

Designing and Flying an Experimental Sounding Rocket



TEAM 24

ALEX MIRE

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Problem Statement & Scope

Design and construct a rocket capable of carrying an experimental payload to be launched and safely recovered within the parameters of the 2017 Intercollegiate Rocket Engineering Competition hosted by the Experimental Sounding Rocket Association.



Figure 1: 2015-2016 Intercollegiate Rocket Engineering Competition ^[1]

The Competition

- **Category:** 10,000 ft using COTS solid or hybrid propulsion
- **Location:** Truth or Consequences, New Mexico
- **Date:** June 20-24, 2017
- **Purpose:** To promote further experimentation in the field of sounding rocketry.



Figure 2: Spaceport America^[2]

Competition Requirements

- Payload
 - 8.8 lbs
 - CubeSat outer dimensions (10cm x 10cm x 11.35cm)
 - Scientific experiment or technology demonstrations (recommended)
- Recovery
 - Dual Deployment required for vehicles 1,500+ ft
- Electronics
 - 1 COTS altimeter
 - Redundant electronics
 - Radio beacon

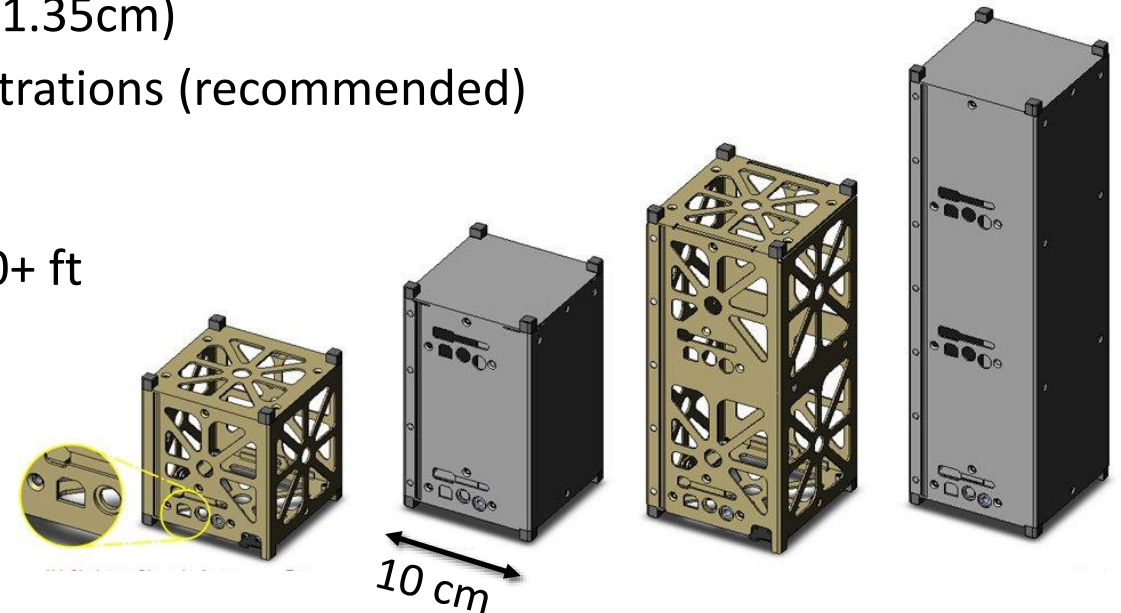


Figure 2: CubeSat Sizes^[3]

Point Breakdown (1,000 Points Total)

- Entry Form and 3 Progress Updates **(100)**
- Project Technical Report **(200)**
 - Analysis
- Design Implementation **(200)**
 - Competency of Design and Construction
 - Degree of SRAD
- Flight Performance **(500)**
 - Apogee
 - Successful Recovery
- Unsafe or Unsportsmanlike Conduct **(-20)**



Spaceport America Cup

Intercollegiate Rocket Engineering Competition
Rules & Requirements Document

Figure 4: Competition rules document coverpage ^[4]

Design Overview

- Length: 97.7 in
- Mass: 66.7 lb
- Rocket ID: 6 in
- Rocket OD: 6.14 in
- 5 segments
- Fiberglass Body

