RECOVERY TEAM REPORT

WEEK 8

These Weeks Tasks

1. Testing the sensors.
2. PCB etching
3. Soldering components onto the PCB
4. Visualize the sequence of parachute ejection
5. 3D printing of piston components.

Time frame

PROJECT TITLE

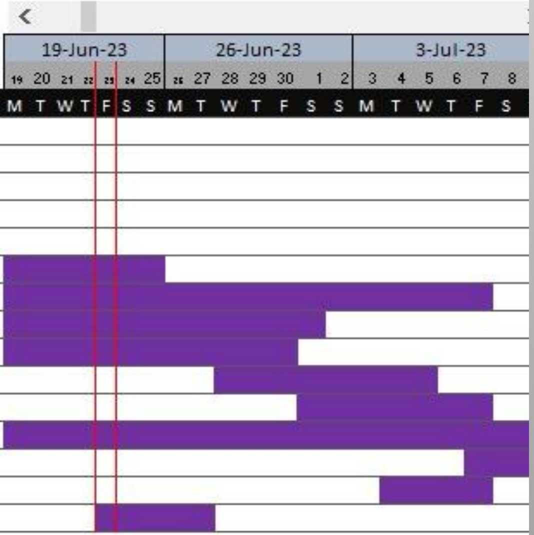
Project name: Nakuja-3

Project Lead: Dr. Aoki

Project Start: Tue,2-May-2023

Display Week: 8

TASK	ASSIGNED TO	PROGRESS	START DATE	END DATE	DURATION
Introduction	N/A	100%	2-May-23	5-May-23	3
Change the piston cylinder to steel	E/T	100%	8-May-23	12-May-23	4
Implement the OTA updates to the system	V/C/B	100%	15-May-23	19-May-23	4
Rectifying the code for the piston test	S/B	100%	17-May-23	19-May-23	2
Design the Mechanism for holding the flight computer	B/E	10%	12-Jun-23	14-Jun-23	2
Design and fabrication of the ejection cap	B/E	50%	22-May-23	25-Jun-23	34
Determine the amount of crimson powder to be used	E/T	10%	22-May-23	7-Jul-23	46
Design and fabricate the PCB for the flight computer	P/C	70%	9-Jun-23	1-Jul-23	22
Design the mechanism to hold the piston in the rocket	B/E	70%	5-Jun-23	30-Jun-23	25
Test the ejection system with the nose cone		0%	28-Jun-23	5-Jul-23	7
Test how to log data from the flash memory		10%	1-Jul-23	7-Jul-23	6
Research the best time to eject the parachute	V/T	20%	22-May-23	9-Jul-23	48
Test the flight computer		0%	7-Jul-23	12-Jul-23	5
Test the communication system		0%	4-Jul-23	7-Jul-23	3
Video transmission from the rocket		15%	23-Jun-23	27-Jun-23	4

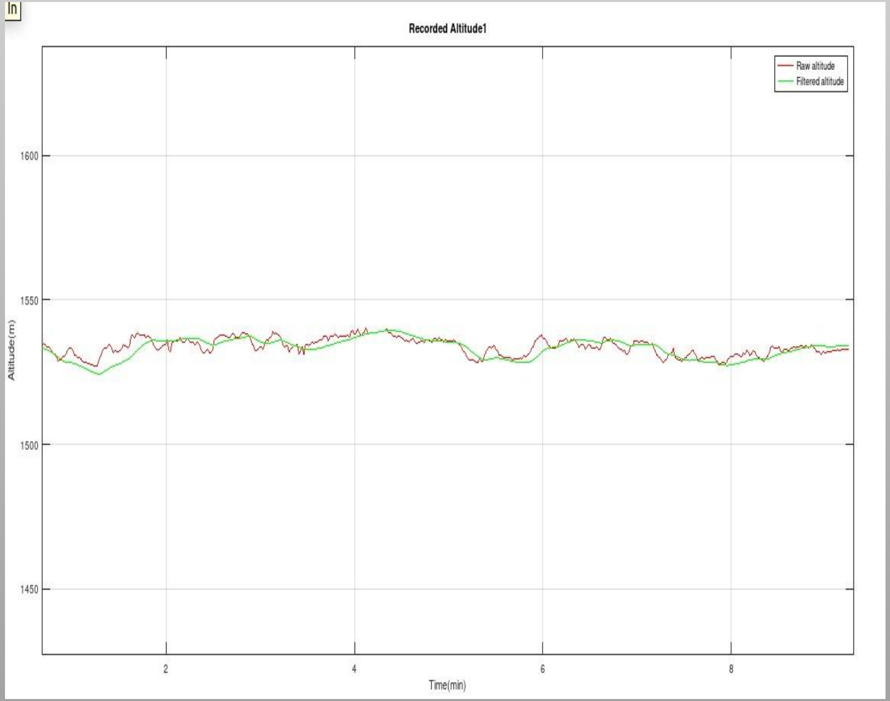


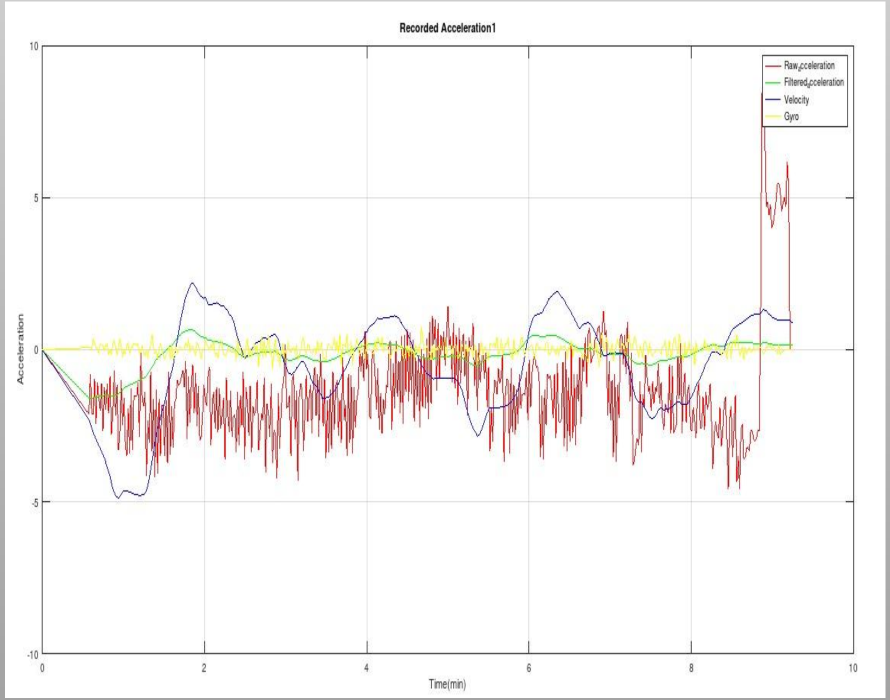
We are behind schedule due fabrication of the flight computer and 3D printing of parts.

