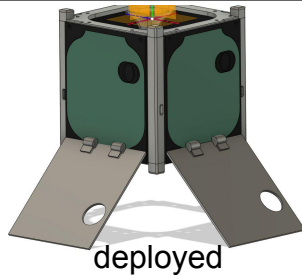
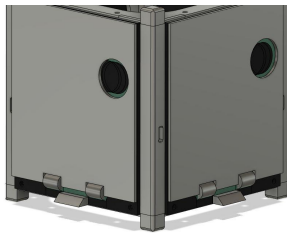


# Mechanical Quad Chart- 11/8/2023

## Update

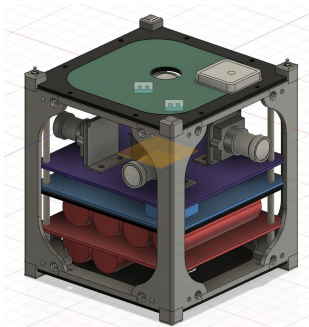
stowed



deployed



## Team Blockers



- Avionics
  - mass of designed boards with components
  - Confirmation on ribbon cables
- Thermal Desktop licensing issues
  - Switching over to Ansys Workbench
- Confirmation on 3rd party CNC quotes

## Milestones

- Deployment mechanism in CAD
  - Outer PCB design, hinge & tape measure mount
- Thermal desktop simulation on going
- Preliminary ribbon cable planning
- Antenna mount update and redesign
- Three 3rd party CNC quotes obtained


## Next Week

- Structural changes to accommodate new deployable hinge
- Further work on design of ribbon cables
- Test of antenna mount with Comms & Ops
- Initial work on PDR requirements
- Update detailed mass budget

## Cross team issues and interfaces

- Boards - continue to reference PC104 document on mechanical wiki
- **Report internal components and masses so we can start formulating testing protocols more fully (thermal, etc.)**
- Need to figure out tape measure mounting for deployable solar panels - holes vs epoxy
- Got information on GPS modules, planning to mount on top and bottom

# Obtained Quote: Protolabs



Frame Top Test v2.step

1852-7138-002

Current Revision: 1

Aluminum 6061-T651 UT/ with Material Cert

Edges broken (tool marks visible)

Anodizing Type II Clear

Mill

Threading (0 features selected [view](#))

X: 100.00mm Y: 100.00mm Z: 14.35mm

Machining Tolerance: +/- 0.005 in. (0.13mm)

[View Analysis](#)

[Configure Part](#)

[Upload Revision](#)

[Part Options](#) ▾

[View analysis details & approve](#) ⓘ

Quantity

-  +


[Get volume pricing from Hubs](#) 🔗

2 Parts @ \$353.94	\$707.88
Anodizing Type II	\$53.00
<b>Total</b>	<b>\$760.88</b>

Order by:  
Today 8:10 PM

Receive by:  
Tue, Nov 21

Expedite Fri, Nov 17	Expedite Mon, Nov 20	Standard Tue, Nov 21	Economy Tue, Nov 28	Economy Tue, Dec 5	Economy Wed, Dec 13
+ \$611.62	+ \$322.80		- \$161.40	- \$237.85	- \$305.81



Frame Legs Test v2.step

1573-2174-003

Current Revision: 1

Aluminum 6061-T651 UT/ with Material Cert

Edges broken (tool marks visible)

Anodizing Type II Clear

Mill

Threading (0 features selected [view](#))

X: 27.85mm Y: 27.85mm Z: 100.00mm

Machining Tolerance: +/- 0.005 in. (0.13mm)

[View Analysis](#)

[Configure Part](#)

[Upload Revision](#)

[Part Options](#) ▾

[View analysis details & approve](#) ⓘ

Quantity

-  +

[Get volume pricing from Hubs](#) 🔗


4 Parts @ \$216.14	\$864.56
Anodizing Type II	\$76.00
<b>Total</b>	<b>\$940.56</b>

Order by:  
Today 8:10 PM


Receive by:  
Tue, Nov 21

Expedite Fri, Nov 17	Expedite Mon, Nov 20	Standard Tue, Nov 21	Economy Tue, Nov 28	Economy Tue, Dec 5	Economy Wed, Dec 13
+ \$746.99	+ \$394.24		- \$197.12	- \$290.49	- \$373.49

# Obtained Quote: Xometry



[Configure Part](#)[Revise CAD](#)[+ Upload Drawings](#)[Remove](#)

 Drawing Required

Quantity - 2 +

**Measurement:** 100.00 mm x 100.00 mm x 14.35 mm | 18211.63 mm³ / 3.937 in x 3.937 in x 0.565 in | 1.111 in³  
**Process:** CNC Machining  
**Material:** Aluminum 6061-T6  
**Finish:** Clear Anodize  
**Threads and Tapped Holes:** Threads and Tapped Holes, None  
**Tolerance:** Tightest Tolerance: +/- .004" (+/- .102mm), Locations: 1  
**Surface Roughness:** Smallest Roughness: 125uin/3.2um Ra  
**Inspection:** Standard Inspection  
**Certificates and Supplier Qualifications:** Finishing Certification

**Expedite | Made in USA** \$826.34 ea.  
6 business days **\$1,652.68**

**Standard | Made in USA** \$487.74 ea.  
10 business days **\$975.48**

**Economy | Made in USA, Canada, or Mexico** \$400.32 ea.  
16 business days **\$800.64**

**Economy | Made Internationally** \$182.34 ea.  
13 business days **\$364.68**



[Configure Part](#)[Revise CAD](#)[+ Upload Drawings](#)[Remove](#)