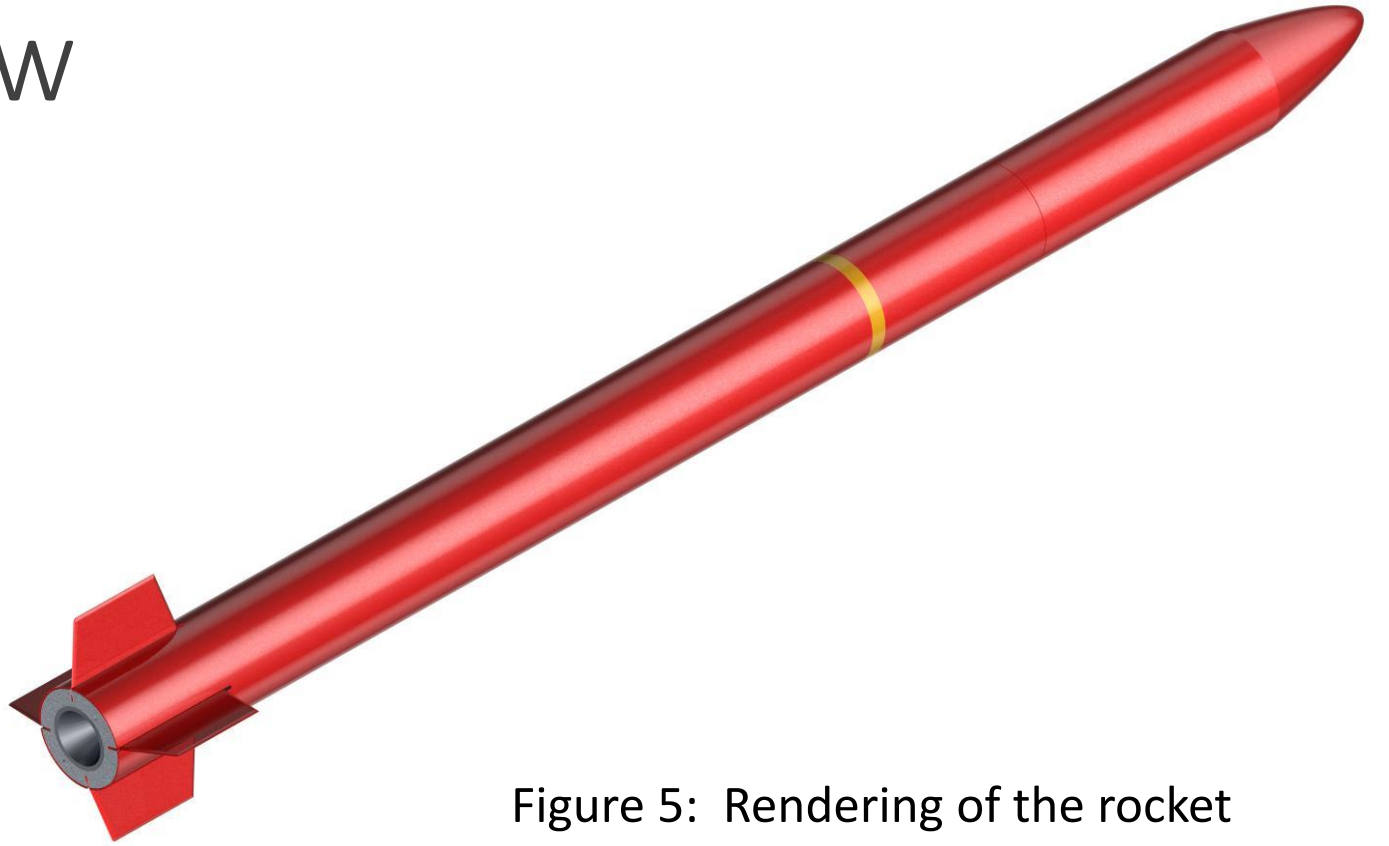
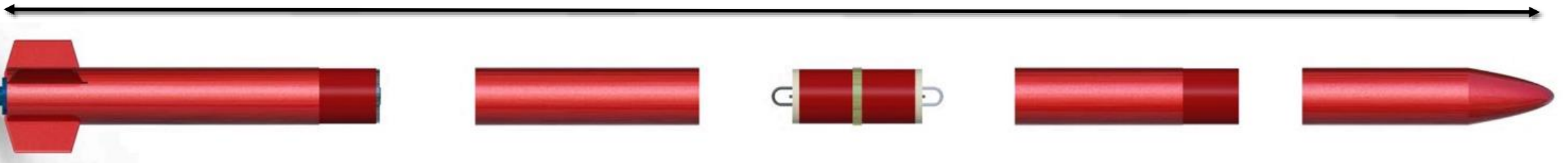


