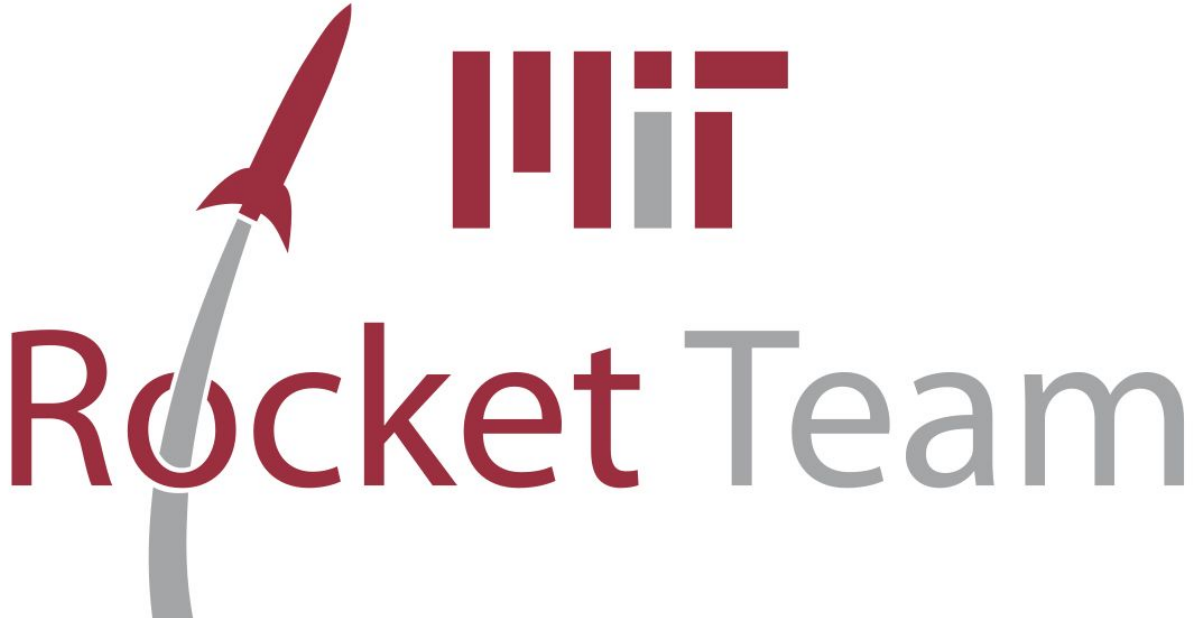


Fin Can

Design Review

Overview of Design Review

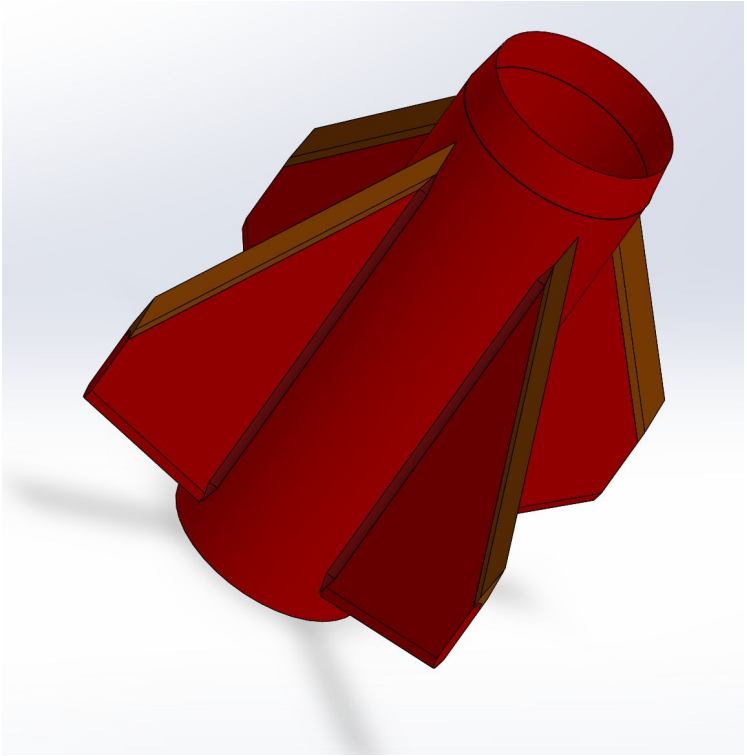
- Design for Fin Can #2
  - Requirements
  - CAD
  - Bill of Materials
  - Manufacturing Process (As-Built)
  - Current Integration Order
- Analysis of Fin Can #2
  - Flutter Analysis
  - Slot Testing
  - Improvements
- Design for Fin Can #3
  - Open Issues
  - Design
  - Schedule to Completion