 Drawing Required

Quantity - 4 +

**Measurement:** 100.00 mm x 27.86 mm x 27.86 mm | 6282.16 mm³ / 3.937 in x 1.097 in x 1.097 in | 0.383 in³  
**Process:** CNC Machining  
**Material:** Aluminum 6061-T6  
**Finish:** Clear Anodize  
**Threads and Tapped Holes:** Threads and Tapped Holes, None  
**Tolerance:** Tightest Tolerance: +/- .004" (+/- .102mm), Locations: 1  
**Surface Roughness:** Smallest Roughness: 125uin/3.2um Ra  
**Inspection:** Standard Inspection  
**Certificates and Supplier Qualifications:** Finishing Certification

**Expedite | Made in USA** \$397.96 ea.  
6 business days **\$1,591.84**

**Standard | Made in USA** \$243.86 ea.  
10 business days **\$975.44**

**Economy | Made in USA, Canada, or Mexico** \$200.53 ea.  
16 business days **\$802.12**

**Economy | Made Internationally** \$91.56 ea.  
13 business days **\$366.24**

# Obtained Quote: Conturo



## QUOTE

DATE QUOTED 11/8/2023

ORDER #: CMU1076

Carnegie Mellon University

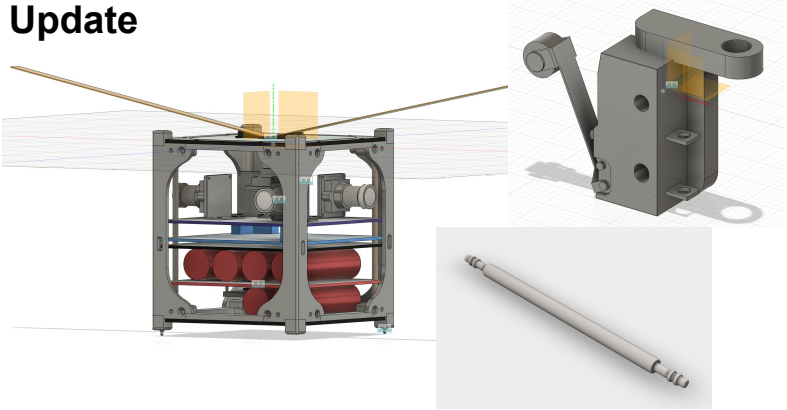
LINE	PART NUMBER	PART DESCRIPTION	REV	MATERIAL	FINISH	QTY	RATE	AMOUNT
1	Leg 1	Leg 1		Aluminum 6061-T6	Tumble	1	\$931.71	\$931.71
2	Leg 2	Leg 2		Aluminum 6061-T6	Tumble	1	\$874.59	\$874.59
3	Leg 3	Leg 3		Aluminum 6061-T6	Tumble	1	\$900.48	\$900.48
4	Leg 4	Leg 4		Aluminum 6061-T6	Tumble	1	\$897.14	\$897.14
SUBTOTAL							\$3,603.92	
TAX RATE							0%	
SALES TAX							\$0.00	
TOTAL							SEE BELOW	

Available Lead Time Options		
Leadtime (business days)	Expedite Fee*	Total Price
6	\$720.78	\$4,324.70

\* Line items with special lead times may have different expedite fees.

# Mechanical Quad Chart- 11/1/2023

## Update



## Team Blockers

- Update on Endurosat?
- Avionics
  - New camera requirements?
  - Access port locations?
  - Weights of electronics and sensors
- Thermal Desktop licensing issues

## Milestones

- Model sent to TechSpark for machining
- Updated 3D print for reference
- Thermal desktop simulation on going
- Proof of concept for tape measure deployment
- Updated detailed mass budget
- 3D printed antenna mounts
- Designed internal mount for rail limit switches

## Next Week

- Working on locking hinge mechanism
- Structural changes to accomodate hinge?
- Start cabling table

## Cross team issues and interfaces

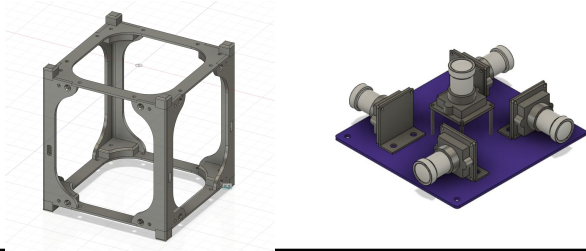
- Boards - continue to reference PC104 document on mechanical wiki
- **Report internal components and materials so we can start formulating testing protocols more fully (thermal, etc.)**
-

	number	mass estimate (g)	total mass (g)				
frame	1	150	150				
outer solar panel boards- XY	4	53	212				
outer solar panel boards- Z	2	53	106				
deployed solar panel boards	4	53	212				
main board	1	100	100				
battery board	1	100	100				
batteries	6	47	282				
jetson board	1	18	18				
camera board	1	100	100				
cameras	6	12	72				
mounts for cameras	6						
PC104 rods	4	22.62292	90.49168				
M3 screws	24	0.385554	9.253296				
M4 screws	16	0.5	8				
antenna system	1	100	100				
inhibit switches	3		0		<b>total mass:</b>	<b>1669.74498</b>	
hinges	4		0				
solar cells(size unknown)	1	110	110				
rail springs	2		0				
helicoil	8		0				

# Mechanical Quad Chart- 10/25/2023

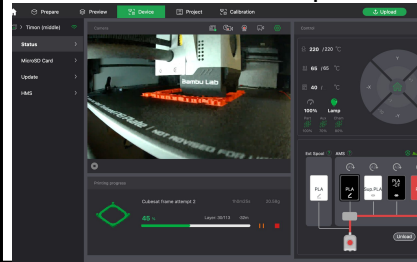
## Update/Milestones

- Updated structure based on TechSpark machining recommendations
- 3D print
- Thermal desktop workup continuing based on just chassis
- Multiple hinge designs considered for solar panels
  - Consulted former lab member on thoughts