1. Kalman Filter

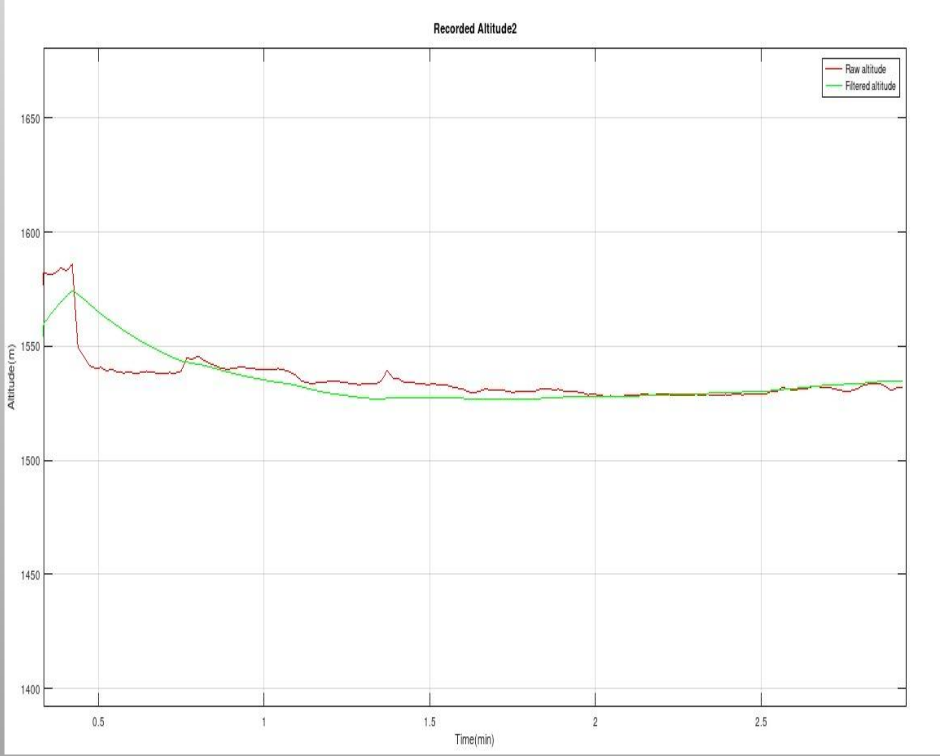
- We carried out tests to check the validity of our filter and sensors.
- We implemented the GPS module to ensure our MPU was working well and if the data received was accurate.
- First tests - walking from IPIC to SPA third floor
- Second tests - walking from SPA third floor to ground.
- Third tests - running in the Rugby field.

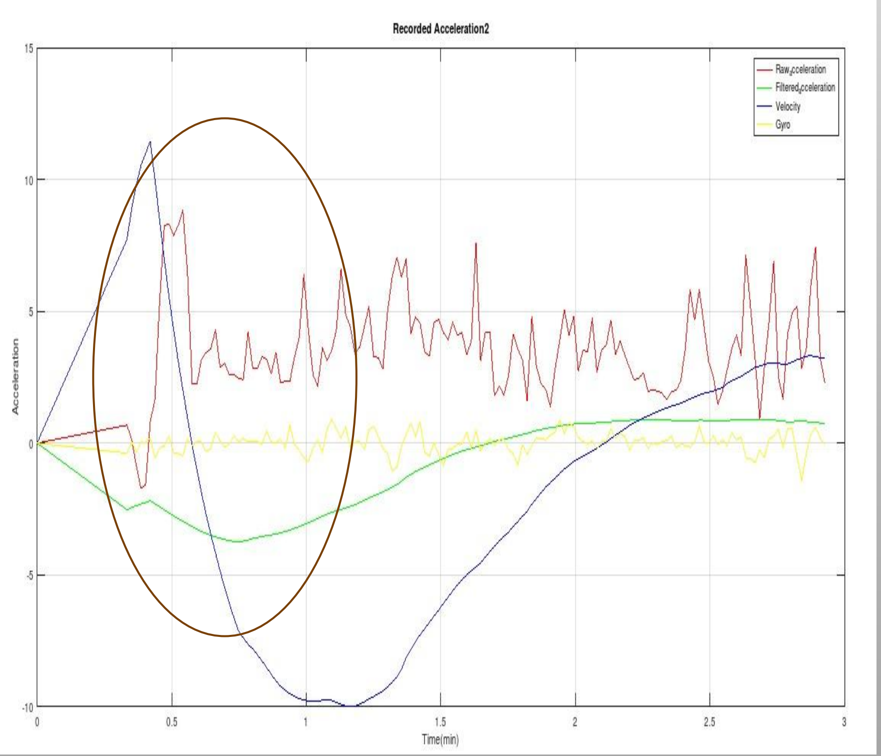
Results (without GPS module)