Requirements

- Withstand expected forces (acceleration force, shock loads, interlaminar shear, flutter)
  - Expected drag - 950 lbs
- Withstand expected heating (esp. at leading edge)
- Minimize weight as much as possible (provided above requirements are met)

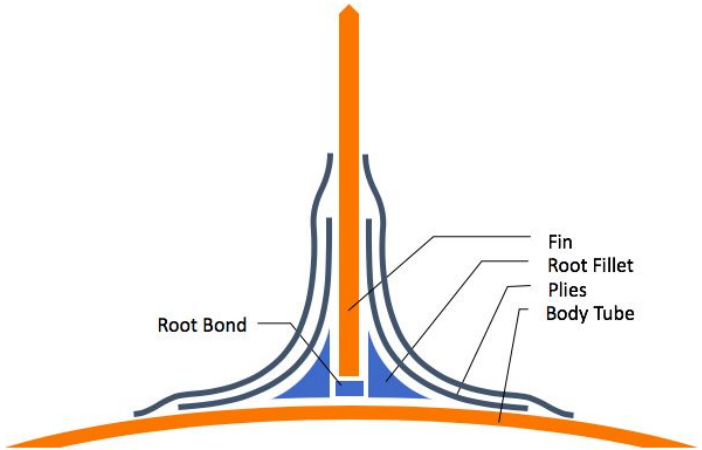
Design Overview (Fin Can #2)

- Phenolic tube with 3 layers of CF overwrap
- Fins: G10 core, phenolic LE
- Tip-to-tip layup: additional 6 layers of CF over each fin
- Interfaces
  - Fin Can Transition



Fin Can Parts

- Phenolic tube (sanded to 6” ID)
  - Overwrapped with 3 layers CF for structural support
  - 22” long, cut to 18” after layup
  - Phenolic insulates the fin can from heat from motor
- Fin Core
  - 0.125” G10 (Garolite)
  - 1/16” thick 0.3” deep tab
  - Used last year, may be subject to change to conserve mass (CF sheet, honeycomb, etc.)
- Phenolic LE
  - 0.210” thick, 15 degree taper
  - 1/16” thick 0.3” deep slot
  - An ablative to mitigate heating on LE and prevent CF from extreme heat
- Carbon fiber for layup (6 plies on either side of each fin)
- Fin Can Transition
  - 0.155” thick, 8 degree taper
  - To transition from OD of motor to OD of fin can



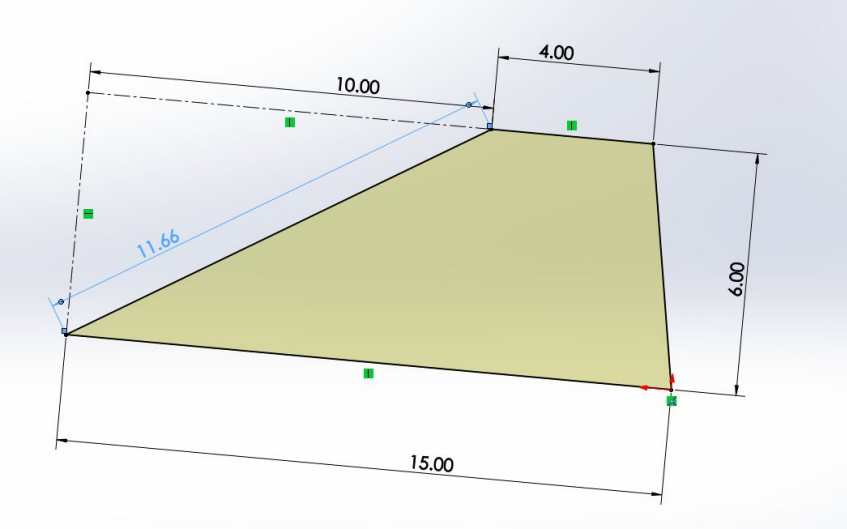
Slot Design

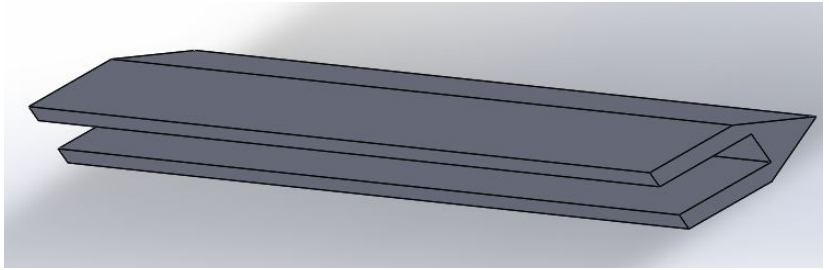
Fin section:

- Chosen as male end that slides into the Phenolic LE

Phenolic LE section:

- Slot is 0.3” deep
  - Chosen through Load Testing
- Angle at 15 degrees





Bill of Materials

Part Name	Estimated Mass	Quantity	Cost	Material
Fin		4		G10
Phenolic LE		4		Phenolic CE
Epoxy	6 boats of 118g each Total: 708g	6 boats		Root fillet: West Systems Fast Hardening Layup: System 3000 (oven-cure epoxy)
Fin Can Tube		1	$41.99	Phenolic CE 6.007” tube
Carbon Fiber Cut-Outs	978g (total dry)	24		

Manufacturing Process (FC #2)

1. Sand phenolic tube to fit over motor case
2. Tube layup (3 plies of CF)
3. Waterjet G10 fins
4. Mill tabs in the G10
5. Waterjet slots in phenolic
6. Sand tabs until they fit in phenolic slots **(improve this step!)**
7. Mill down the 0.020” on each side of phenolic
8. Attach fins to fin can tube
9. Root fillets with epoxy + colloidal silica filler
10. Use West systems slow hardening epoxy to attach phenolic to fins
11. Lasercut CF cutouts
12. Prepare vacuum bagging materials
13. Layup
14. Vacuum bag
15. Oven cure
16. Sanding +Finish with gloss coat/paint

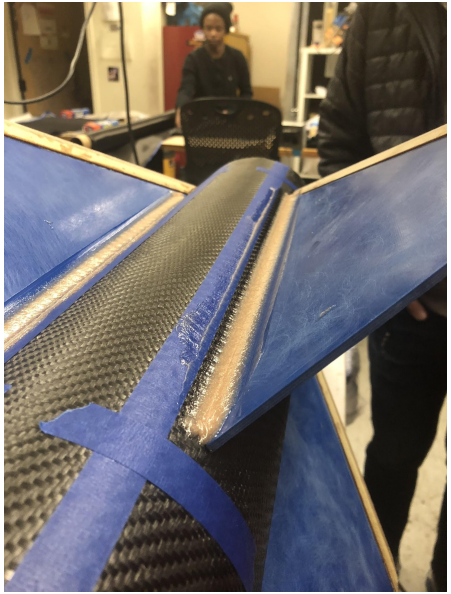
Manufacturing Process (FC #2)

Water-jetting fins

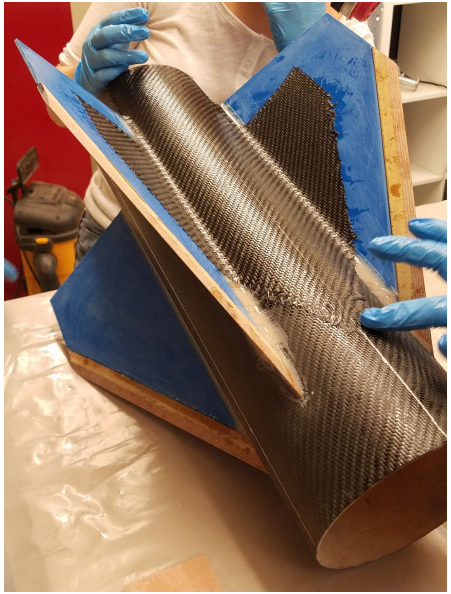
Creating slots in the fins

Fins and Phenolic LE (before they are tapered) with slots to fit into each other

Manufacturing Process (FC #2)



