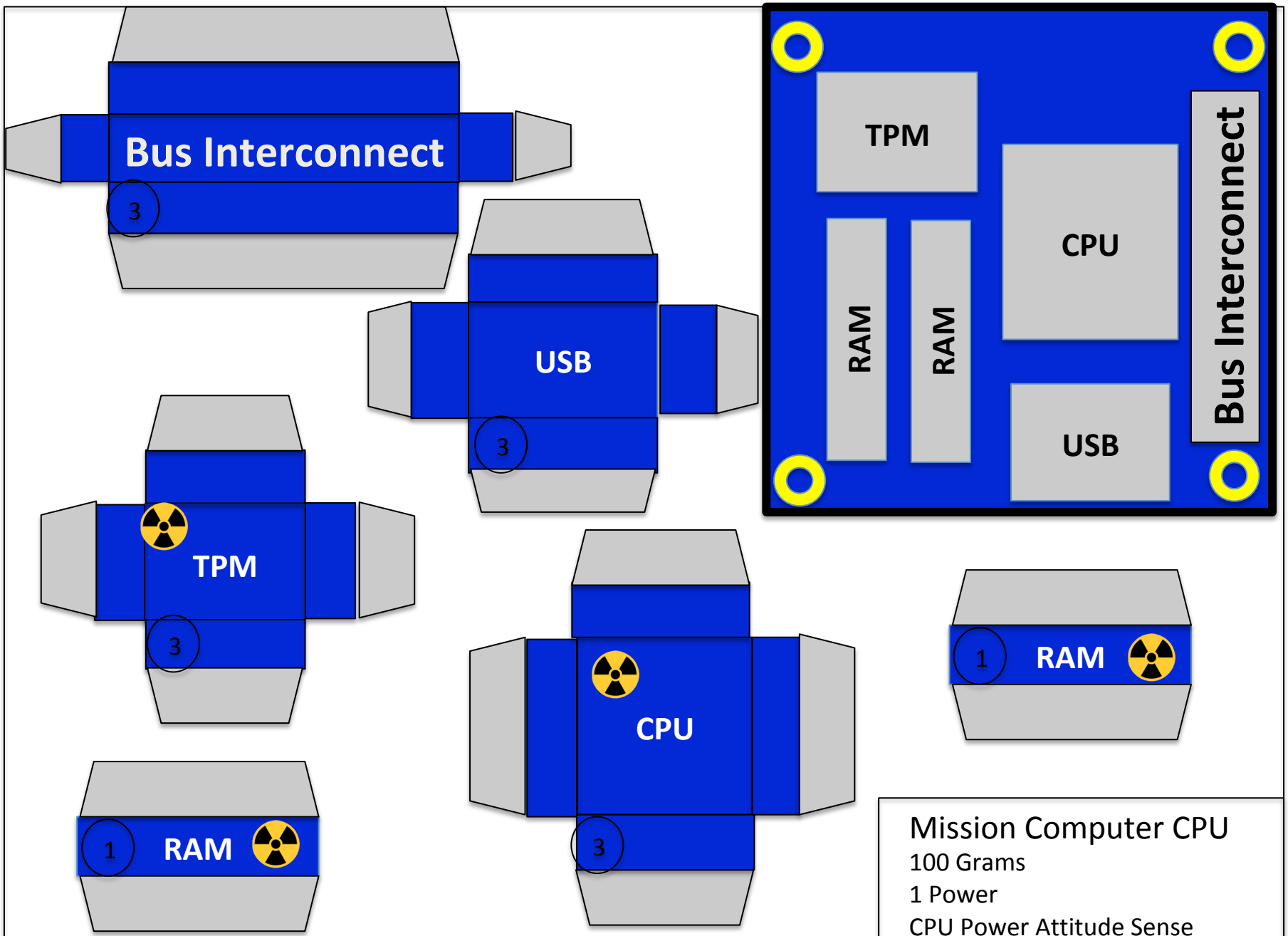

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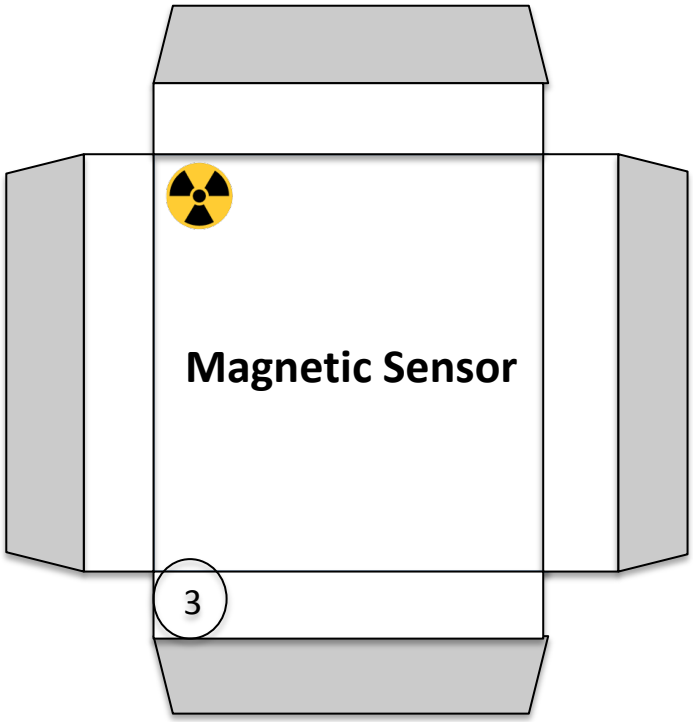