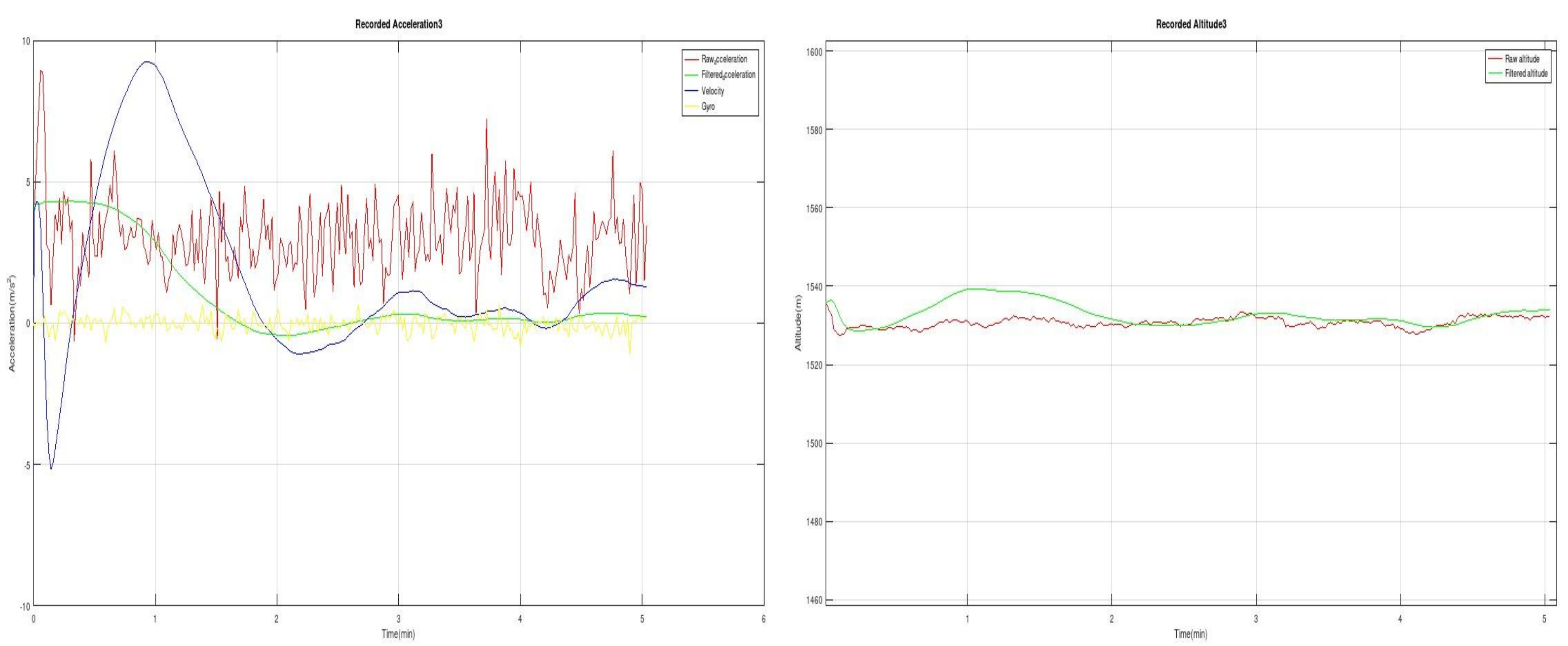


- The kalman filter and sensors behaved as expected.