Figure 5: Rendering of the rocket

~8'



Booster Segment

- Cesaroni M1450-P motor (98mm)
 - 6.87 second burn
 - Rocket will experience 6.6 G's
- Wooden centering rings
- Fiberglass fins

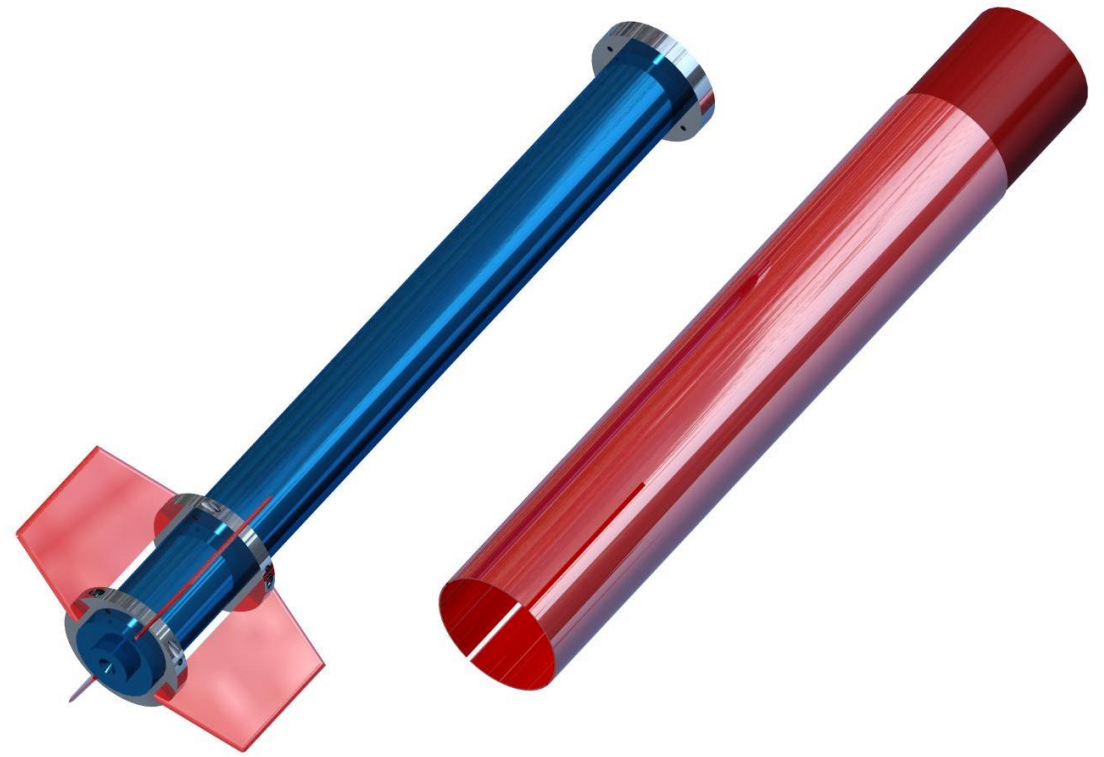
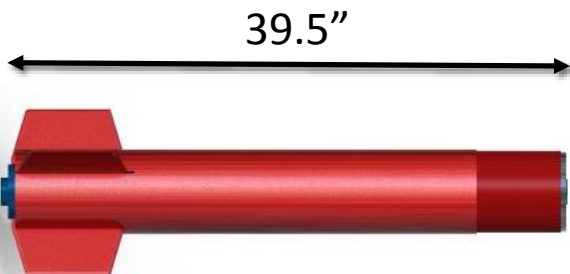