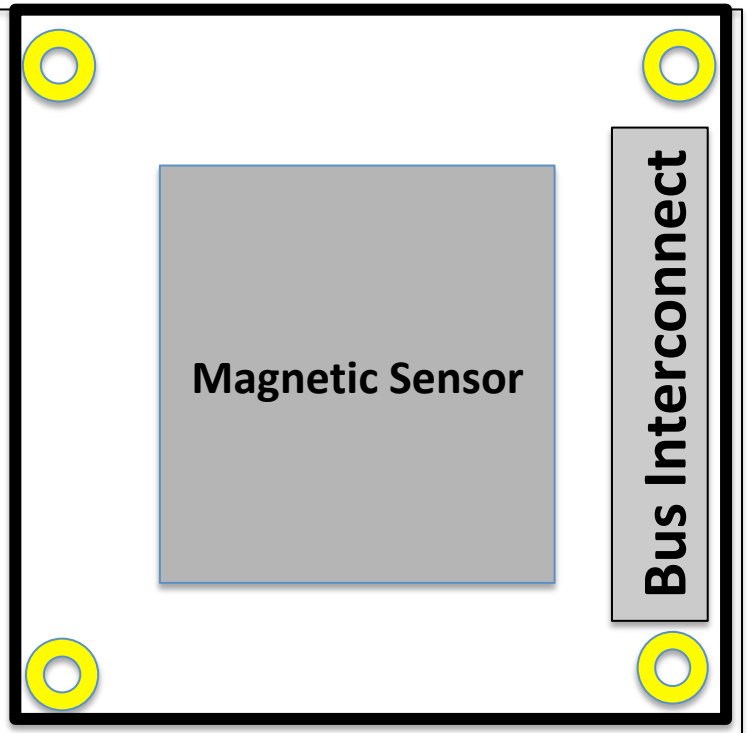
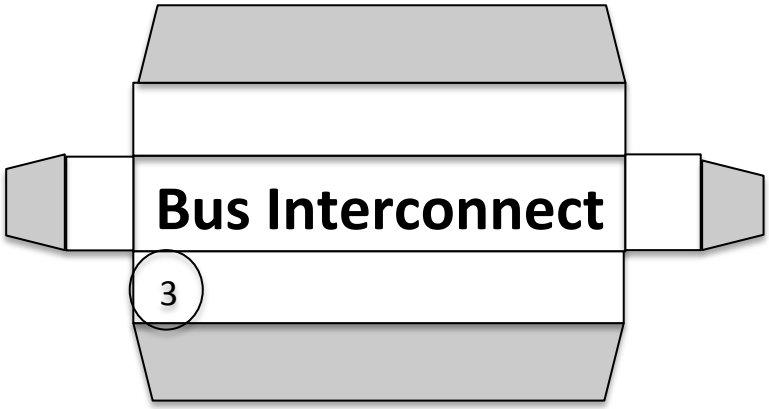
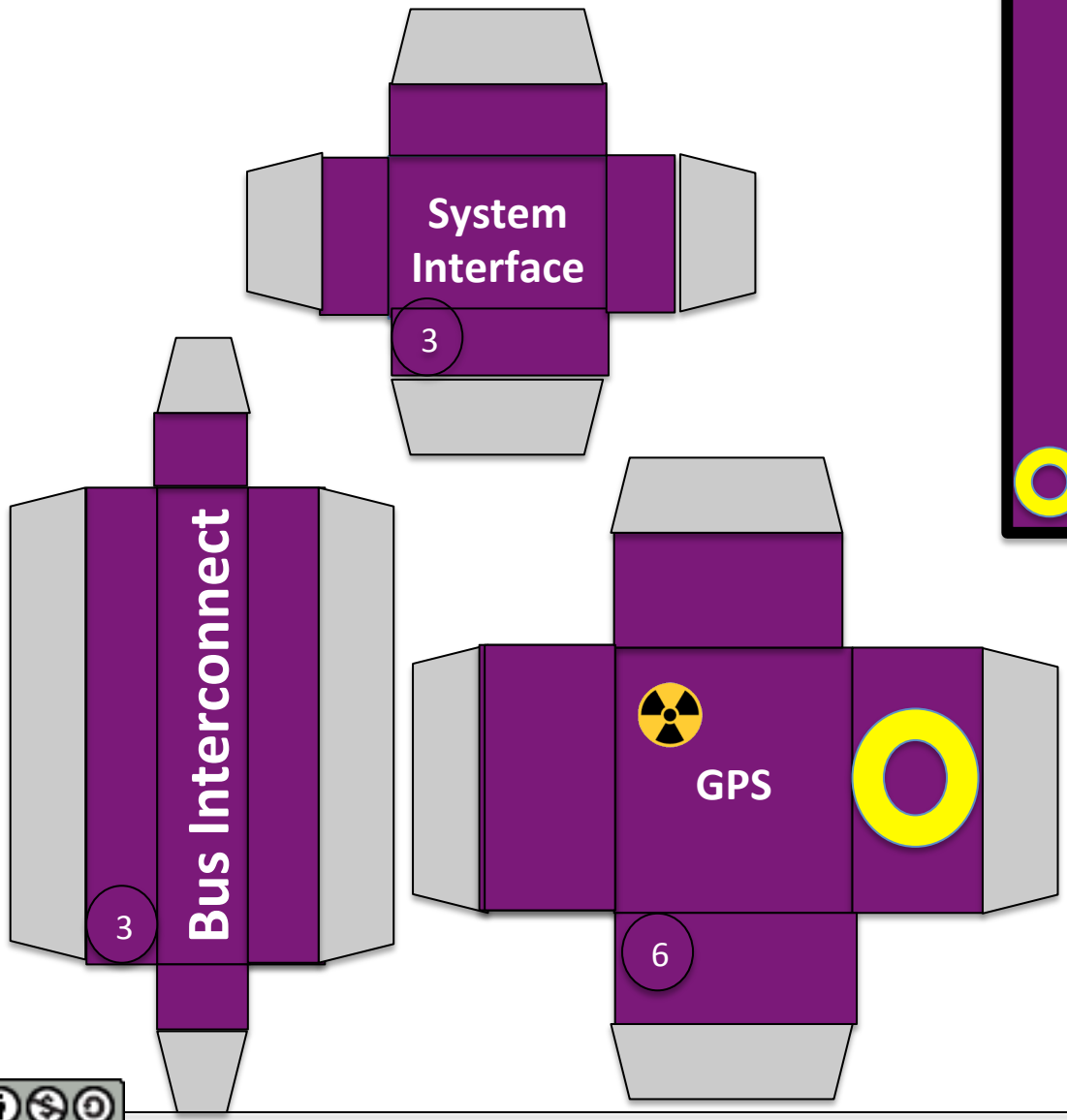