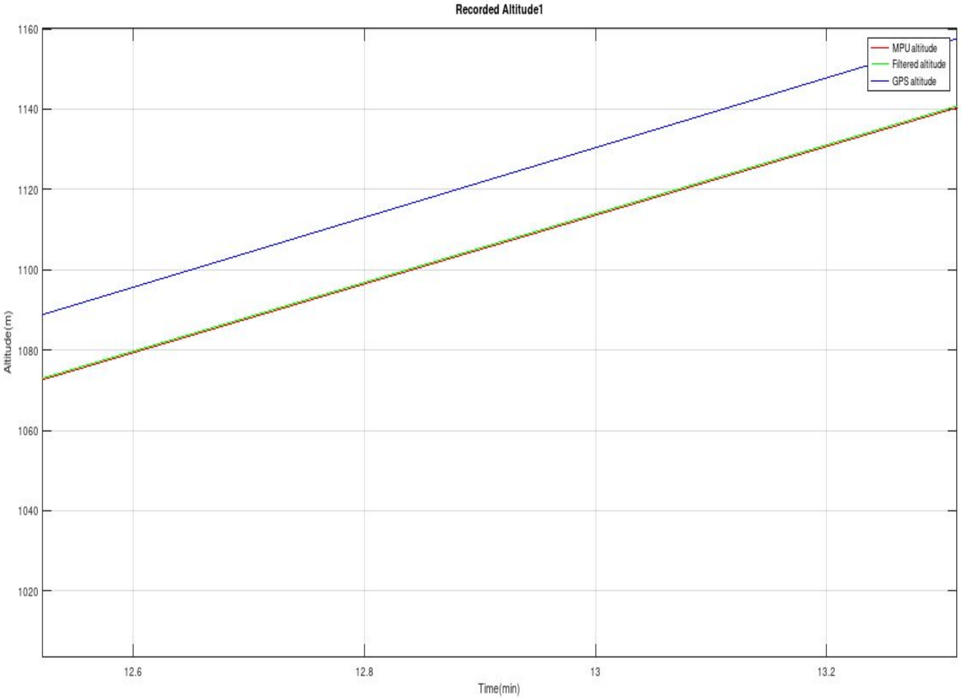


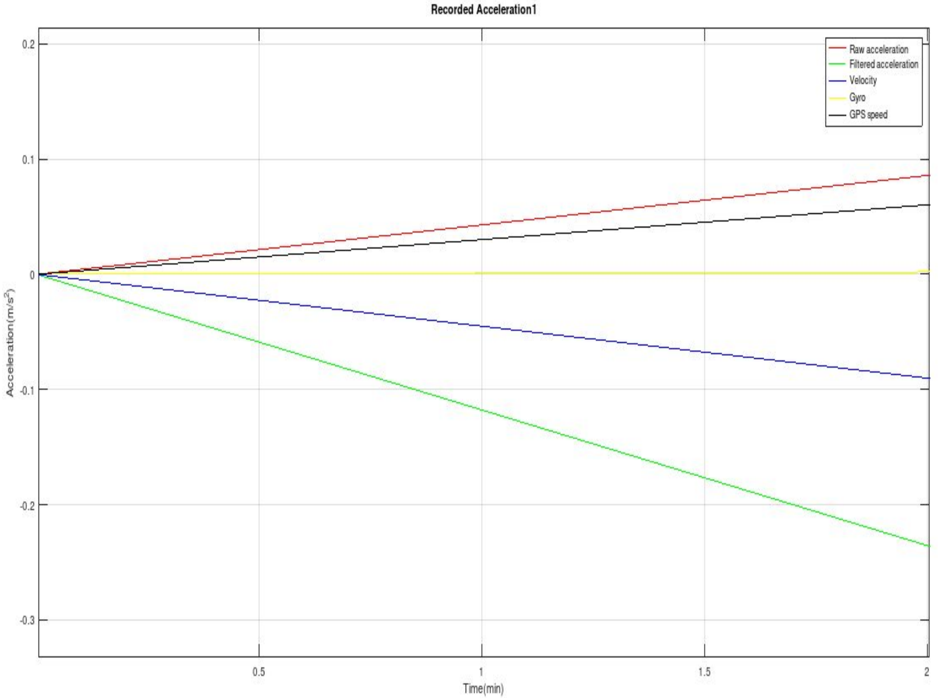
There is a decrease in altitude as expected, however in case of acceleration it was filtered as decelerating.



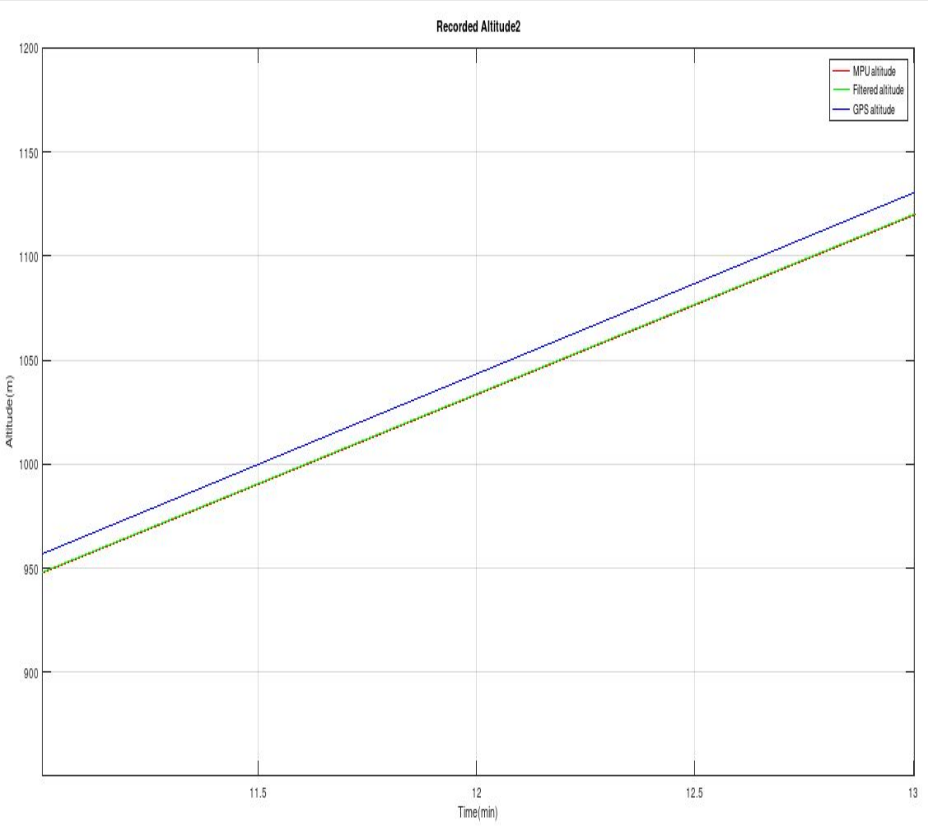
The MPU and filter maintained a steady altitude and acceleration was as expected.