Creating fillets



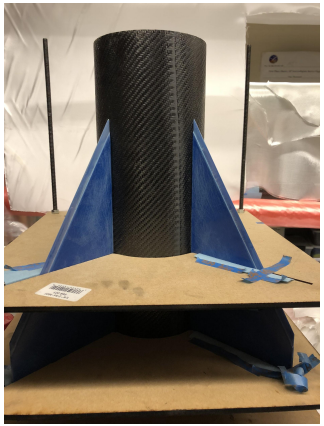
Layup process - laying on sheets of CF

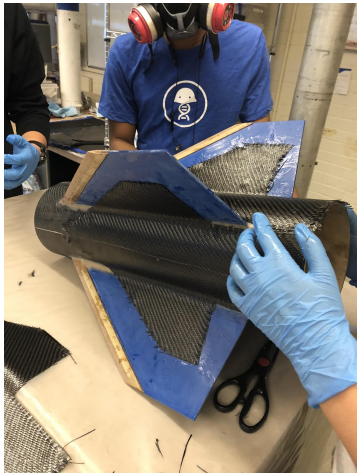
Finished layup of Fin Can #2

Vacuuming to pull out excess epoxy

Manufacturing Improvements

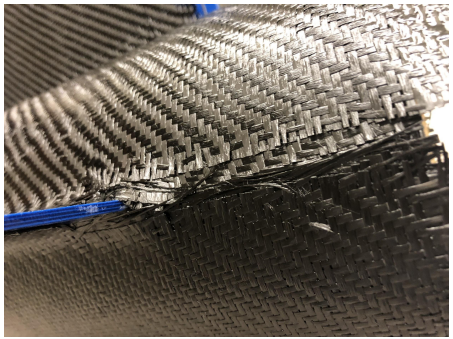
1) Adjust shape of carbon fiber cutouts
    a) Only taper carbon fiber cutouts at trailing edge, not leading edge, so that CF is flush with phenolic
    b) More plies of carbon fiber (no areas where there is only one layer)
2) Modify fin can jig so that fins are more aligned
3) Modify setup for milling tabs in G10 and phenolic to make it more precise
4) Position fin can vertically in the oven to avoid fins moving
5) Taper trailing edge of G10 fin core to improve layup quality

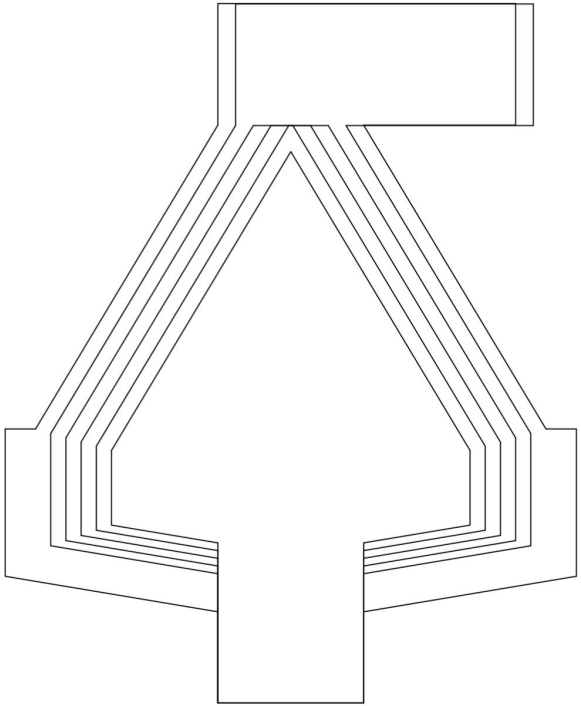




Manufacturing Improvements (Cutouts)

1) Add slight tab extensions to the portion of the cutouts below the fins
2) Make extra layers at full width from fin-to-fin width at top and from leading edge-to-leading edge
3) Make final (complete) layer identical to layer below
4) Incrementally shrink larger CF layers to accounts for stacking

