Research and Design of a High Powered Rocket and Reaction Control Wheel Payload

Nurettin Kagan Aslan, Jose Chavez, Tsz Pan Chu, Cristian Edgar, Matthew Estenoz, Gavin Gamble, Bilal Hassan, Faisal Khanfar, Wiler Sanchez, Asher Siddiqui

Swamp Launch IREC

AIAA Region II Student Conference, April 4-5th, 2022

Copyright © by Swamp Launch Rocket Team
Published by the American Institute of Aeronautics and Astronautics, Inc., with permission.

How to Design a Rocket?

IREC Spaceport America Cup 22

- 10,000 feet target altitude
- COTS Motor
- Payload > 8.8 lbs and CubeSat Form Factor
- Must be GPS trackable

Team Structure

Project Manager

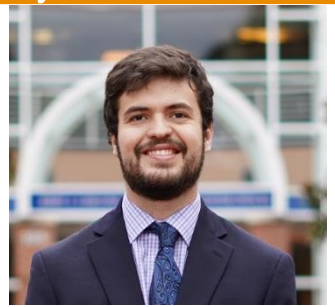
Flight Dynamics

Structures

Avionics & Recovery

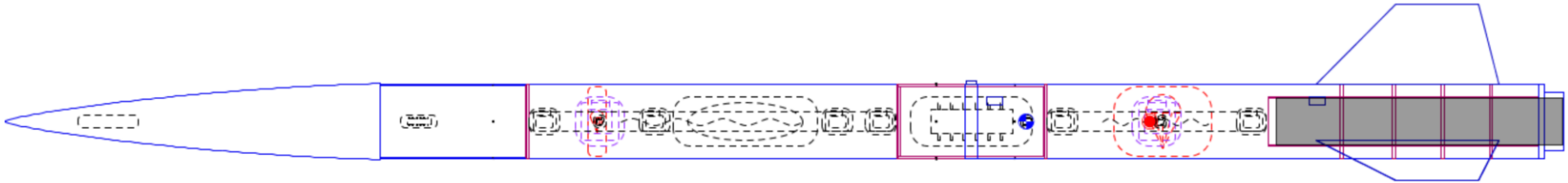
Payload Controls

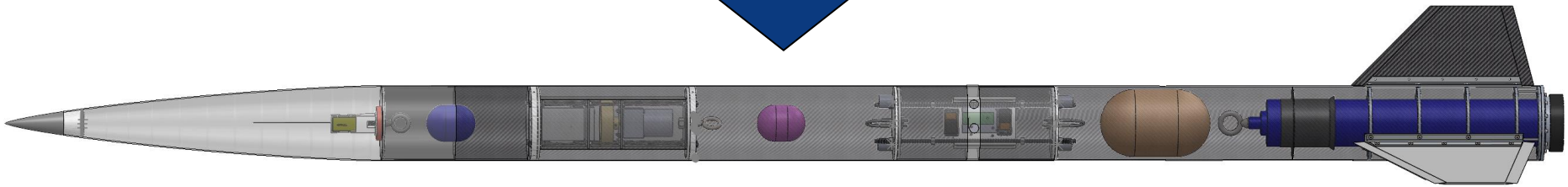
Payload Structures



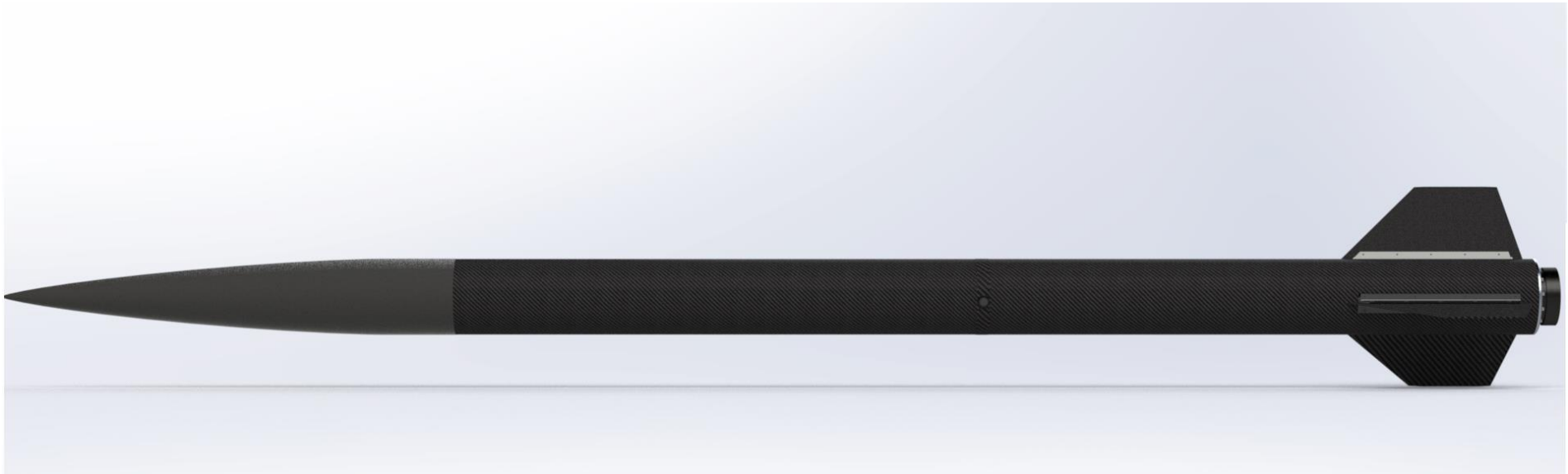
Payload Electronics

Flight Dynamics

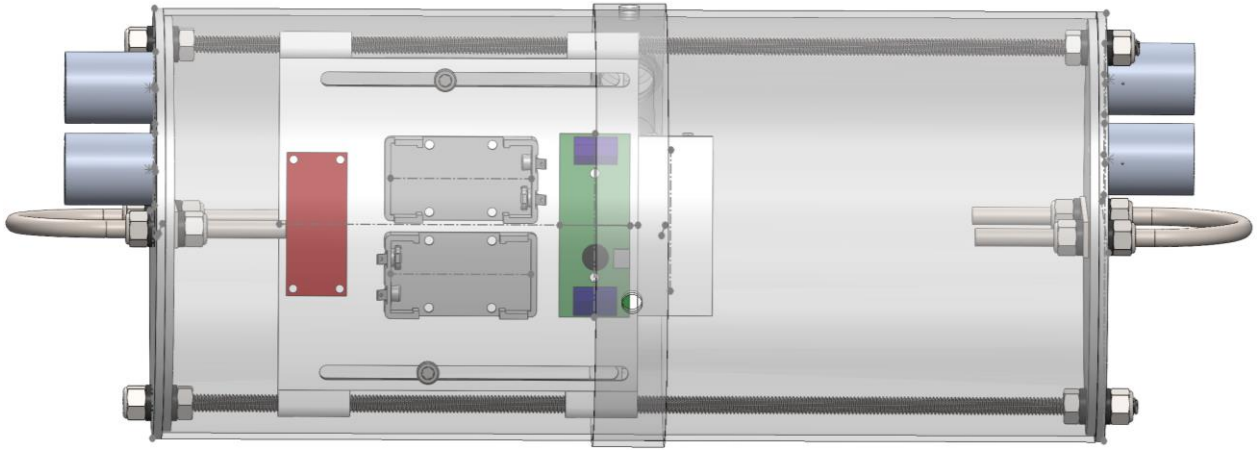




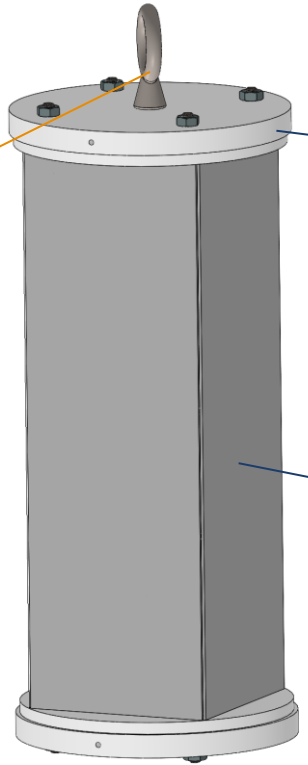
Structures



Avionics & Recovery