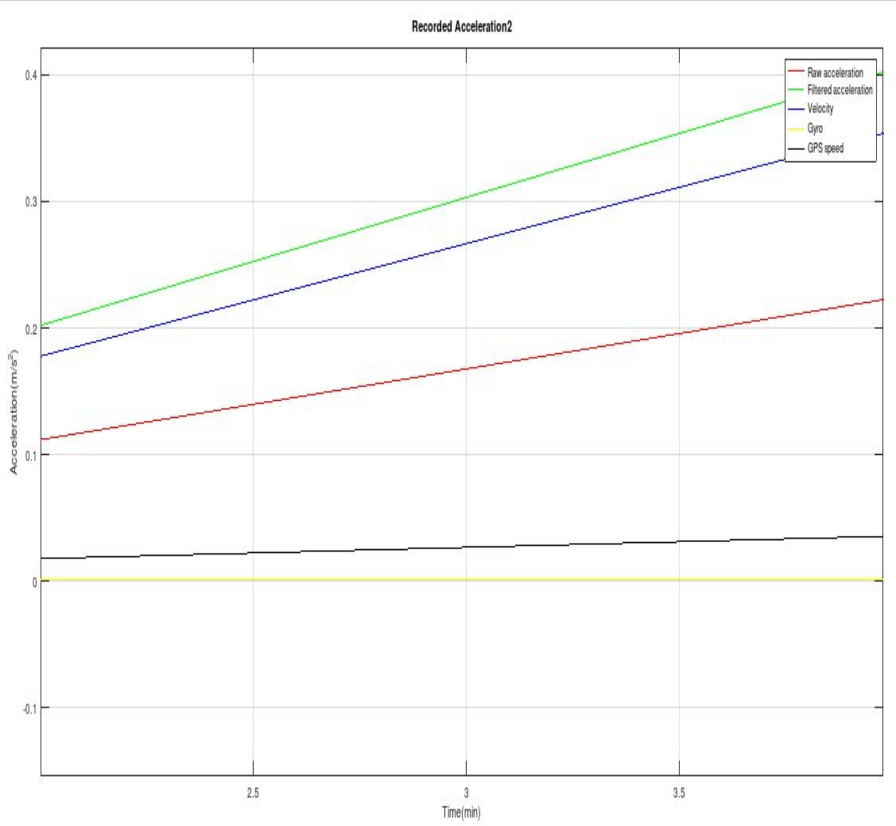
Results with GPS and MPU



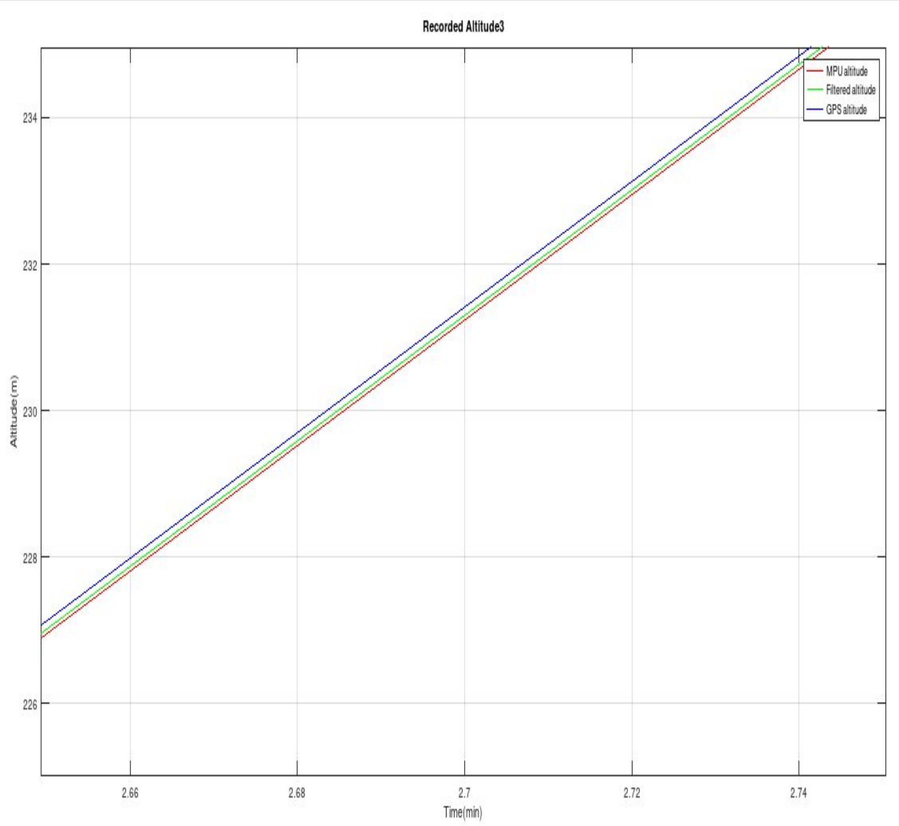


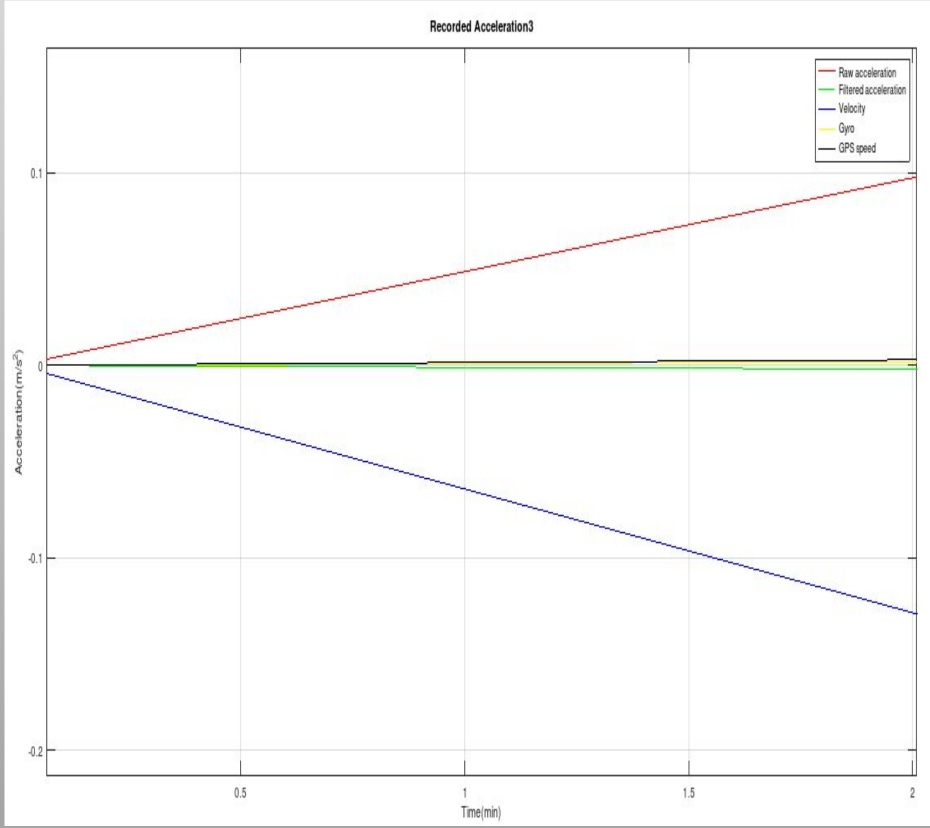
- Both sensors record an increase in altitude and are well filtered. The filtered acceleration records a deceleration despite the sensors recording acceleration.