## Team Blockers

- Endurosat chassis has not arrived
- Avionics
  - Updated board requirements?
  - Access ports location



## Next Week

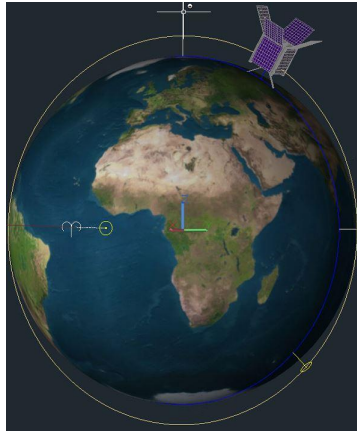
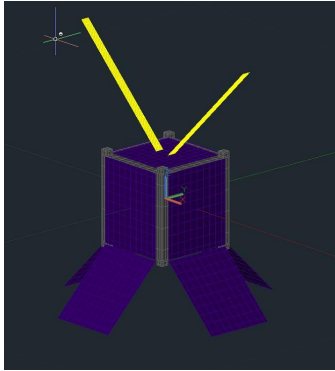
- Crash course on FEA
- EOW- Submit for machining at Tech Spark
- Parts order: PC104 rod selection, screws/fasteners
- Start ribbon cable design
- Update keep out zones for XY panels with new cameras
- Deployable solar panels
  - Attempt at hinge printing
  - construct design ideas
- Check for fit on solar panel deployment sides

## Cross team issues and interfaces

- Boards - continue to reference PC104 document on mechanical wiki
- **Continue thinking about internal components and materials so we can start formulating testing protocols more fully (thermal, etc.)**
- Outer boards will be thicker than previously thought to accommodate torque coils
- Any vibe test implications of epoxying limit switches to PCBs?

# Mechanical Quad Chart- 10/11/2023

## Update



## Team Blockers

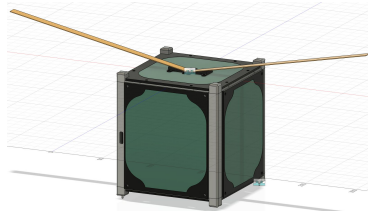
- Missing physical components- Endurosat and springs
- Solar panel surface area
  - To determine need for deployable solar panels
  - Surface area we can provide without deployables= approx. 70 cm<sup>2</sup> per side
- Need to know exact camera boards being used to rebuild interior board stack

## Milestones

- Updated CAD model for chassis
- Interior stack integrated to model
- Currently building thermal model
- DXF file for “keep out zones” on wiki
- Met with machine shop at TechSpark

## Next week

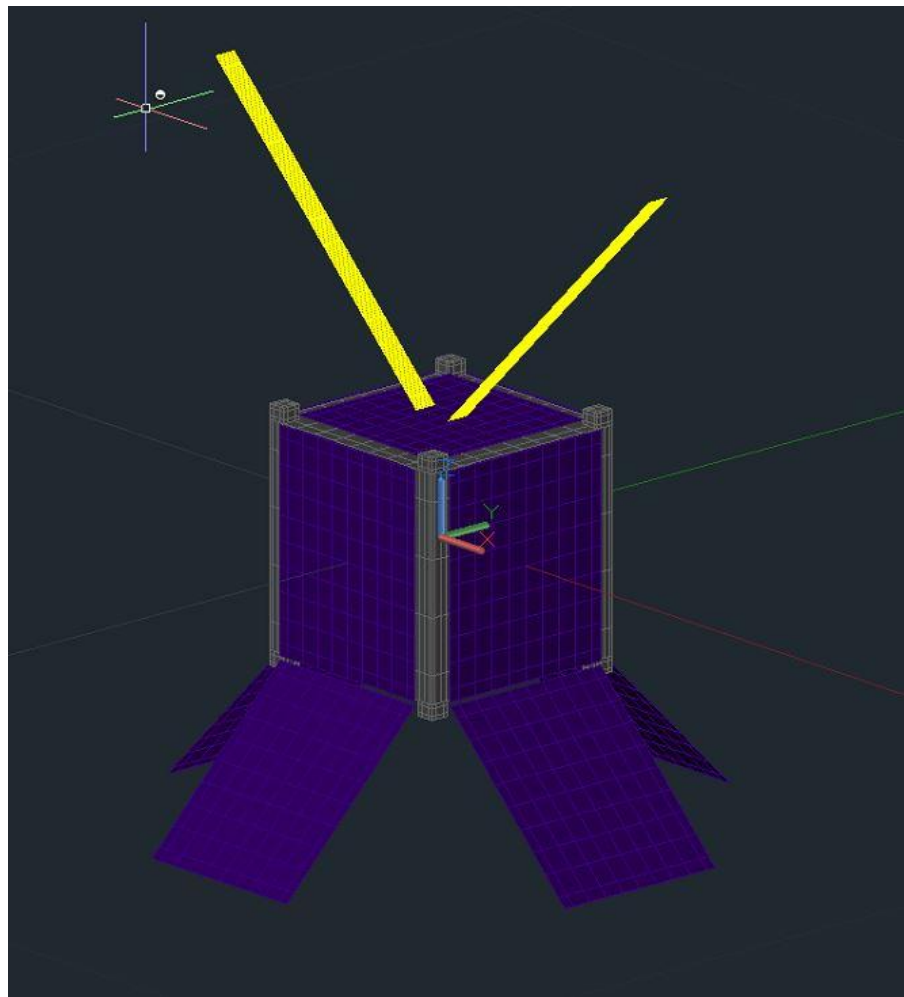
- Play with endurosat structure if we get it
- Start machining our chassis design?