Payload Structures



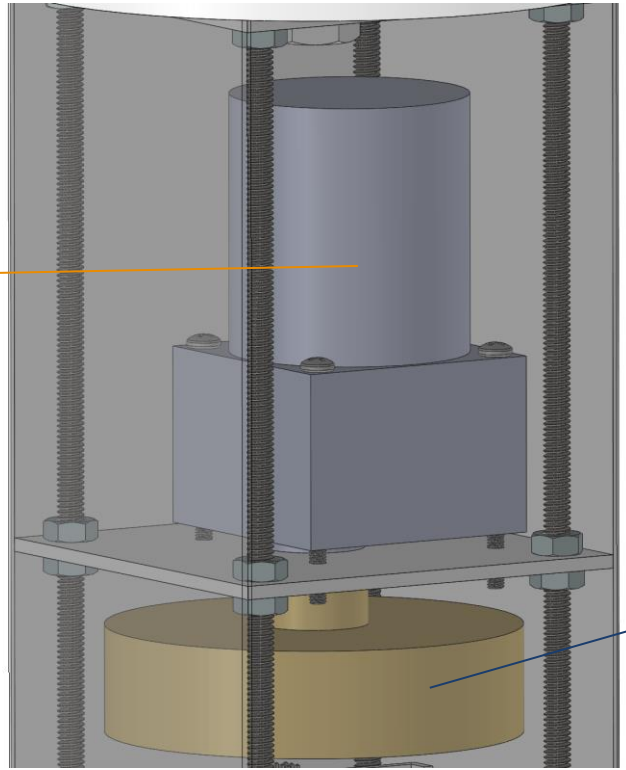
Steel Eyebolt

Payload Adapter

CubeSat Structure

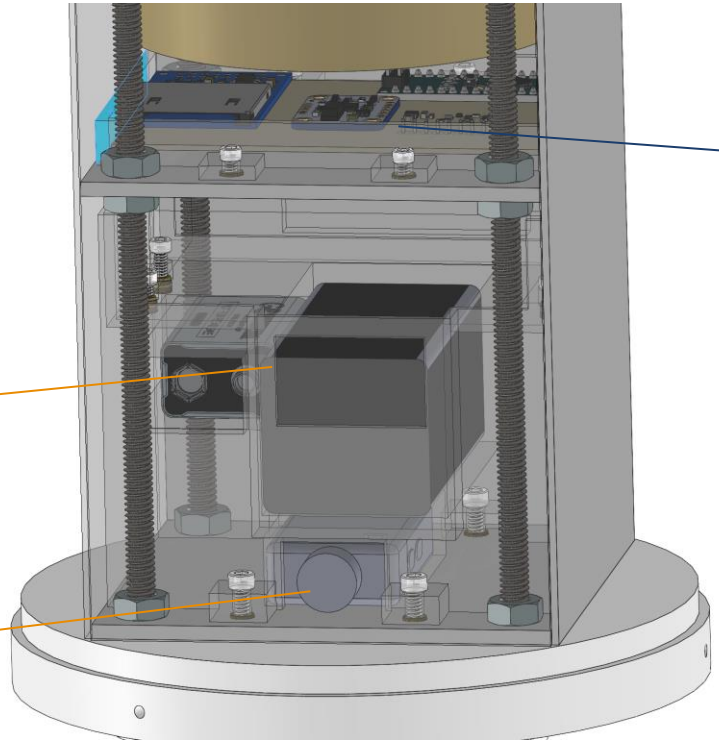
Payload Controls

BLDC Motor

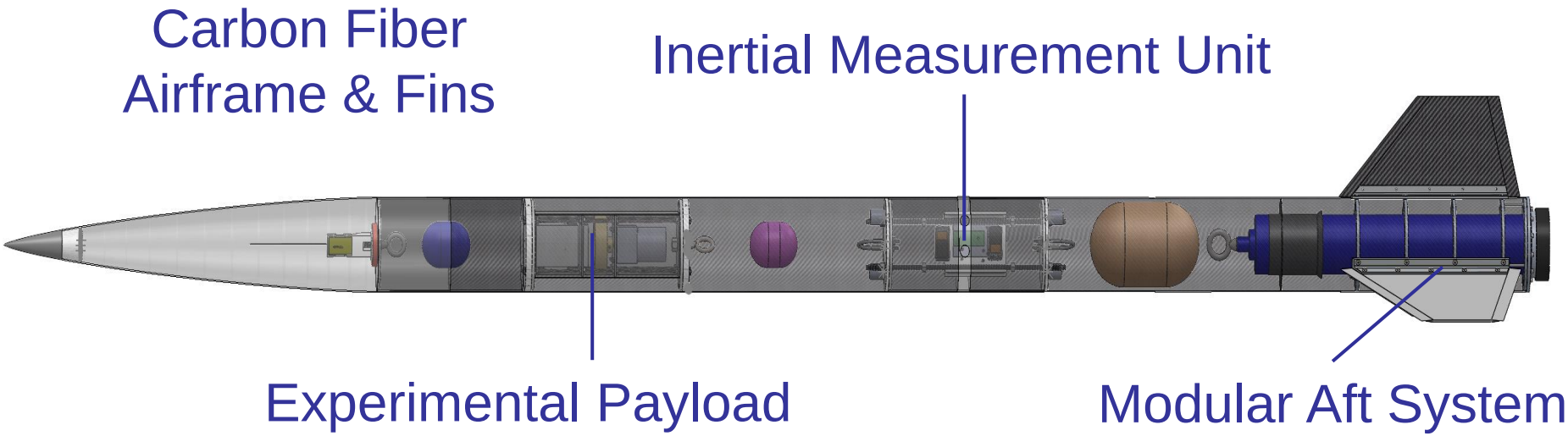


Brass Flywheel

Payload Electronics



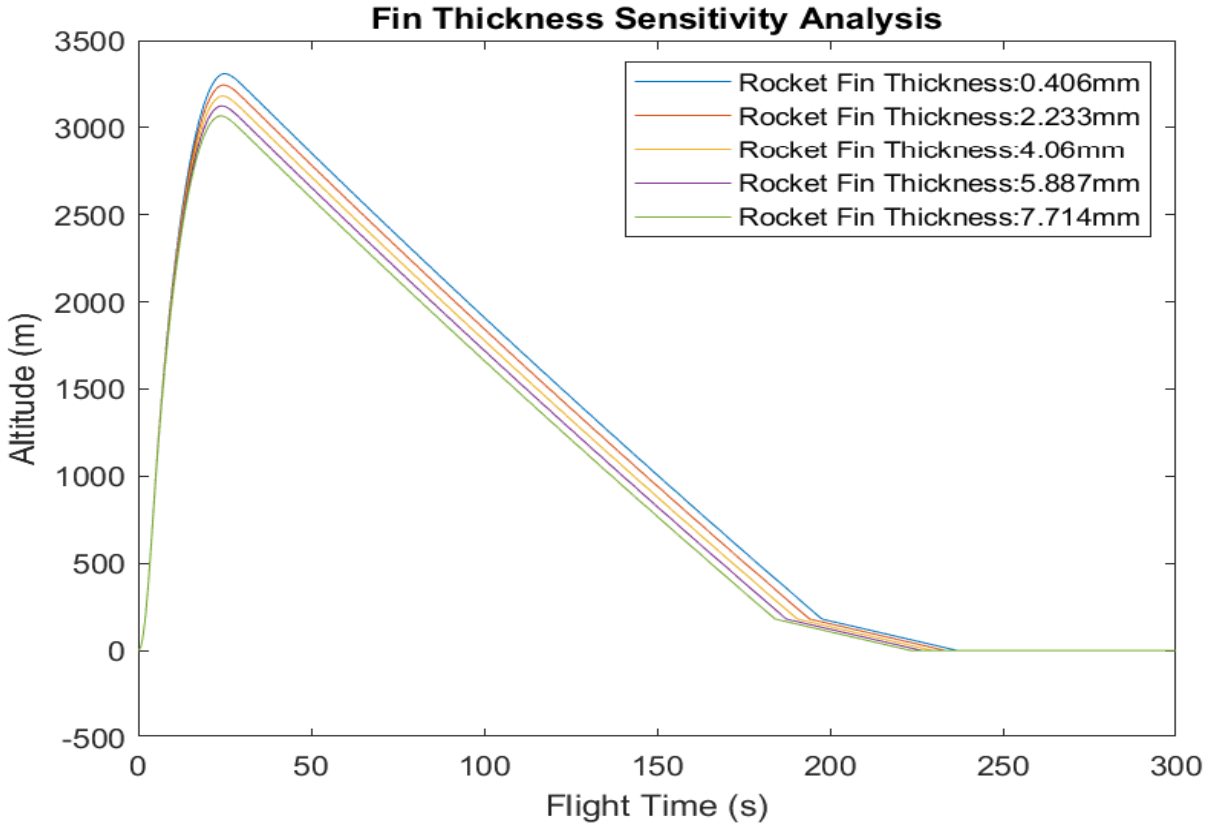
Launch Vehicle Overview



Flight Dynamics

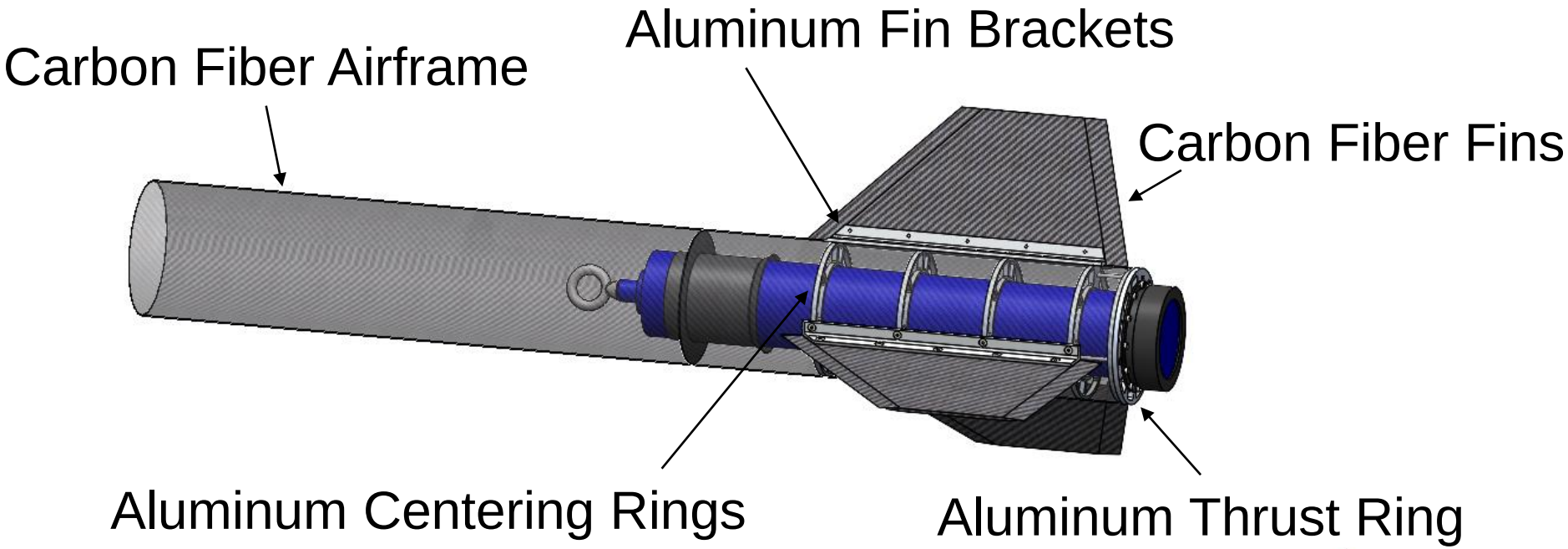
	OpenRocket	MATLAB	Percent Deviation
Apogee (ft)	10524	10437	0.827
Max Mach Number	0.890	0.873	1.91
Static Stability Margin	1.64	1.66	1.22