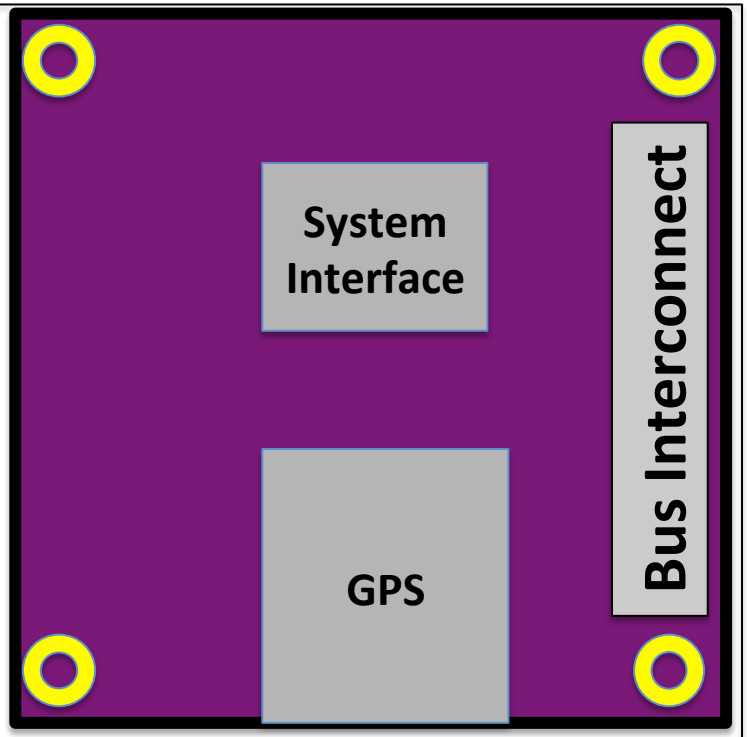




Magnetic Sensor
50 Grams
1 Power

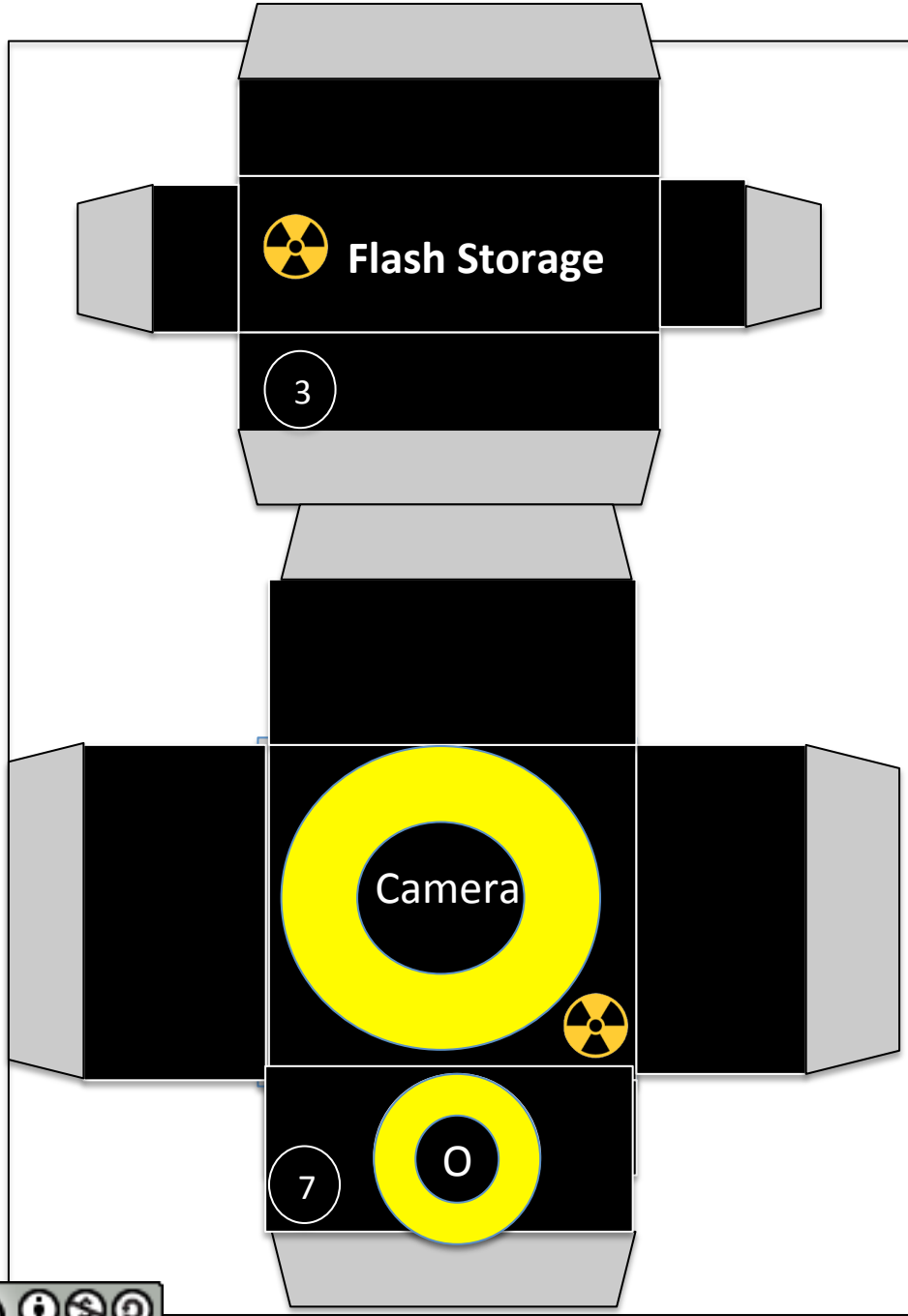
Attitude Camera

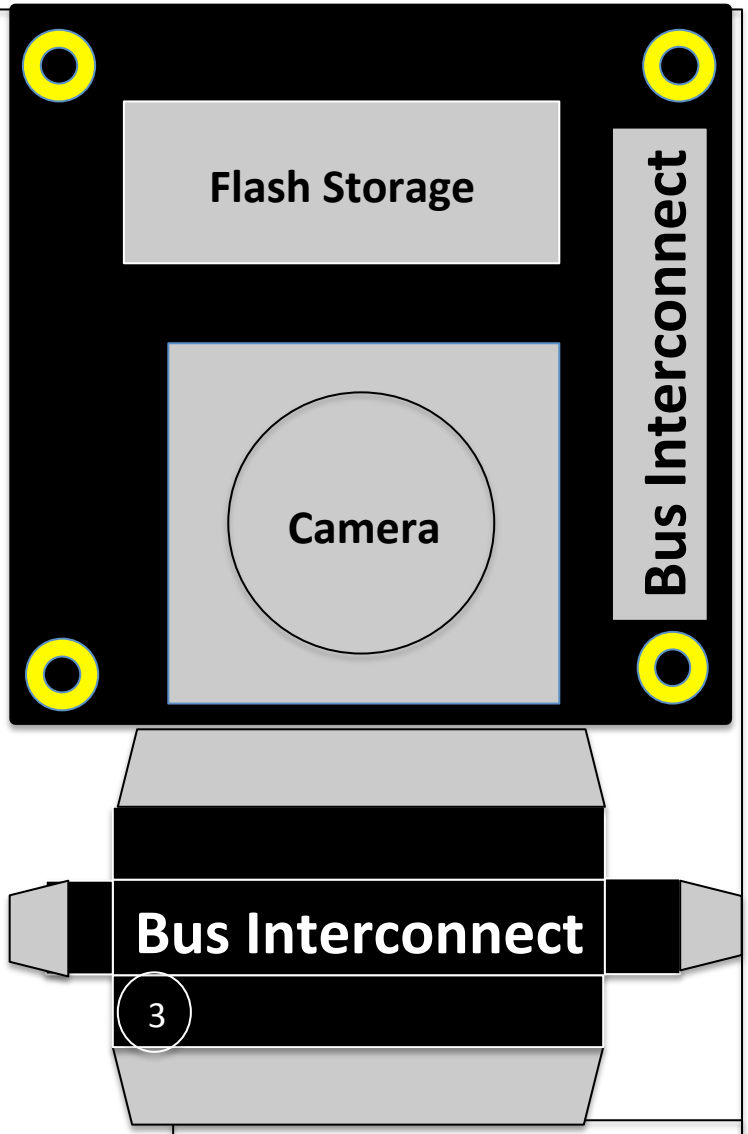