The sensors record an increase in altitude despite losing altitude.





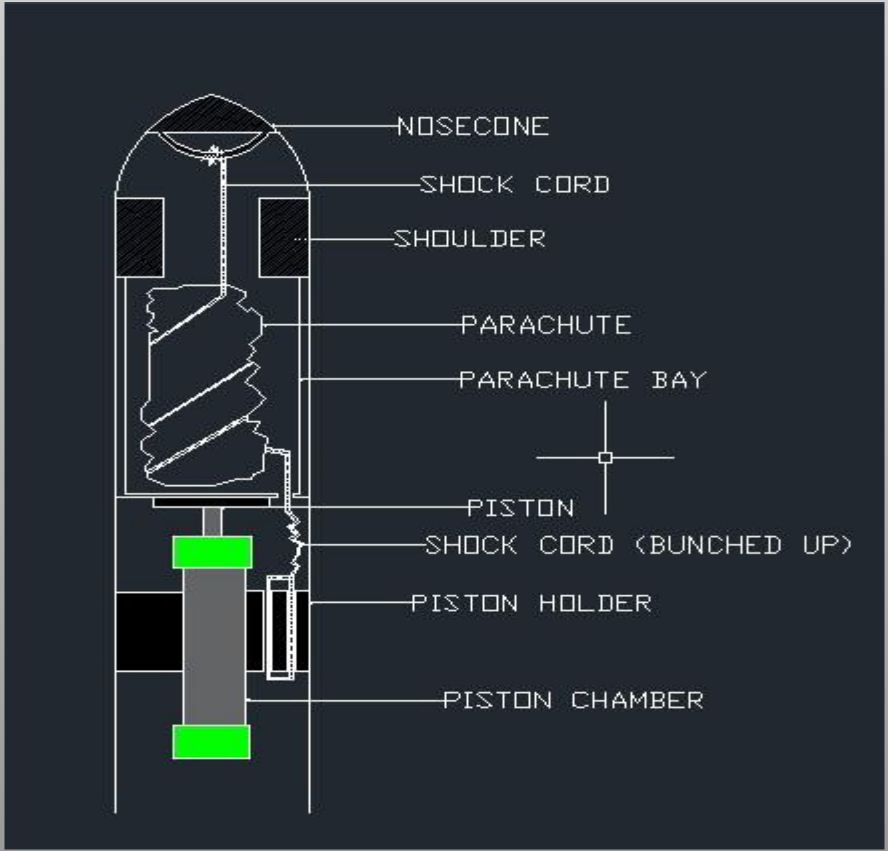
There is increase in acceleration as expected when running, however it was filtered to be constant.

Conclusion

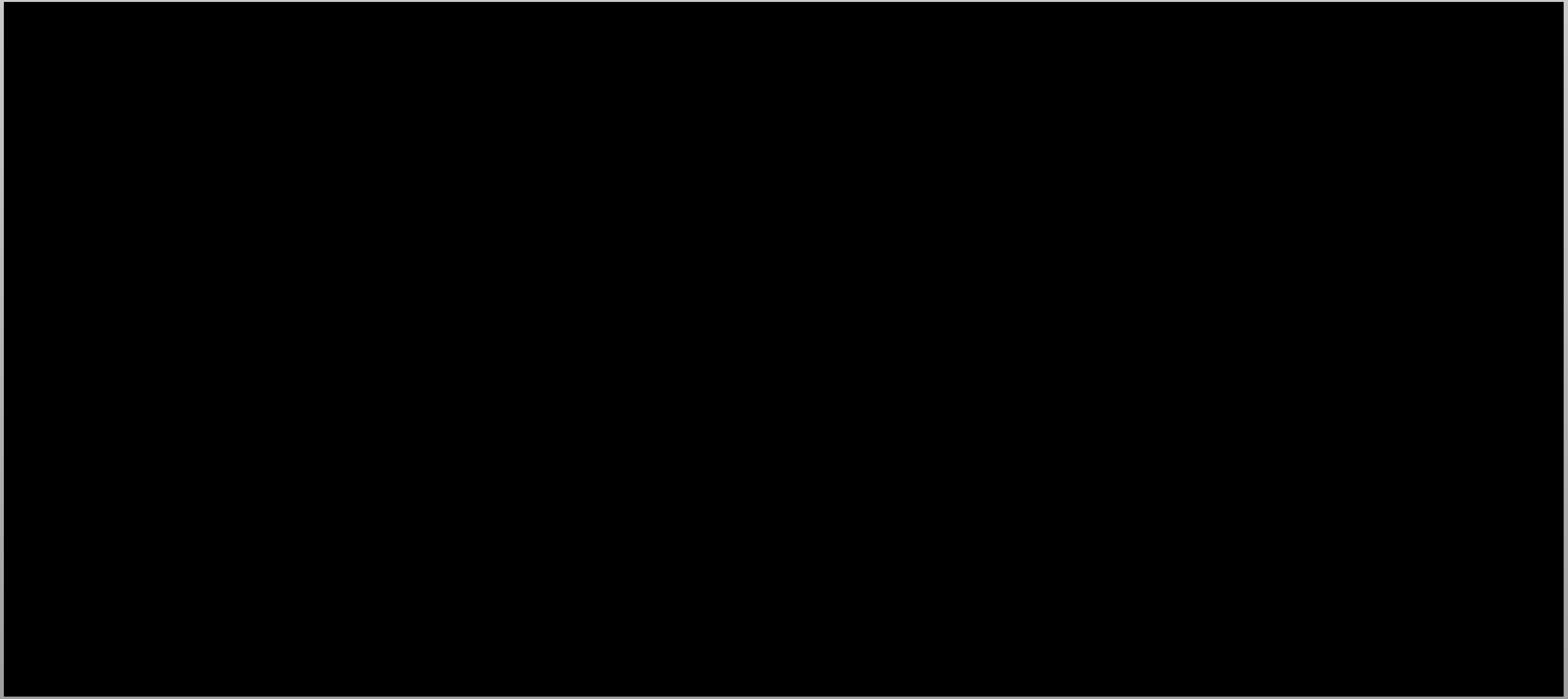
- In conclusion, we think the MPU sensor values are fairly accurate when compared to the GPS module.
- The kalman filter works fine for most of its analysis but questionable results on acceleration.