Flight Dynamics



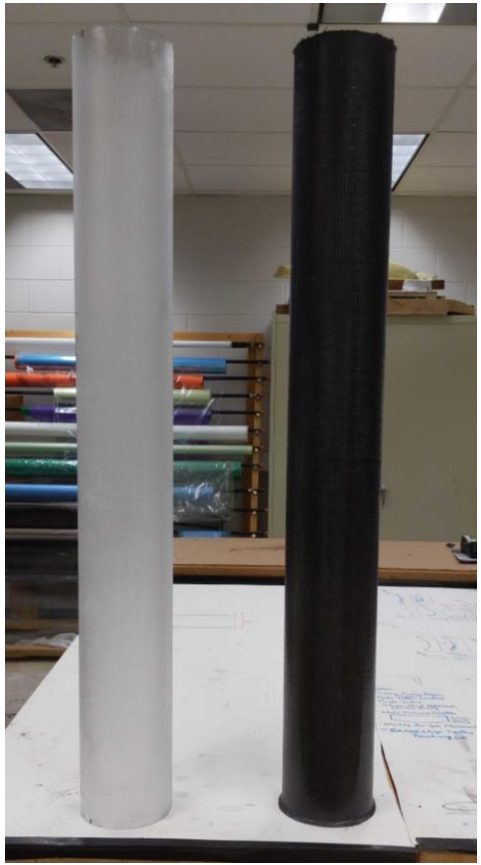
Structures - Modular Aft

Student-Designed and Manufactured Components

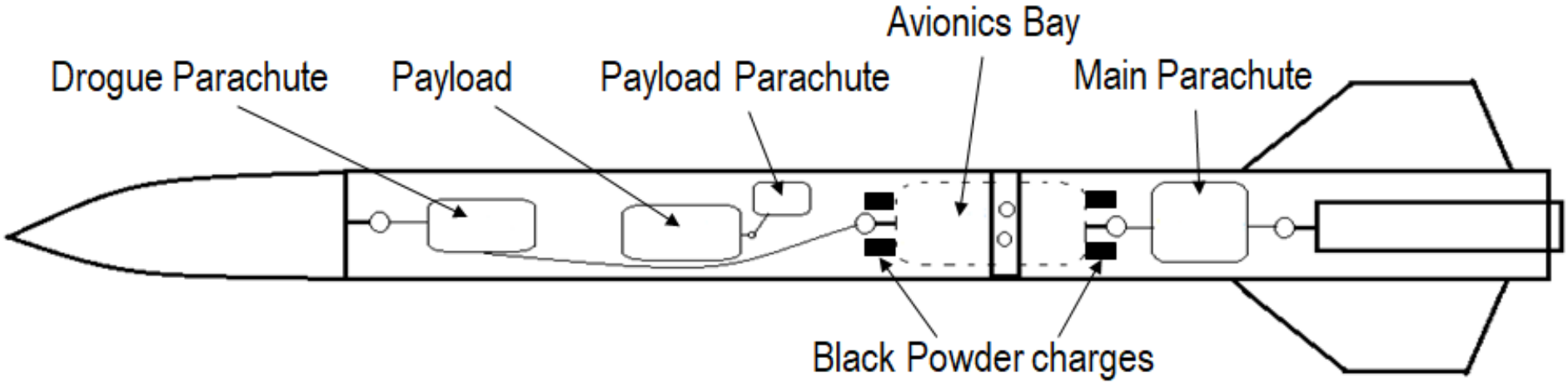


Structures – Composite Materials

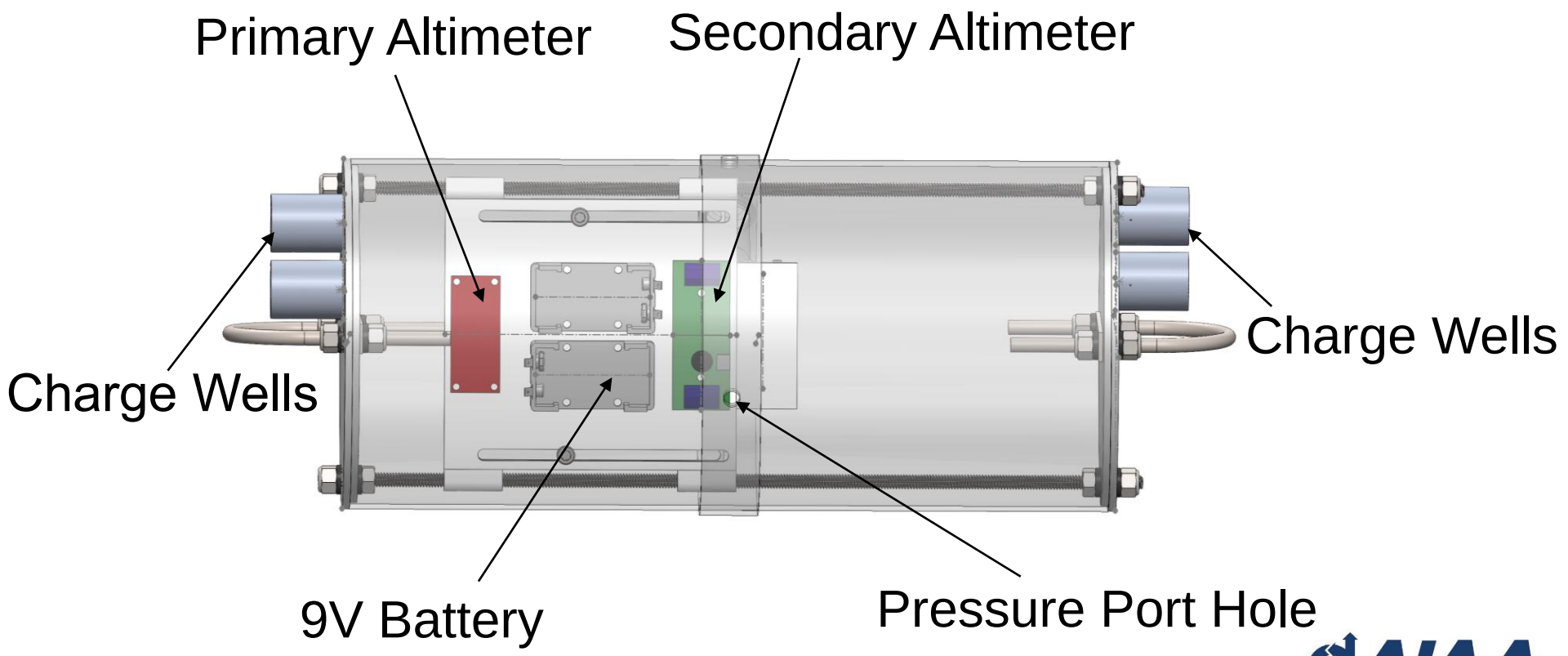
- Airframes
  - Wet layup with sleeves
  - ~40% lighter than COTS G12
  - < $30 per foot
- Fins
  - Custom Prepreg Layup
  - ~ 20% lighter than COTS G10
  - Increased flutter resistance