Figure 6: Booster section and surrounding tube

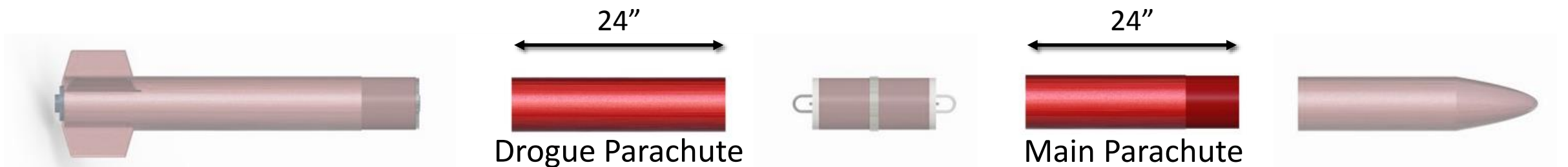


Parachute Bays

- Drogue parachute: Rocketman 3ft parachute
 - Decent rate of 90 ft/s
- Main parachute: XXL B2 parachute
 - Decent rate of < 17 ft/s
- “Zipper-less” design



Figure 7: Separated drogue parachute bay.



Avionics Bay

- Fiberglass outer body
- Ejection charges
- Exposed ring for Altimeters
- Parachute Mounting U-bolts
- Redundant electronics

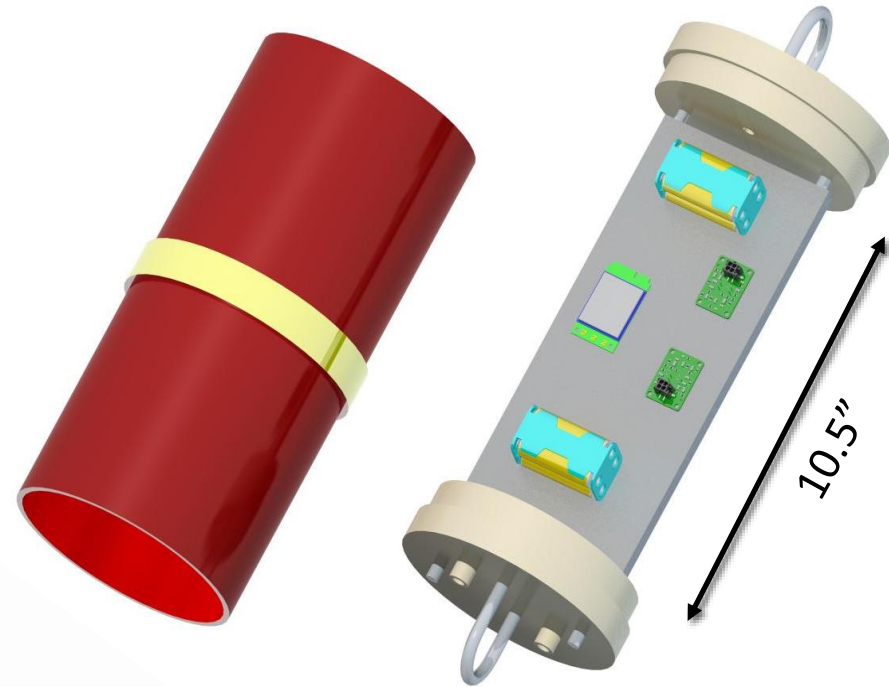
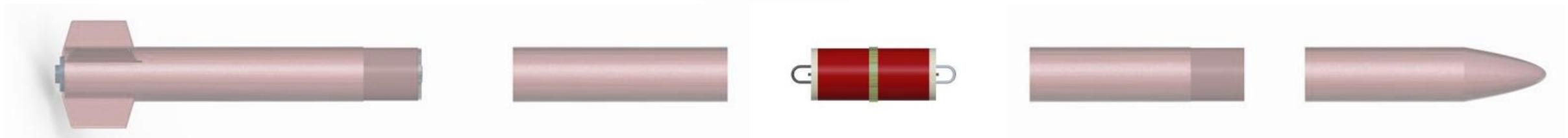
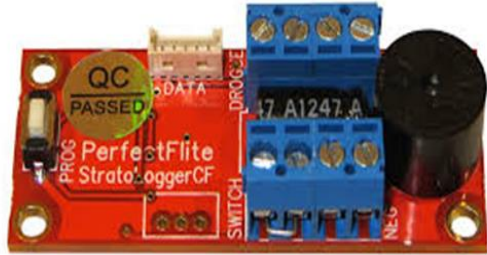