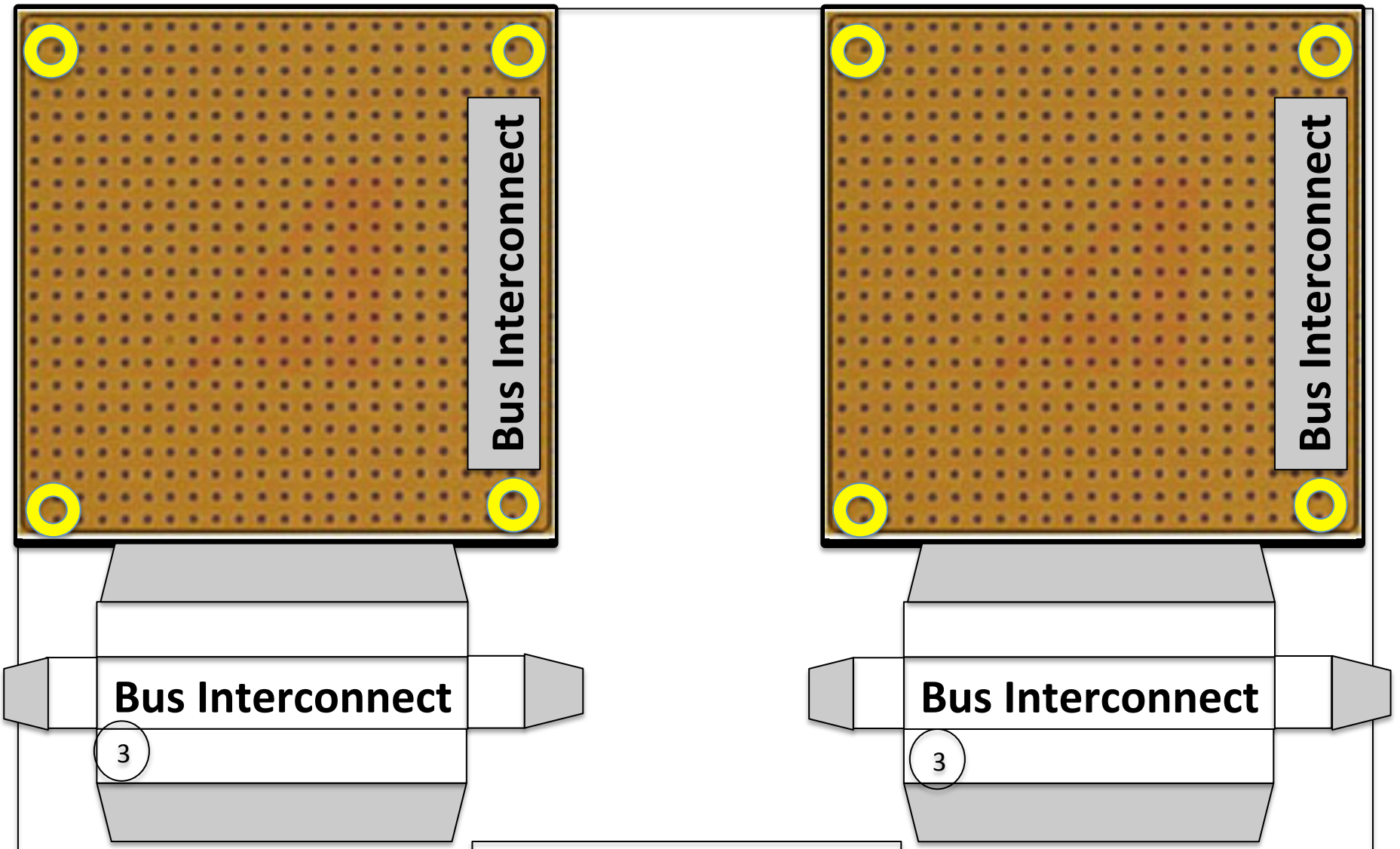
Attitude Camera

100 grams
1 Power
CPU Attitude determination star sensor





Payload Camera
100 Grams
2 Power



Punchboard Custom
Variable Grams