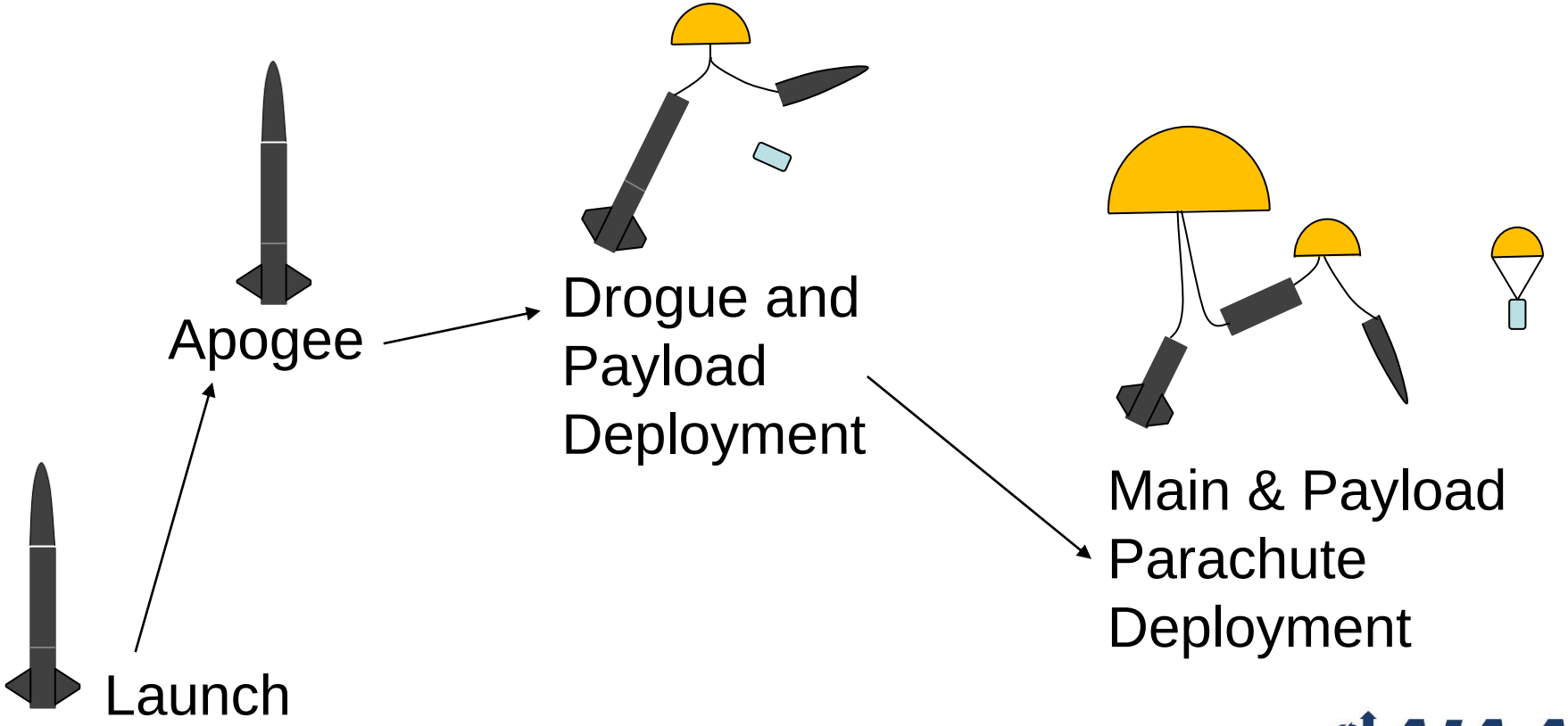
Avionics & Recovery



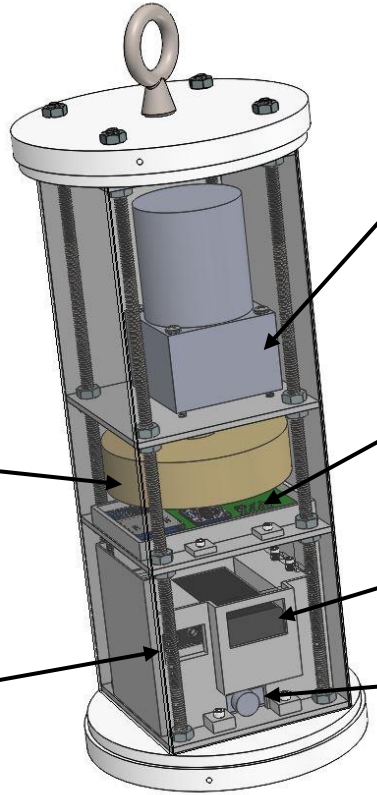
Avionics & Recovery



Avionics & Recovery



Payload Overview



30W BLDC Motor

Microcontroller

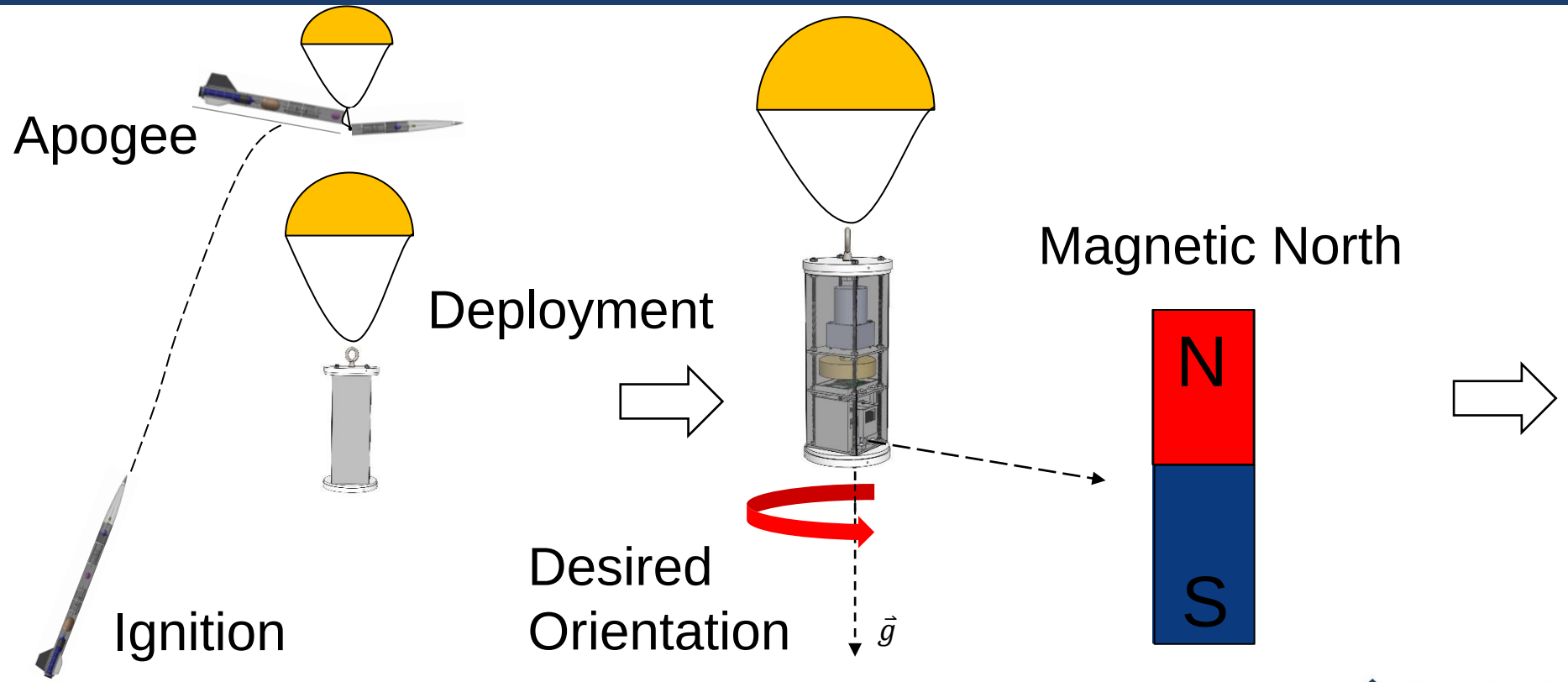
Brass Flywheel

14.8V Motor Battery

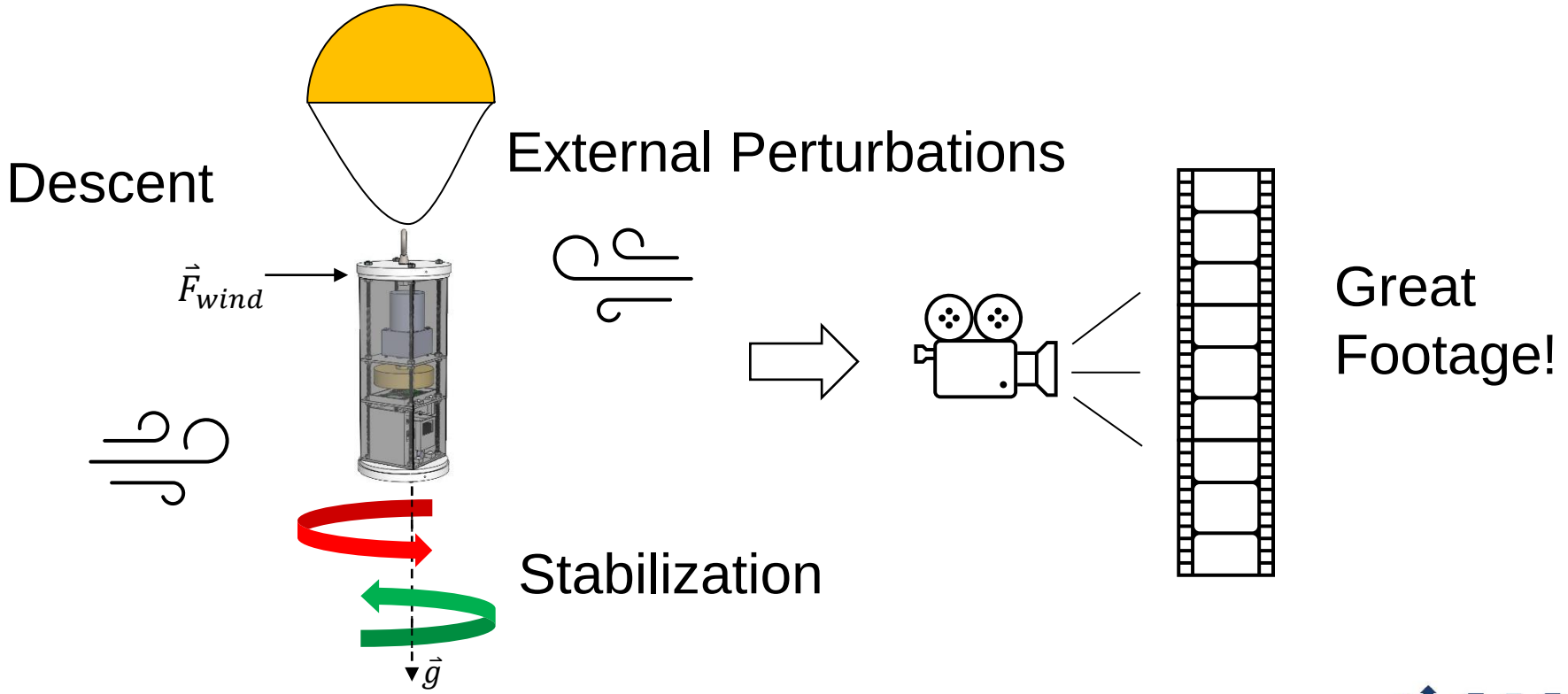