## Cross team issues and interfaces

- Boards - continue to reference PC104 document on mechanical wiki
- Avionics-
  - number of access ports (charging, etc.) so we can work on structure adaptation for that
  - Updated final power budget
- **Continue thinking about internal components and materials so we can start formulating testing protocols more fully (thermal, etc.)**

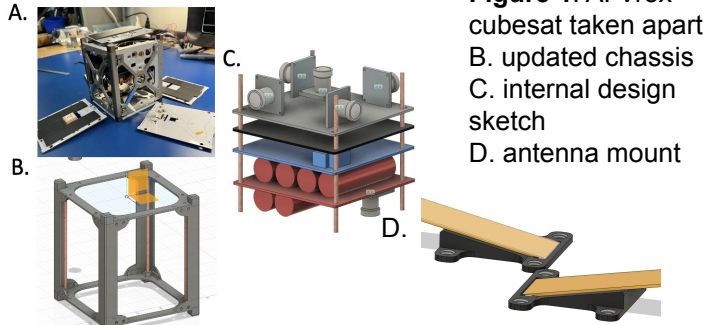




# Mechanical Quad Chart- 10/4/2023

## Update

Took apart 1u cubesat in lab to better understand board infrastructure and connectivity



**Figure 1:** A. Vr3x cubesat taken apart  
B. updated chassis  
C. internal design sketch  
D. antenna mount

## Team Blockers

- Chassis hasn't arrived
- Springs haven't arrived
- Solar panel surface area
  - To determine need for deployable solar panels
- Not critical right now: thermal offloading capabilities of the chassis
  - Do we need an additional radiator?

## Milestones

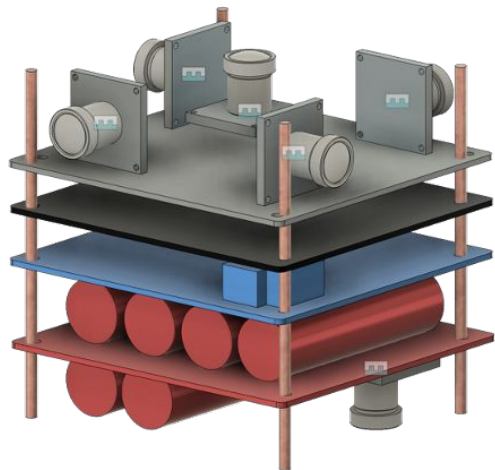
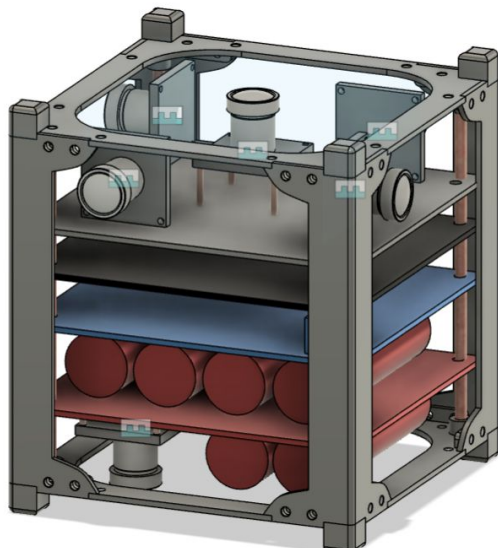
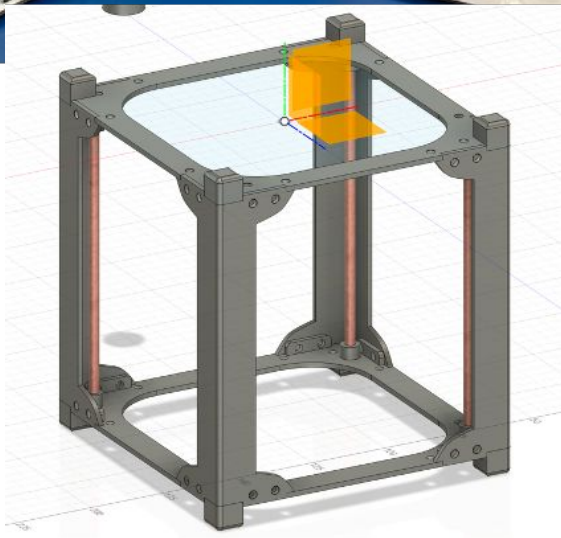
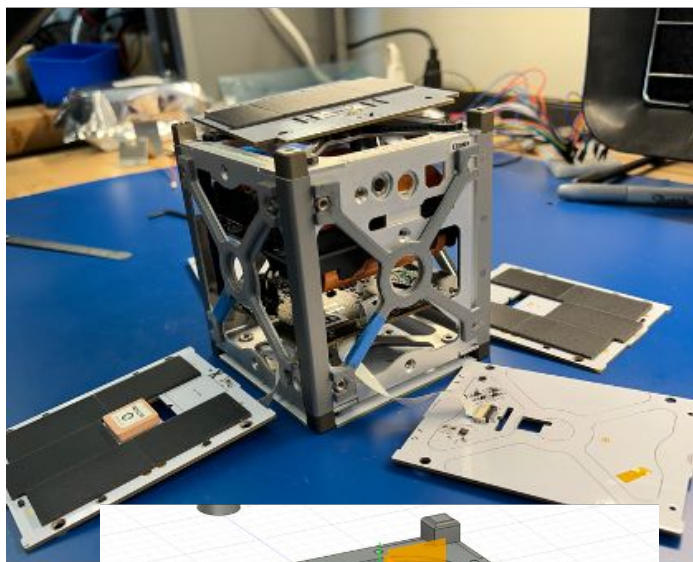
- Updated CAD model for chassis
- Z dimension/board heights determined
- Number of boards determined/more refined interior stack
- Antenna design

## Next week

- Continued manufacturability considerations:
  - Integrating switches/holes on chassis
  - How to take apart/build: ie top comes off
- Play with endurosat structure if we get it
- Start machining our chassis design?