Variable Power
Be creative

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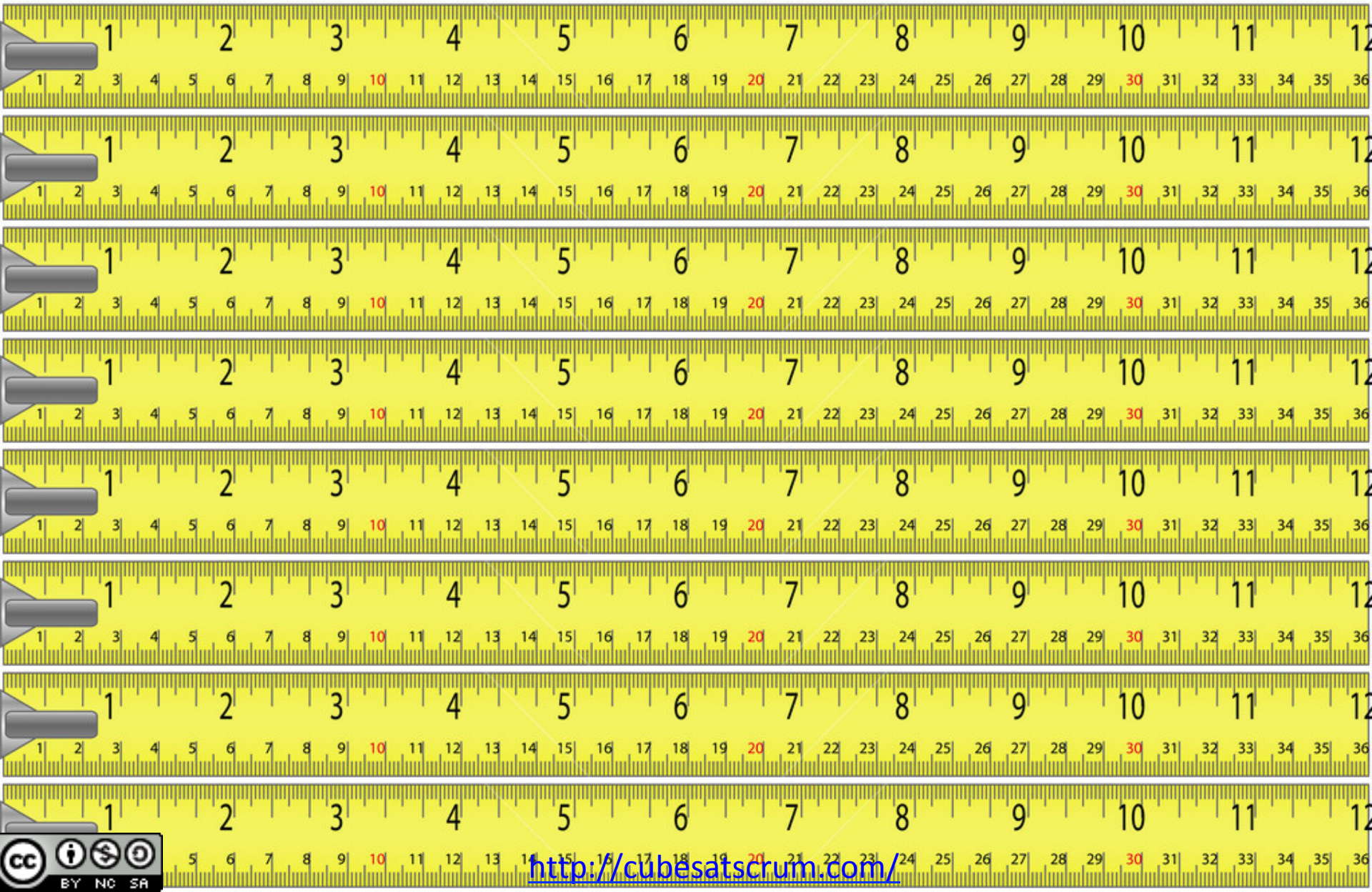
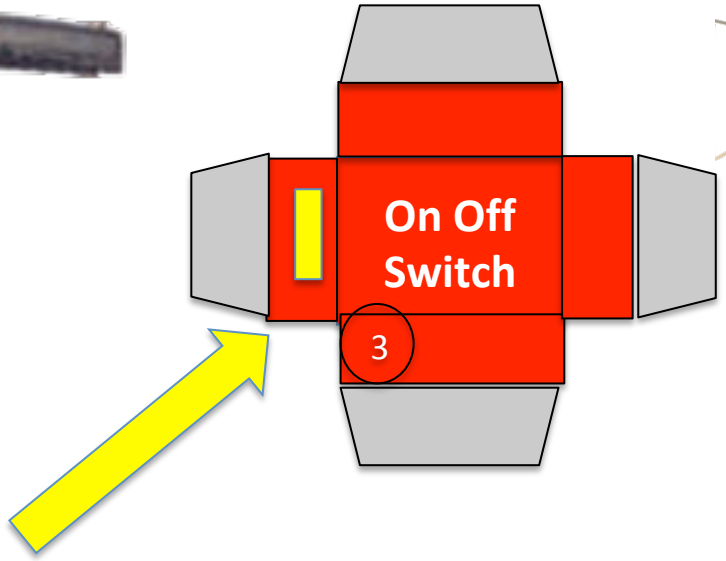
Antenna