9V Battery

Camera

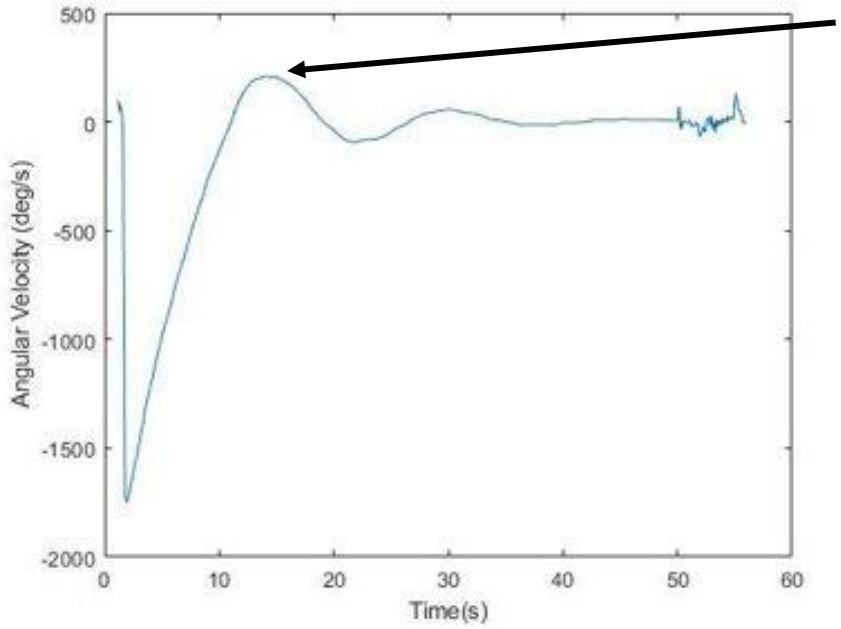
Payload Overview



Payload Overview



Sizing Components for Control System



200 deg/s peak

$$I_{RW}\omega_{RW} = I_{PL}\omega_{PL}$$

30W, 3000 rpm BLDC motor

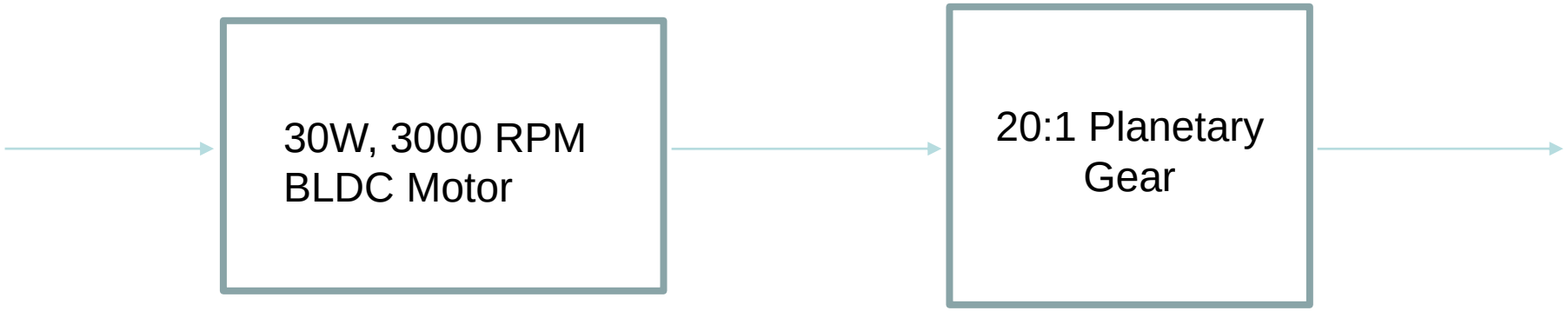
20:1 Gear Ratio

Payload Power Flow

$V_{in} = 12\ V$