## Cross team issues and interfaces

- Boards - use PC104 board dimensions
  - Will give "keep out" zones for passive components on pcbs due to frame
- Avionics- number of access ports (charging, etc.) so we can work on structure adaptation for that
  - Where will they be?
- **Starting thinking about internal components and materials so we can start formulating testing protocols (thermal, etc.)**
- **All sizes locked in by 10/6- try to avoid major component size changes after this date**



# Mechanical Quad Chart- 9/27/2023

## Update

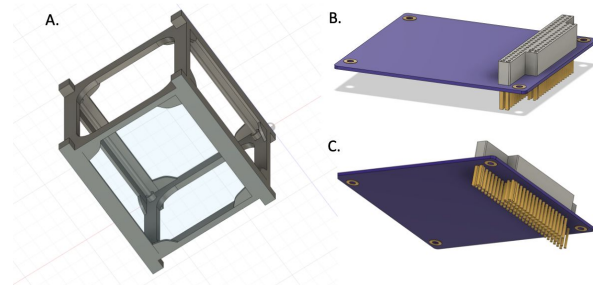


Figure 1: A. chassis structure B. top view of PCB C. bottom view of PCB

## Team Blockers

- Endurosat chassis purchase
  - Don't have arrival date
- Power budget
  - To determine solar panel surface area needed
  - Thermal offloading capabilities of the chassis
    - Do we need an additional radiator?
- Component sizes for each team to determine stack height for each board
  - Number of boards you need

## Milestones

- Cad model: chassis and PC104 start
- Placing orders for switches, springs, chassis
- We have a deployable solar panel idea if needed and would adjust structure accordingly

## Next week

- Integrating antenna design to structure
- Manufacturability:
  - Integrating switches/holes on chassis
  - How to take apart/build: ie top comes off
- Play with endurosat structure if we get it

## Cross team issues and interfaces

- Boards - use PC104 board dimensions and hole positions
  - Will post the dimensions on the mechanical wiki by end of week
- Camera dimensions - will need cutouts in some boards
- Avionics- number of access ports (charging, etc.) so we can work on structure adaptation for that
- **By 10/6, have all internal component sizes sent to us for inner cad model**
  - **Like batteries, cameras, tall board components, etc.**

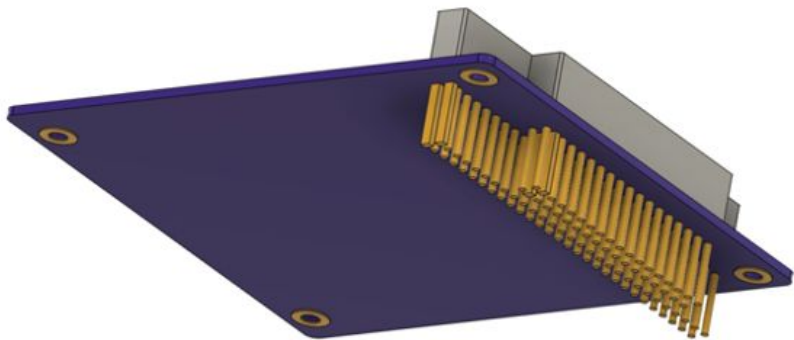
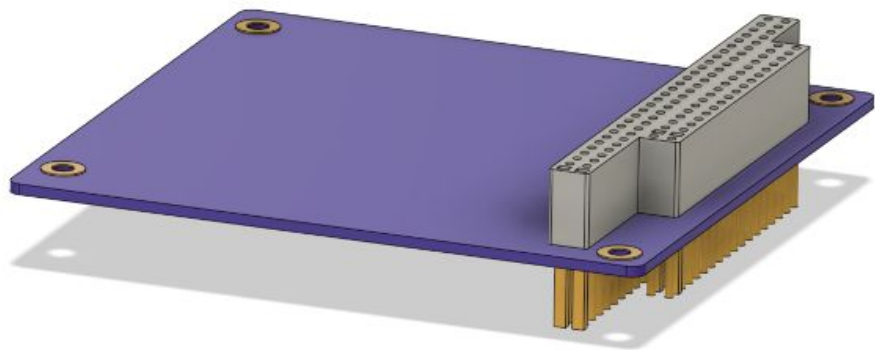
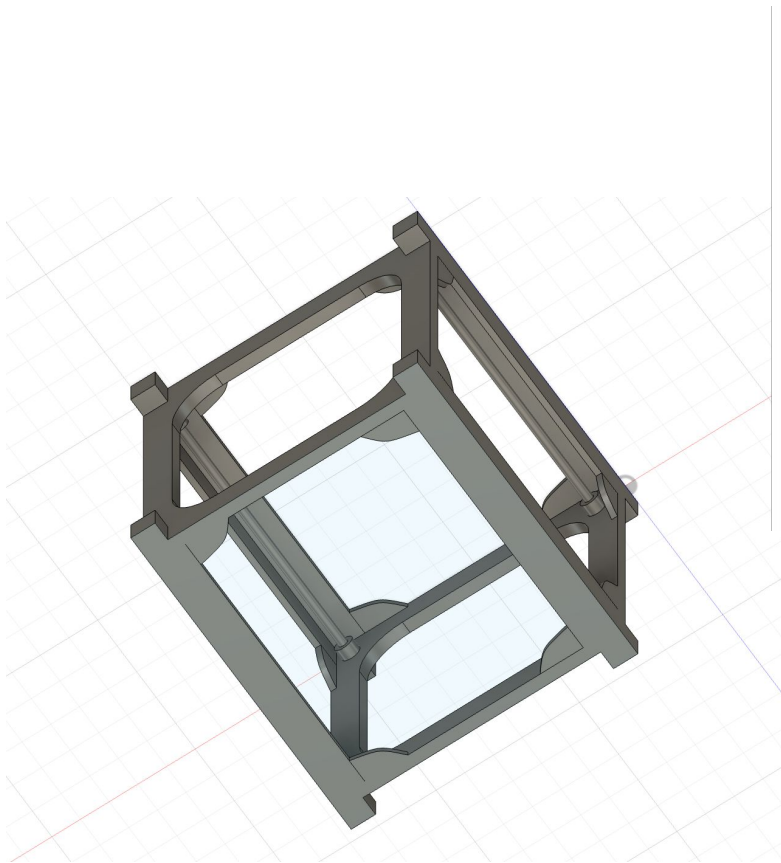
# Mass budget estimate updated