Cut &Tape & Fold / Connect with Pipe Cleaner

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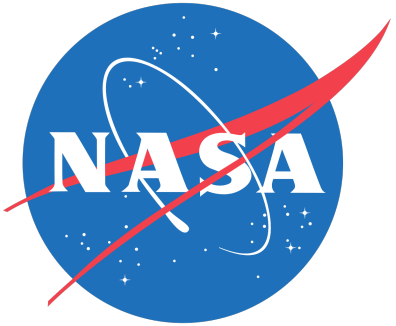
Decorations



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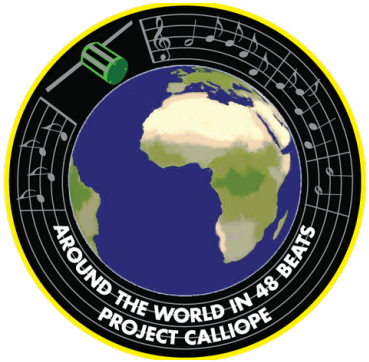
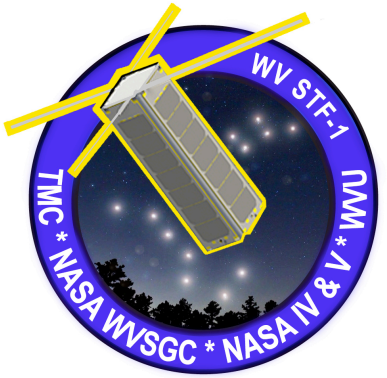
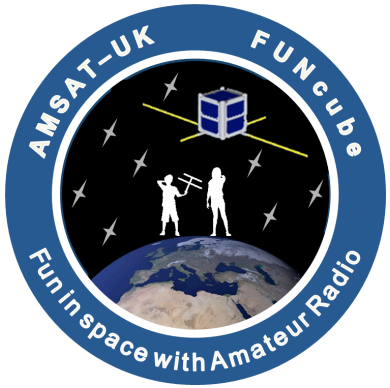
Past CubeSat Mission Patches







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Build Your Patch

http://cubesatscrum.com/

Instructor Class Materials Checklist

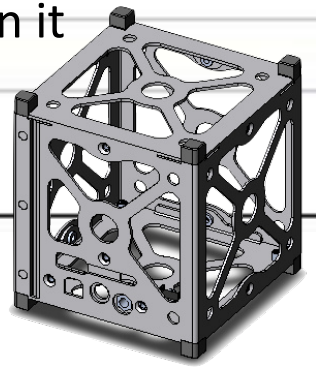
- 4 Long Pipe cleaners
- 4 Long Straws
- 4 Coffee Stirrers
- 2 rolls of scotch tape
- 5 Foam Plates or pieces of cardboard
- 2 Large Post its notes
- 1 pack of colored makers or crayons
- 1 Foam Test bed base
- 3 Pens or pencils for team
- 5 Sheets Blank Paper a team
- Print the following cards 2 per page for Students

1. CubeSat Frame

As a mission commander I want a frame to house and protect my CubeSat components so that my mission can be launched and executed.