$I_{in} = 3.3$ amp

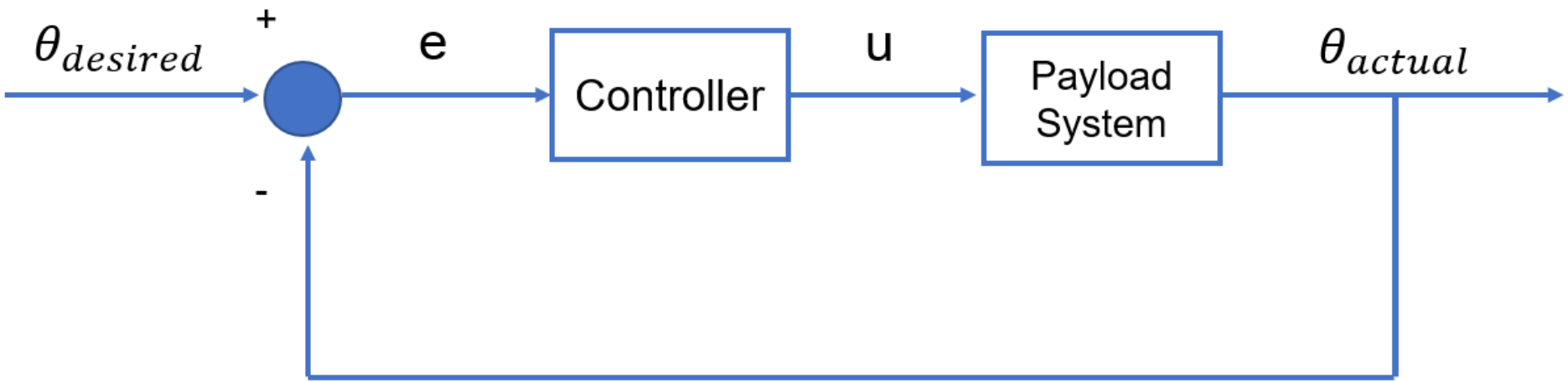
$T_{\text{mtr}} = 0.1$ Nm
$n_{\text{mtr}} = 3000$ RPM

$T_{\text{RW}} = 2$ Nm
$\omega_{RW} = 150$ RPM

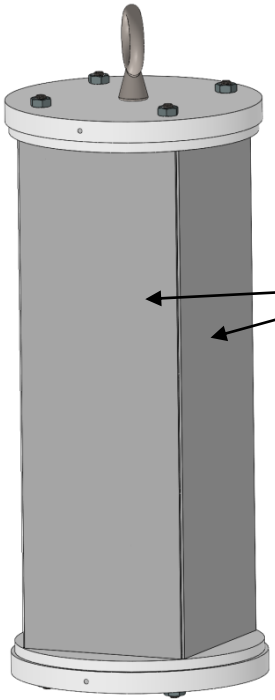


$$\frac{I_{RW}\omega_{RW}}{I_{PL}} = \omega_{FW,max} = 203.4 \text{ deg/s}$$

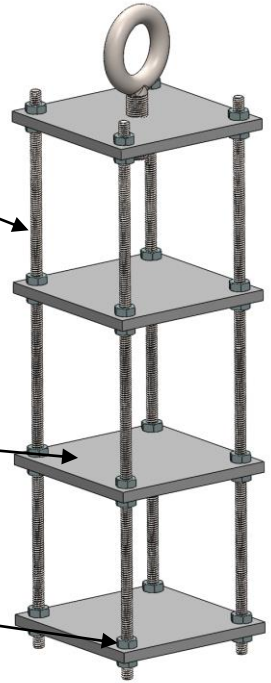