## 1500g target (up to 2000g)

- Chassis- 120 g (Endurosat)
- Batteries- 282g if we use 6
- GPU/vision- 500g
- ~~Torque coil- 46g (probably 2 coils so 92g)~~
- Antenna design- 100g
- PCBs- 70g per board? (so 420g for all 6 potential boards, ~~then additional 70 for back panel?~~)
- Solar panels/outer panels- approx. 50g per side (around 300 total depending on size on each side)
- Ballast- ??g
- Deployable solar panels (4)- 176g

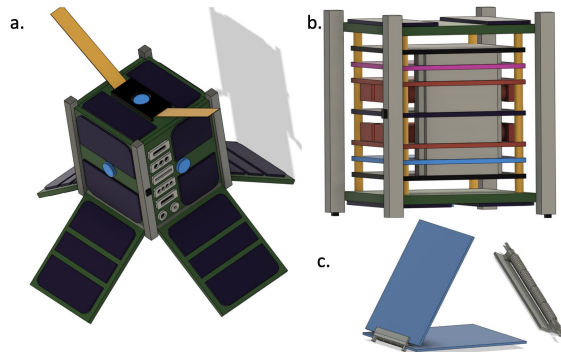
Total right now: 1878g





# Mechanical Quad Chart- 9/20/2023

## Update



**Figure 1:** a. Overall design with outside panels. b. Internal board stack. c. initial design for solar panel deployment (hinges)

## Team Blockers

### Endurosat

- Potential chassis design
- Requires CMU legal representative to start looking at CAD drawings
- Was sent the data sheet

### Other

- Power budget to determine final solar panel surface area

## Milestones

- Came up with initial deployable solar panel idea
- Refined initial CAD design
  - No magnetic torquer rod (embedded in outer panels)
  - Board connection and support with chassis
- No turn-style antenna
  - Thinking V shape

## Next week

- Finalize inner board design and maybe 3D print a model so everyone has dimensions and constraints
- Continue buy/build considerations for chassis

## Cross team issues and interfaces

### Vision- camera and GPU selection

- Will potentially having antenna in camera view be something you can work around?

**GNC-** updated size with solar panels (each deployed panel will be an additional 10cm with an additional 176g at the bottom)

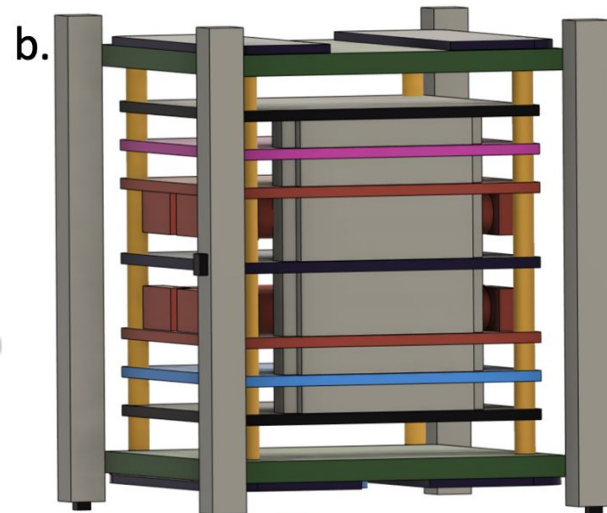
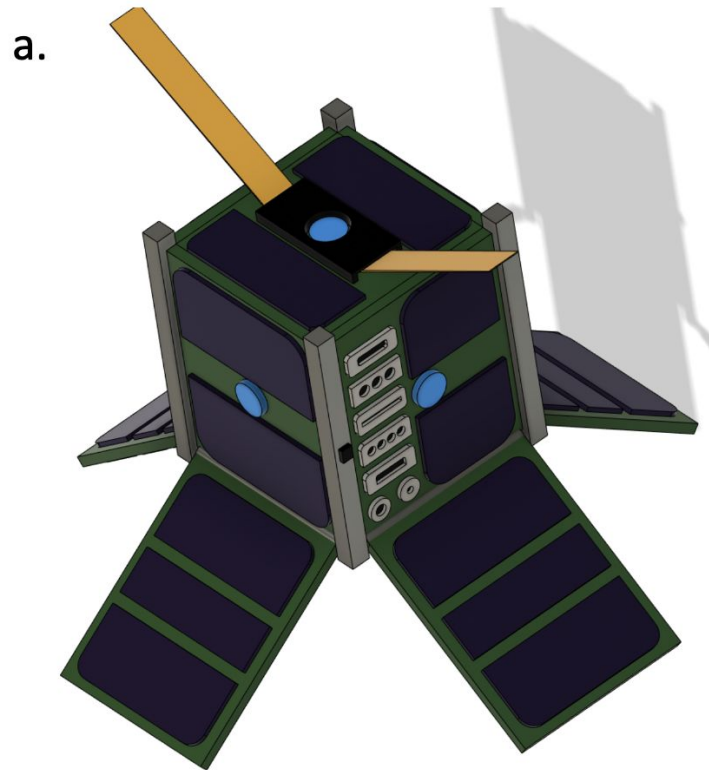
**Avionics-** power budget