2. Deployment of Parachute

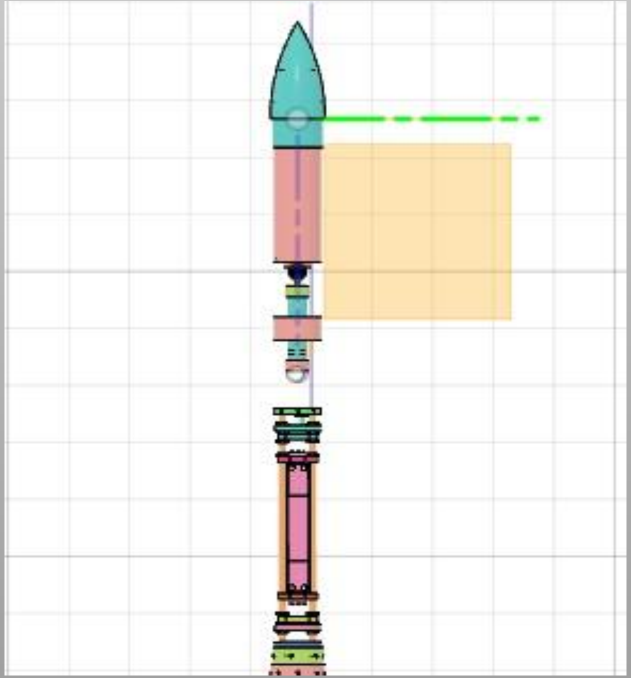
- A shock cord runs from the parachute nose cone, attached to the parachute and held onto the rocket by the piston holder.
- Crimson powder blows → Piston hits parachute bay → Shoulder of nose cone hit → Nose cone is dislodged → Parachute is pulled off with with gravity.



Animated video



Set up in the rocket

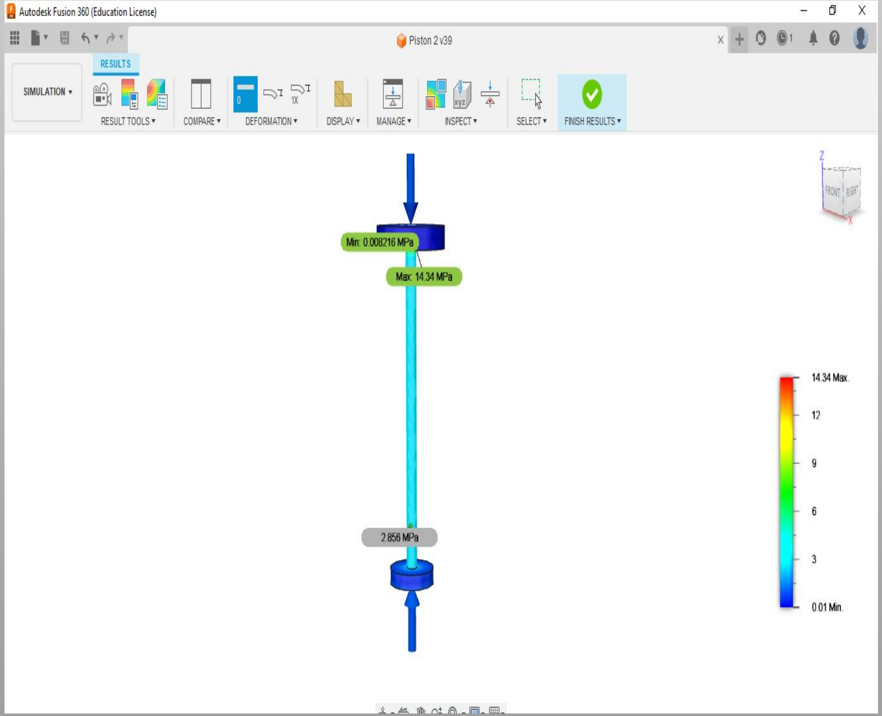


- The piston and parachute bay are in the upper body of the rocket, above the avionics bay, with the piston in direct contact with the parachute bay.
- The crimson powder is at the bottom of the piston casing cap

3. Piston Test

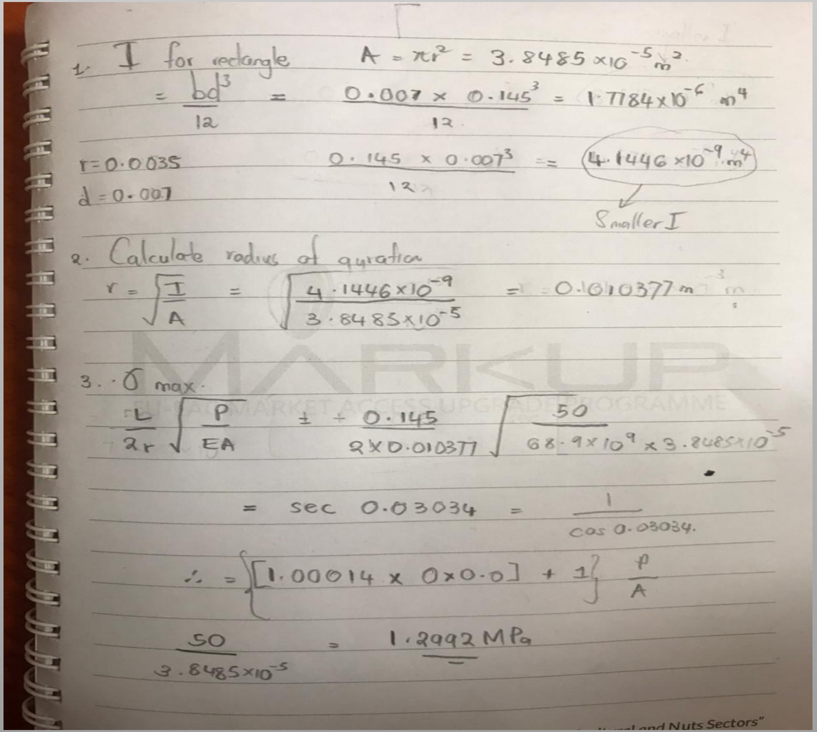
- We have agreed to work with the airframe team where they will provide a nose cone and the upper frame that we will attempt to dislodge.
- This is because we think it will be more effective to ensure that the force from the estimated piston powder is enough to dislodge the nose cone from the body.