Payload Control Diagram



Payload Structure



Fiberglass Plates



Payload Electronics

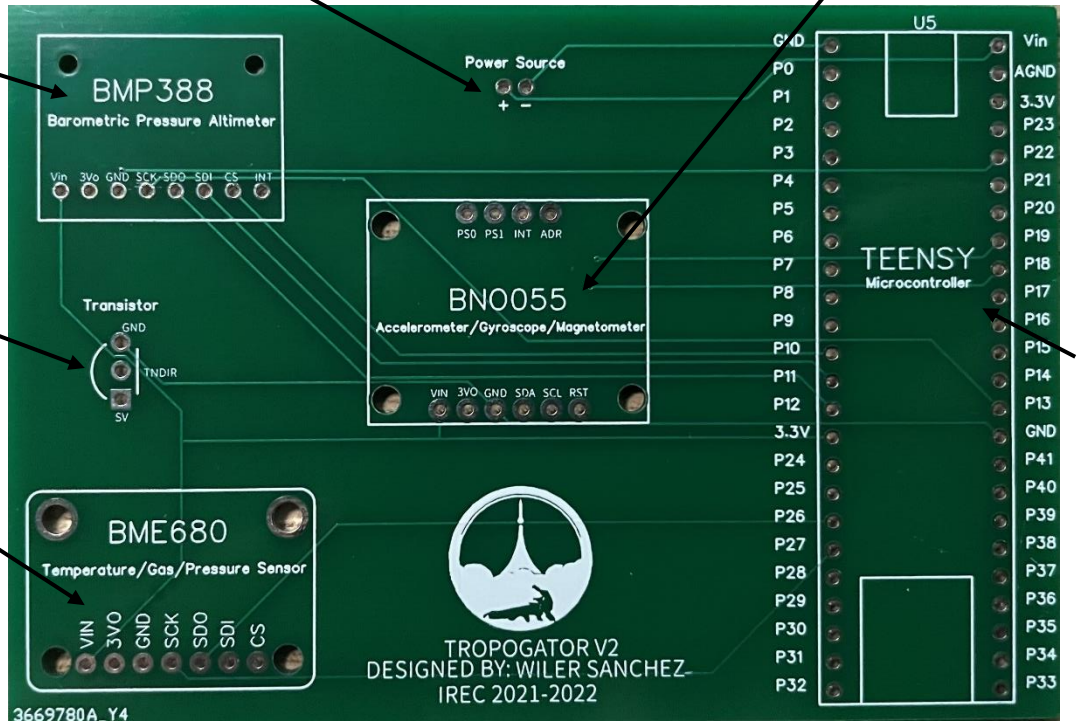
Barometric Pressure Altimeter

Power Source

Accelerometer

Transistor

Barometric Pressure Altimeter



Microcontroller

Conclusion

AMERICAN INSTITUTE OF
AERONAUTICS AND ASTRONAUTICS