**Coms/ops-** link budget

Main structure: 10 cells  
+ Deployable structure: 16 cells  
Total cells: 26 cells

2.4 W per cell x 26 cells= 62.4W  
X 29.5% efficiency

Total power generated= 18.408W





# Mass budget estimate updated

## 1500g target (up to 2000g)

- Chassis- ideally less than 100 g
- Batteries- 282g if we use 6
- GPU/vision- 200g worst case
- Torque coil- 46g (probably 2 coils so 92g)
- Antenna design- 100g
- PCBs- 70g per board? (so 420g for all 6 potential boards, then additional 70 for back panel?)
- Solar panels/outer panels- approx. 50g per side (around 300 total depending on size on each side)
- Ballast- ??g
- Deployable solar panels (4)- 176g

**Total right now: 1740g**

# Mechanical Quad Chart- 9/13/2023

## Update

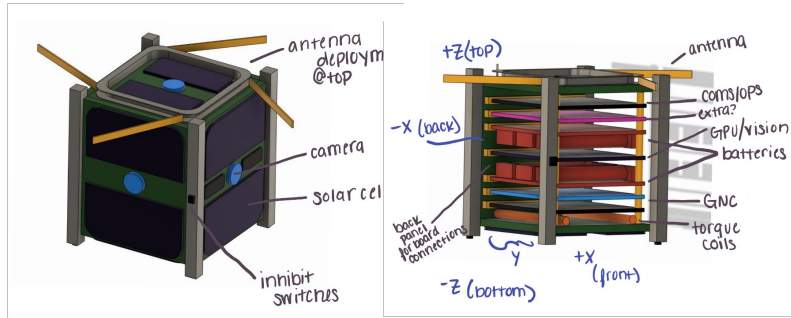


Fig.1- initial CubeSat Rev.1 sketch

## Team Blockers

Need link budget to get power budget to get solar panel size and design

We need to know when each team decides what physical components they want to use so we can finalize mass budget (ie work towards more than just an estimate)

Make sure to keep track of what materials you will be using (or if they can be coated with NASA-approved materials)- we are comprising a list

## Milestones

- interfacing with the other teams
- Revised Level 2 requirements
- Started visualizing first iteration model with initial stack ideas
- First idea for antenna

## This week

- Finalizing initial mass budget estimate as we collect more information from other teams
- Starting CAD models for chassis design
- Deciding how to organize the boards

## Cross team issues and interfaces

Figure out power and link budget to begin determining battery number and subsequent solar arrays (ASAP)\

Vision- camera size to determine placement location- next week?

GNC- sensor and actuator selection- early next week

Coms/Ops- working on antenna design first iteration

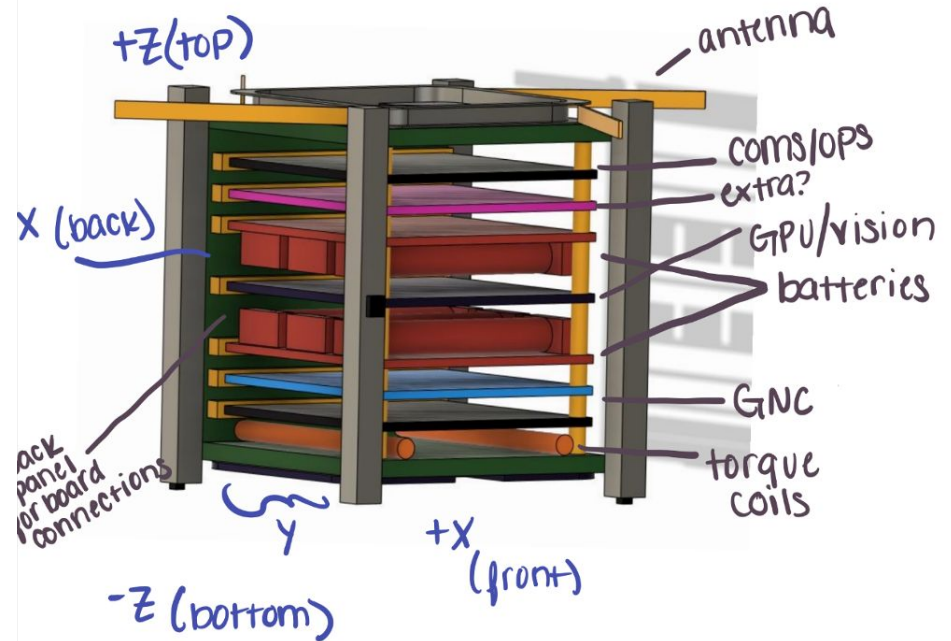
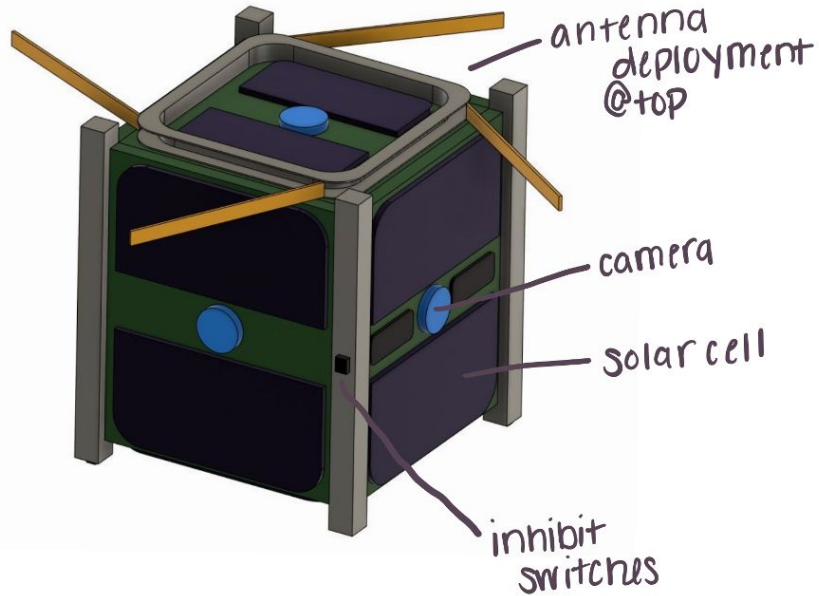
# Mass budget estimate (rough)