Figure 7: Avionics sled and bay body section^{[5] [6] [7]}



Avionics



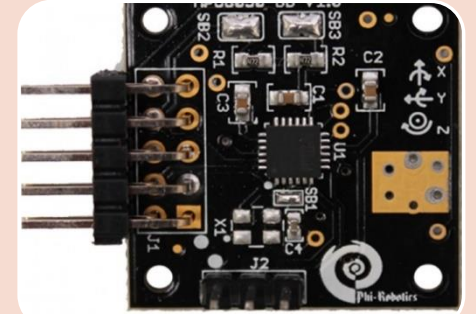
StratoLoggerCF
Altimeter will serve as the official log of the rocket's altitude and meet the COTS requirement ^[8]



The **Freescale Freedom** microcontroller will connect all of the components and log data ^[9]



The **Xbee s3b** RF beacon will allow the team to locate the rocket after a safe landing ^[10]



The **Inertial Measurement Unit** will serve as an accelerometer and altimeter ^[11]

Nose Cone and Payload

- 3D printed nose epoxied to fiberglass tube
- Centering Rings hold CubeSat
- CubeSat contains 8.8lb payload

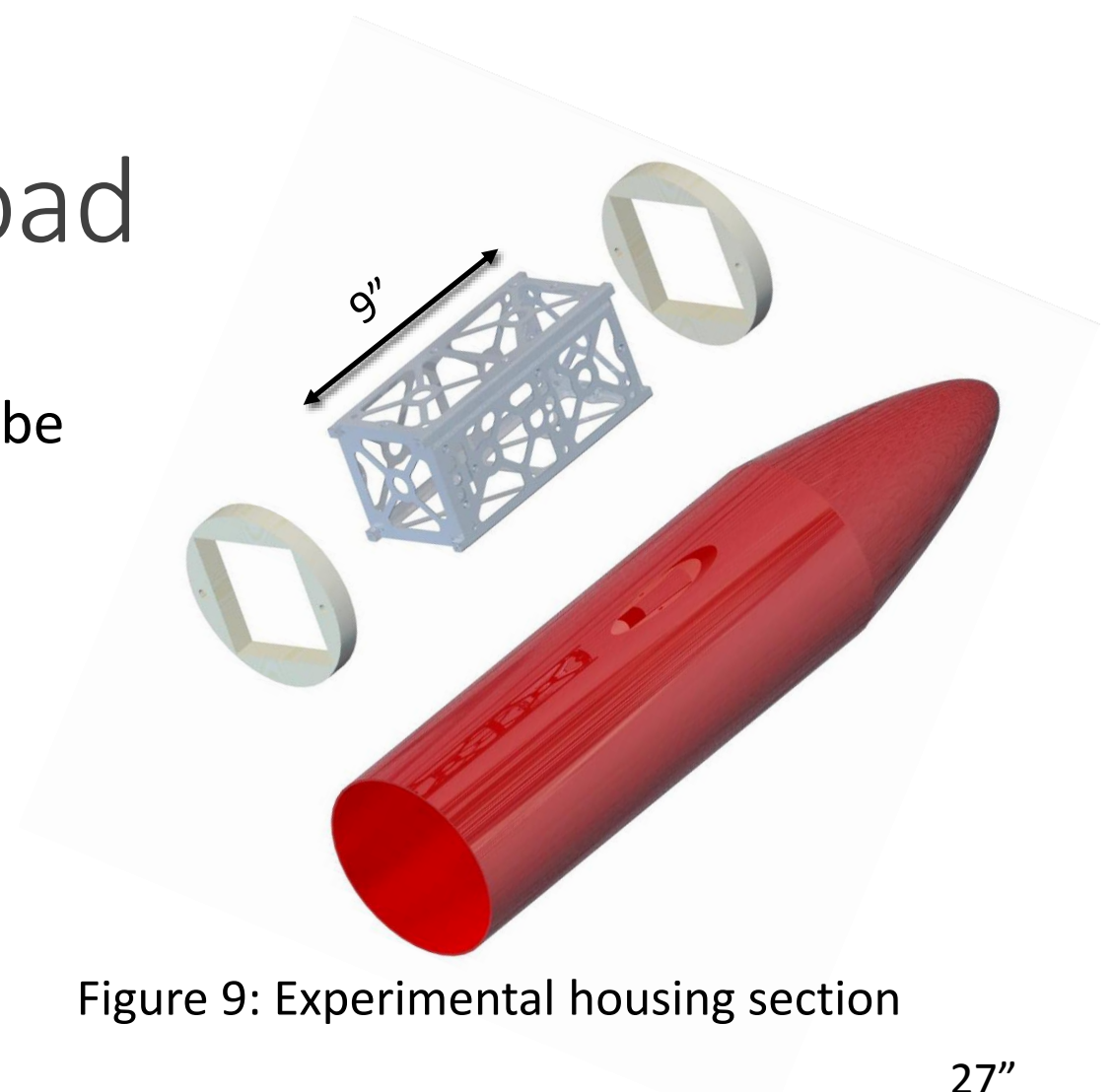
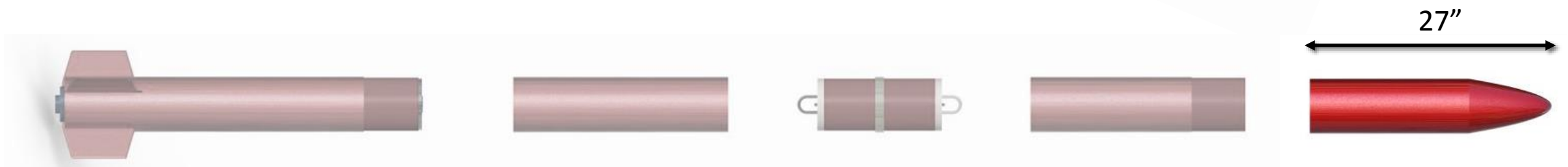