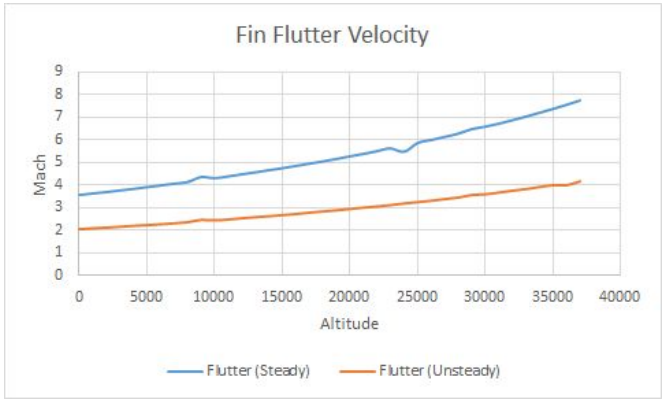


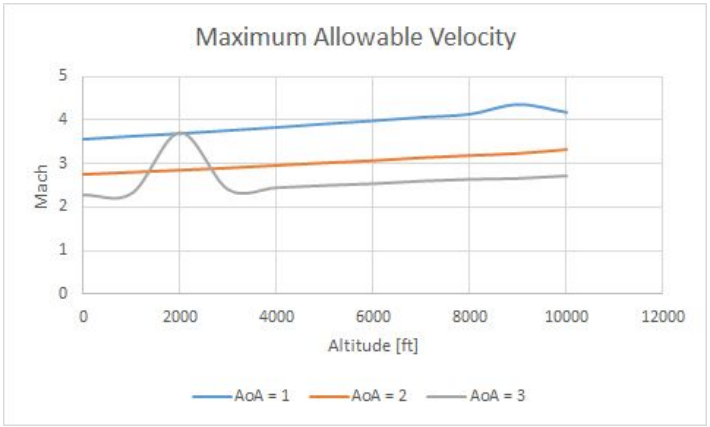


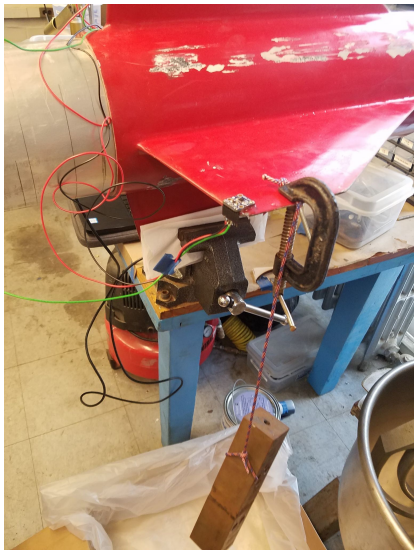
Current Integration/Assembly Order

- Slide fin can up the motor tube until it reaches fin can transition
- Attach boattail to secure fin can in place

Analysis



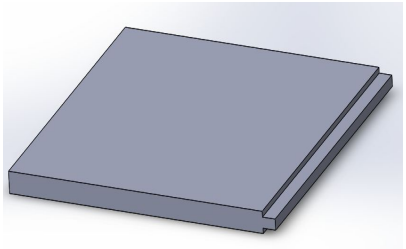


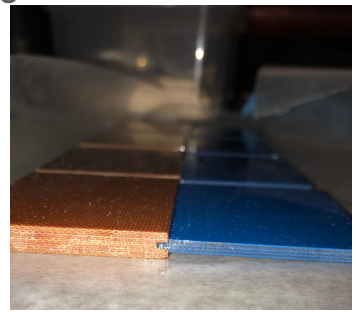


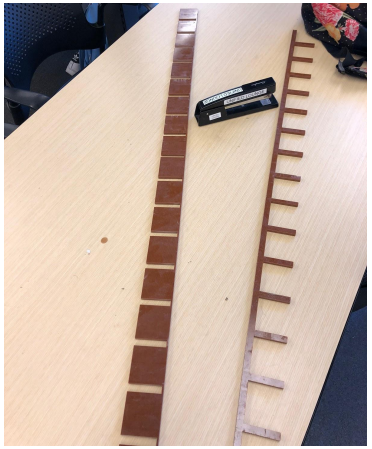
- From Rasaero: M_{max} = 3.4
  - 14,000 - 15,000 ft
- Static loads
  - Primarily drag - 956 lbs

Slot Testing

- Cut G10 and Phenolic squares with waterjet, milled tabs and slots into them, then epoxied them together
- How we tested
- 0.2 inch vs 0.1 inch depth slots/tabs
  - 0.1”-Held 22kg before breaking
    - Neither phenolic nor G10 broke, probably fell because the epoxy gave away
  - 0.2”- Held at least 50kg and did not break
- Decided on 0.3” depth for safety margin







Open Issues

- Updating size of fins (based on mass budget, sims)
- G10 or G10/honeycomb
- G10 tab misalignment
- Number of layers of carbon fiber
- Creases on fillet after vacuum bagging
- Better fin can jig/milling setup
- Sanding inside of phenolic tube is tedious
- The kind of ablative
- LE temp
- Drag on Fin Can

Safety issues:

- The oven, need to have shifts

Fin Can #3 Design

- Phenolic tube with 3 layers of CF overwrap
- Fins: G10 core (subject to change), phenolic LE
- Tip-to-tip layup: additional 6 layers of CF over each fin
- Cotronics epoxy on LE (thermal)
- Interfaces
  - Fin Can Transition

Schedule to Completion

Cutouts **Date: IAP**	**Layup Prep** **Date: IAP**	**Layup/Vacc bagging: 12 hours** **(1 day later)**	**Sanding** **Date: IAP**	**Oven Cure** **Date: (Day after)**
• Fin cutouts and slots • LE cutouts and slots • Attaching LE to fin	• CF cutouts • Vacc bag cutouts	• Oven 12 hours (day after layup)	• Root bond • Fillets	• Oven Cure

Yay rockets!

← spooky