## 1500g target (up to 2000g)

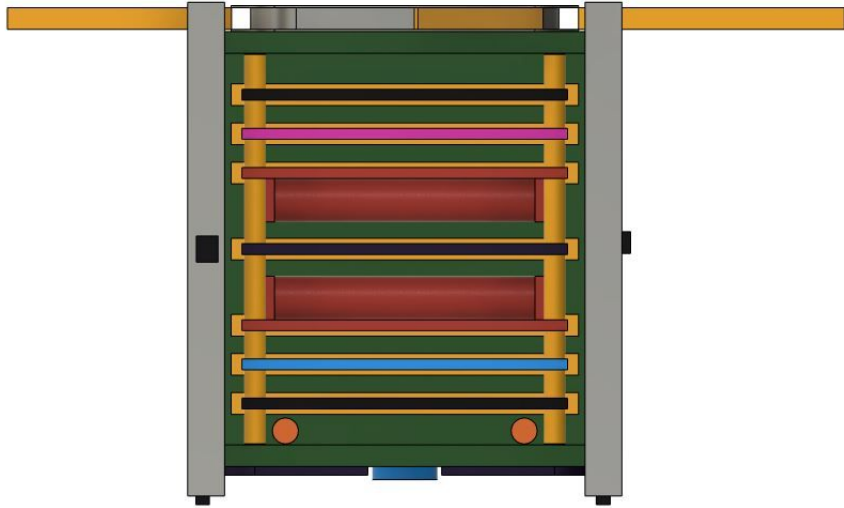
- Chassis- ideally less than 100 g
- Batteries- 282g if we use 6
- GPU/vision- 200g worst case
- Torque coil- 46g (probably 2 coils so 92g)
- Antenna design- 100g
- PCBs- 70g per board? (so 420g for all 6 potential boards, then additional 70 for back panel?)
- Solar panels/outer panels- approx. 50g per side (around 300 total depending on size on each side)
- Ballast- ??g
- 

**Total right now: 1564g**

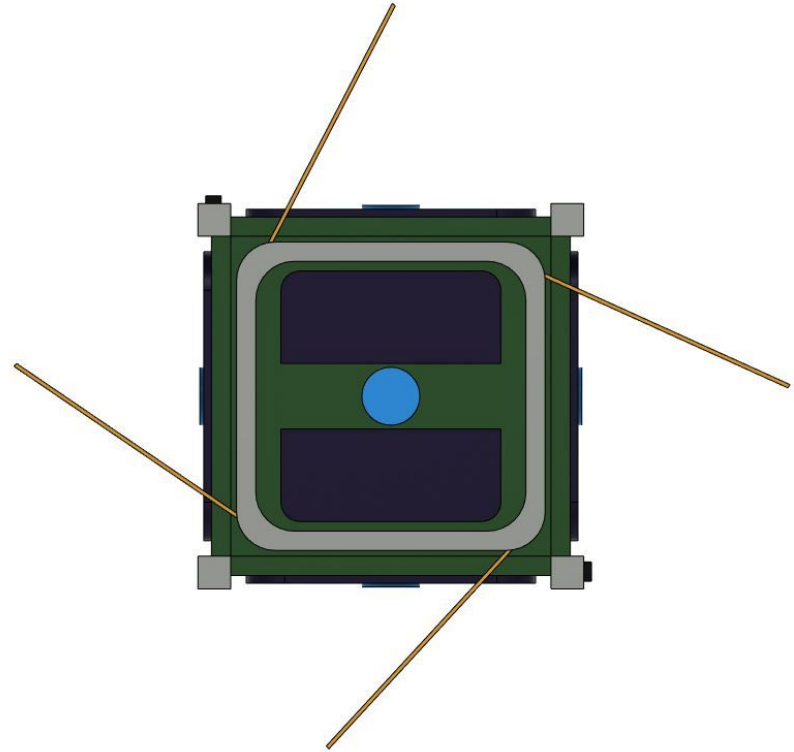
Close-up images if needed



Close-up images if needed



Inside front



top