Figure 9: Experimental housing section



Parts Ordered

FIBERGLASS CONSTRUCTION

- Fiberglass Cloth
- Epoxy
- Hardener
- Aluminum Pipe (Mandrill)
- Mold Release Lubricant



Figure 10: Fiberglass [12]

STRUCTURAL COMPONENTS

- Hex Nuts
- Nut Plate
- Threaded Rods



Figure 11: Hex Nut [13]

AVIONICS

- StratoLoggerCF Altimeter
- 9 Volt Battery Clip
- Mounting Hardware
- Data Transfer Kit
- 20 AWG Wire



Figure 12: StratoLoggerCF [8]

COST

- Parts and materials: \$508.71
- Competition fees: \$200
- **Total Spent: \$708.71**

Changes and Current Issues

Changes

- Transitioned from metal to wooden centering rings.

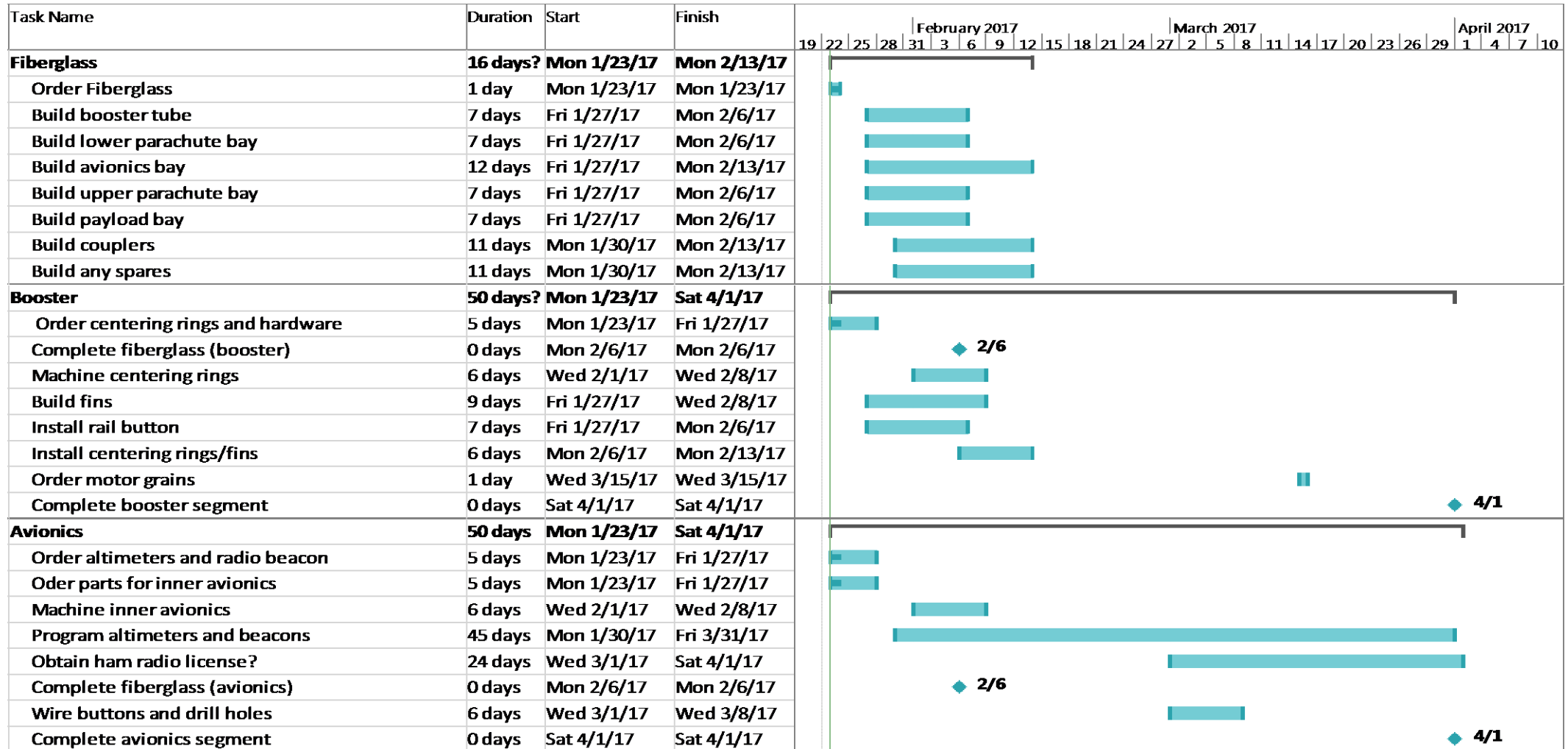
Current Issues

- May need to reevaluate motor choice.
- Fiberglass may affect weight more than anticipated.