Acceptance Criteria:

- All the open areas of the cubesat must be cut out due to weight
- Any mission payload that uses cameras or sensor must have sufficient room in the frame to operate.
- There must be 4 rails that surround the sides of the cube sat that fit in the P-POD rail system
- The CubeSat must be able to open to inspect the internal components.
- The external frame must have the name and logo place on it
- There must be remove before flight Pin Cubesat



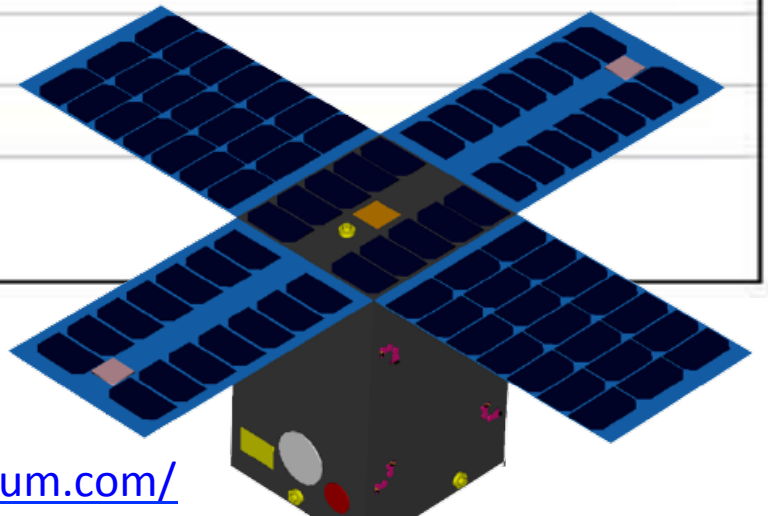
2. Solar Array / Power Storage

As a CubeSat in orbit
I want solar power for all my components at all times
So that my mission will be a success.

Acceptance Criteria:

- Solar Cells with sufficient power to run and charge the batteries
- Batteries that can run the components while behind the earth
- Solar Array will fold to conform with P-POD launcher
- Calculate the power produced

Documentation: Complete the Orbital Mission Power Management Worksheet

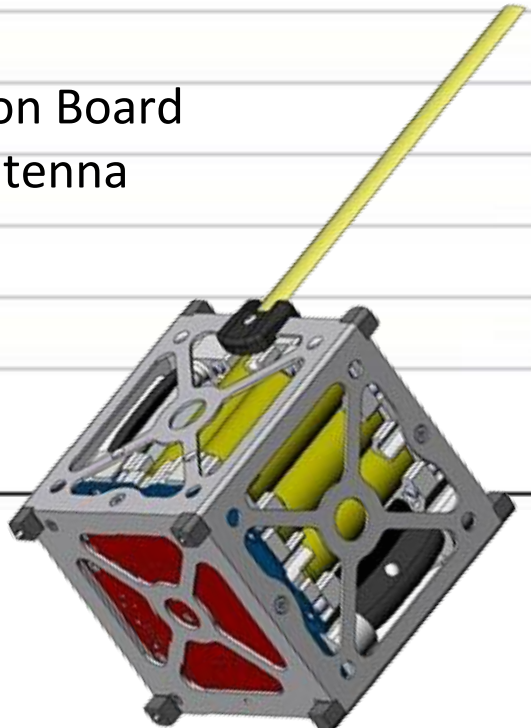


3. Communication

As a CubeSat
I want to have a communication system, Transmitter and Receiver, Send and Receive
So that I can communicate Housekeeping data, commands, and to relay payload data.

Acceptance Criteria:

- Assemble Cellular / Radio modem communication Board
- Connect to At least 2 arms of a tape measure antenna
- Power Amplifier to boots signal
- Antenna will auto deploy after exit from P-Pod
- Antenna will not interfere with the solar array

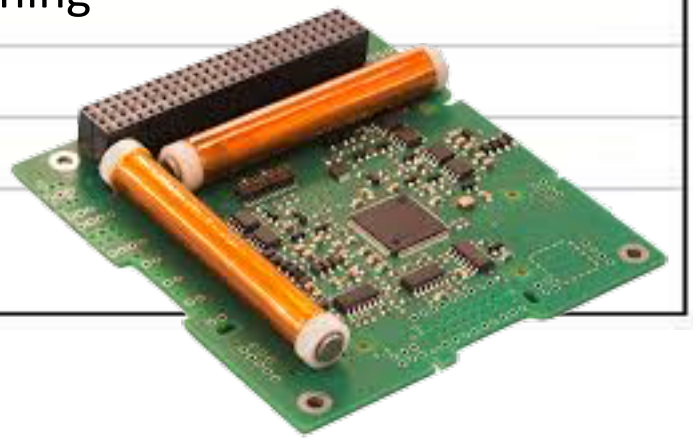


4. Stabilization

As a CubeSat Mission
I need to have Stabilization
So that my payload camera can be oriented on my mission objectives.

Acceptance Criteria:

- Assemble Magnetic Rod Stabilization component
- Integrated to Attitude Sensing Component
- Must run continuously for Solar and camera pointing.
- Integrate with Attitude Cameras for positioning



5. Navigation GPS

As a CubeSat Mission
I need to have GPS Navigation
So that I can track my mission, manage commutation, take pictures, move from Sun to dark power modes.

Acceptance Criteria:

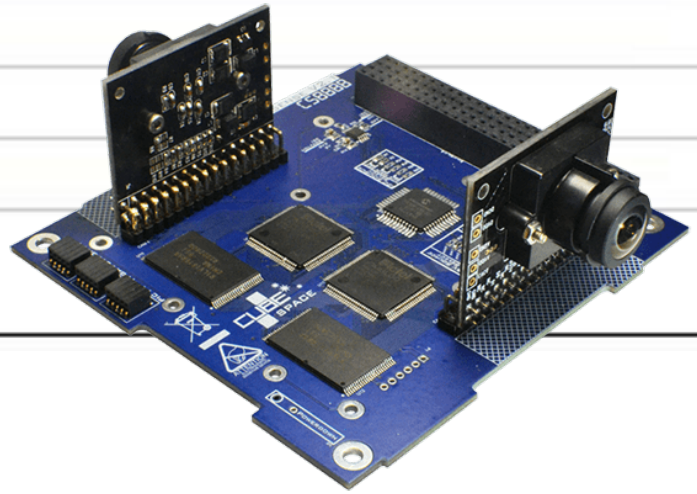
- Assemble GPS component assembly
- GPS is next to the CPU in the stack
- Must run continuously for Solar and camera pointing.

6. Payload

As a mission product owner
I want my payload to have optical sensors
So that I can capture images to transmit them to the ground station.

Acceptance Criteria:

- The CubeSat will have a payload camera
- The frame will accommodate the objective lenses of the camera
- The cubesat payload camera will be able to operate at all times.



7. Remove Before Flight

As a mission product owner
I want to incorporate my remove before flight tag
So that my cubesat will go live when it is removed.

Acceptance Criteria:

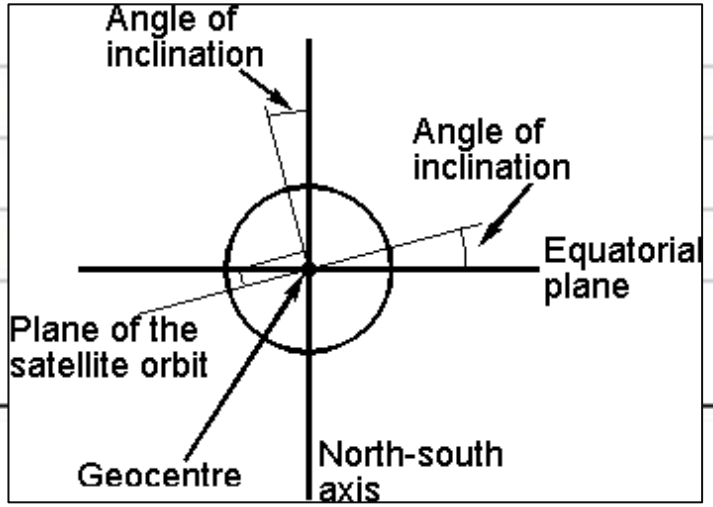
- The CubeSat will have a remove before flight tag
- The remove before flight tag will be connected to On off Switch
- Placement of on off switch location as needed

8. Launch Vehicle Selection

As a mission product owner
I want to have a launch vehicle
So that I can fly my mission

Acceptance Criteria:

- Select from the list of options the right launch vehicle.
- Ensure that cost is kept to a minimum.
- Ensure that orbit is polar.
- Ensure that size is appropriate.



9. Mission control Pre Launch Checklist

As a mission commander
I want my cubesat to pass the prelaunch checklist
So that I can be cleared for launch and fly my mission.

Acceptance Criteria:

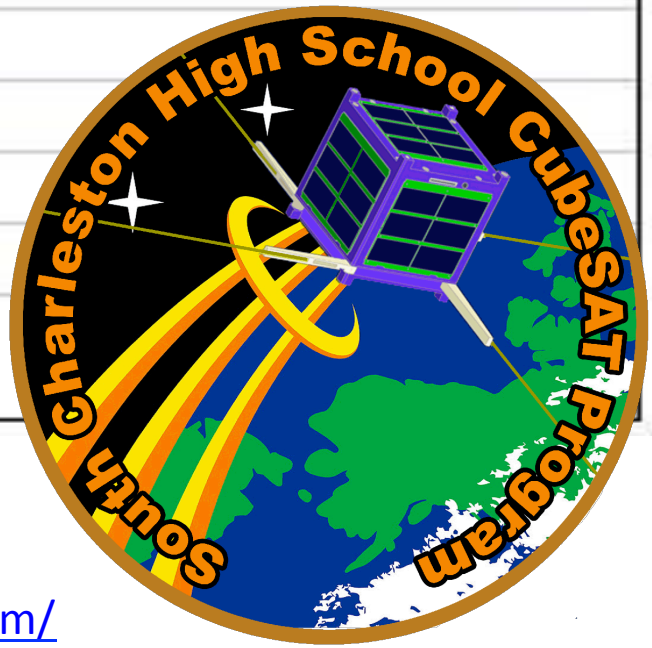
- The CubeSat will conform to the mission checklist
- All components required will be present
- Weight conforms to size 1.33 KG per 1U
- Mission will be chair flown. Instructor will be mission command.

10. Mission Patch (Extra Credit)

As the CubeSat Mission sponsor
I want to have a way cool mission patch and logo
so I can show off the awesomeness of my mission on my jacket.

Acceptance Criteria:

- Way Cool patch that fits in a box that is 8 cm x 8 cm.
- Has to have over 5 colors
- Has to have the names of the team members
- Needs to have the mission logo.



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11. Sponsor Branding (Extra Credit)

As the CubeSat Mission sponsor
I want to have social media coverage with my branding on the cubesat
So my support of the mission will have great coverage in social media.

Acceptance Criteria:

- CubeSat will have Sponsor branding
- Launch System Selected Branding
- Flags of countries that contributed
- Space agency logo supporting mission
- Team mission logo.

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