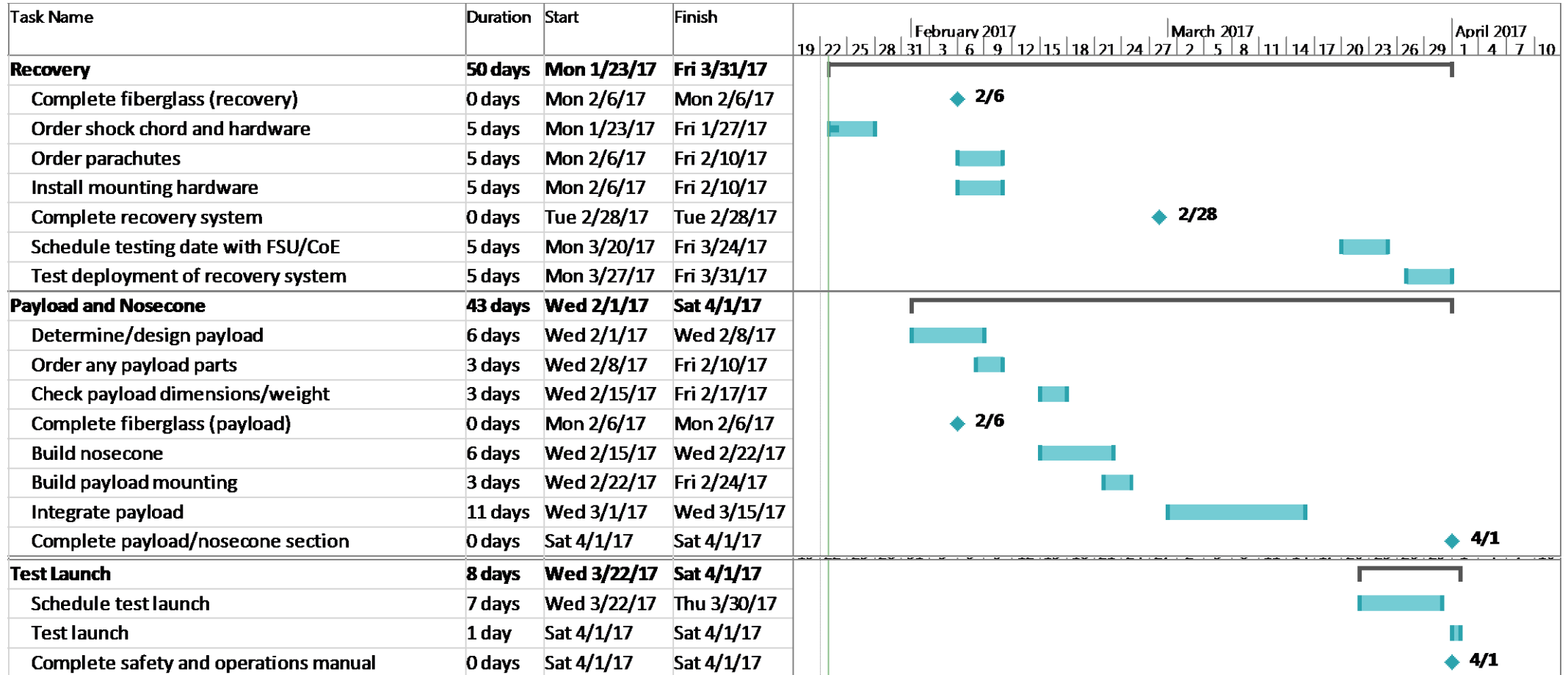


Figure 13: Aircraft-grade Finnish Birch ^[14]

Gantt Chart



Gantt Chart



Safety

Fiberglass Production	Recovery System Test	Flight Test	Storage & Handling Energetics	Electrical
<ul style="list-style-type: none">• Nitrile gloves• Safety glasses• Face masks• Skin coverage• Defined roles & procedure• Off-campus	<ul style="list-style-type: none">• Remote arming & detonation• On-campus• Supervision	<ul style="list-style-type: none">• Off-campus• Launch Safety Officer• Remote arming & launch• Review protocol	<ul style="list-style-type: none">• On-campus• Limited access• Safety protocol• Staff notice	<ul style="list-style-type: none">• Research• Review• Proper purchasing• Circuit Testing

References

[1] <http://www.soundingrocket.org/latest-news>

[2] <http://www.americaspace.com/?p=72686>

[3] Vyonyx ltd

[4] <http://www.soundingrocket.org/sac-documents--forms.html>

[5] <https://grabcad.com/library/battery-pack-2>

[6] <https://grabcad.com/library/printed-circuit-board-4>

[7] <http://www.pro38.com/products/pro24/pro24.php#>

[8] <http://openrocket.sourceforge.net/>

[9] <http://www.nxp.com/products/software-and-tools/hardware-development-tools/freedom-development-boards:FREDEVPLA?tid=vanFREEDOM>

[10] <http://www.mouser.com/ProductDetail/Digi-International/XBP9B-DMWT-012/?qs=NnxJOTDiCpOOEE6pVdOjDg%3D%3D&gclid=CLPj7J3T2dECFUkDhgodvHAEDw>

[11] https://www.tinkerforge.com/en/doc/Hardware/Bricks/IMU_V2_Brick.html

[12] <https://www.urbanwebsites.com/sabalan-enterprises/index.html>

[13] <http://www.webstaurantstore.com/nemco-45050-stainless-steel-hex-nut-for-easy-frykutters/59245050.html>

[14] <https://woodcraft-assets-weblinc.netdna-ssl.com/Images/products/600/152976.jpg>

Thank you!

Questions?