4. Piston simulation



- The piston has an aluminium bottom and a PLA top.
- The use of these materials makes the piston too sturdy, with a minimum safety factor of 15 despite reducing the girth of the rod.
- On calculating critical load for buckling, we got 2.9348MPa.
- The highest measured force acting on the rod is about 2.902MPa. We think aluminum will withstand buckling load.

Calculations



1. I for rectangle $A = \pi r^2 = 3.8485 \times 10^{-5}\ m^2$

$= \frac{bd^3}{12} = \frac{0.007 \times 0.145^3}{12} = 1.7784 \times 10^{-6}\ m^4$

$r = 0.0035$

$d = 0.007$

$\frac{0.145 \times 0.007^3}{12} = 4.1446 \times 10^{-9}\ m^4$

Smaller I

2. Calculate radius of gyration

$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{4.1446 \times 10^{-9}}{3.8485 \times 10^{-5}}} = 0.010377\ m$

3. σ max

$\frac{L}{2r}\sqrt{\frac{P}{EA}} \pm \frac{0.145}{2 \times 0.010377}\sqrt{\frac{50}{68.9 \times 10^9 \times 3.8485 \times 10^{-5}}}$

$= \sec 0.03034 = \frac{1}{\cos 0.03034}$

$\therefore = \left\{[1.00014 \times 0 \times 0.0] + 1\right\} \frac{P}{A}$

$\frac{50}{3.8485 \times 10^{-5}} = 1.2992\ MPa$

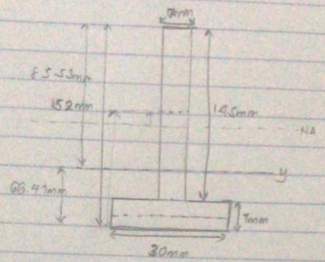
- The allowable stress is 1.2992MPa
- The ideal safety factor is 2.26

Buckling Stress

$$P_{cr} = \frac{\pi^2 E I}{4L^2}$$

E of Aluminium = 68.9 GPa = 68.9 GN/m²

Calculating for I



$$\bar{y} = \frac{\Sigma A_1 y_1 + A_2 y_2}{A_1 + A_2}$$

$$= \frac{(7 \times 145 \times 79.5) + (30 \times 7 \times 3.5)}{(7 \times 145) + (30 \times 7)}$$

$$= 66.47\,mm$$

$$I = I_{NA} + Ah^2$$

$$I_{NA} = \frac{BD^3}{12}$$

$$I = \left[\left[\left(\frac{7 \times 145^3}{12}\right) + (7 \times 145 \times 3.5^2)\right] + \left[\left(\frac{30 \times 7^3}{12}\right) + (30 \times 7 \times 62.97^2)\right]\right] 10^{-12}$$

$$= \cancel{(1778197.083 + 14081.2) \times 10^{-12}} \qquad = (1790798.333 + 833553.859)\, 10^{-12}$$

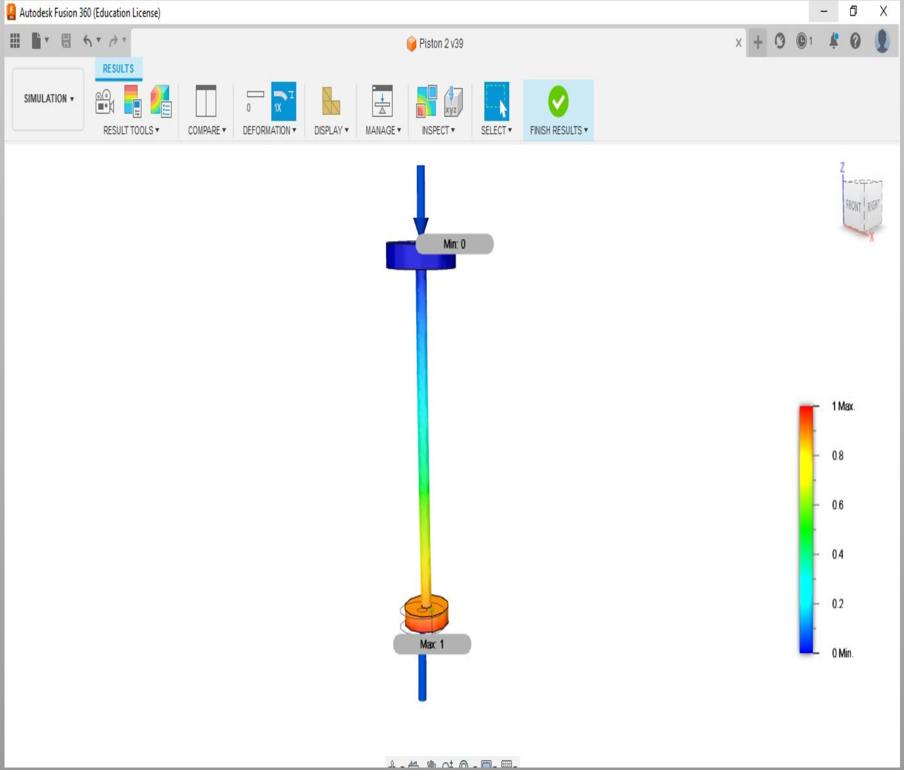
$$= \cancel{1.7960 \times 10^{-6}\, mm^4} \qquad = 2.624 \times 10^{-6}\, m^4$$

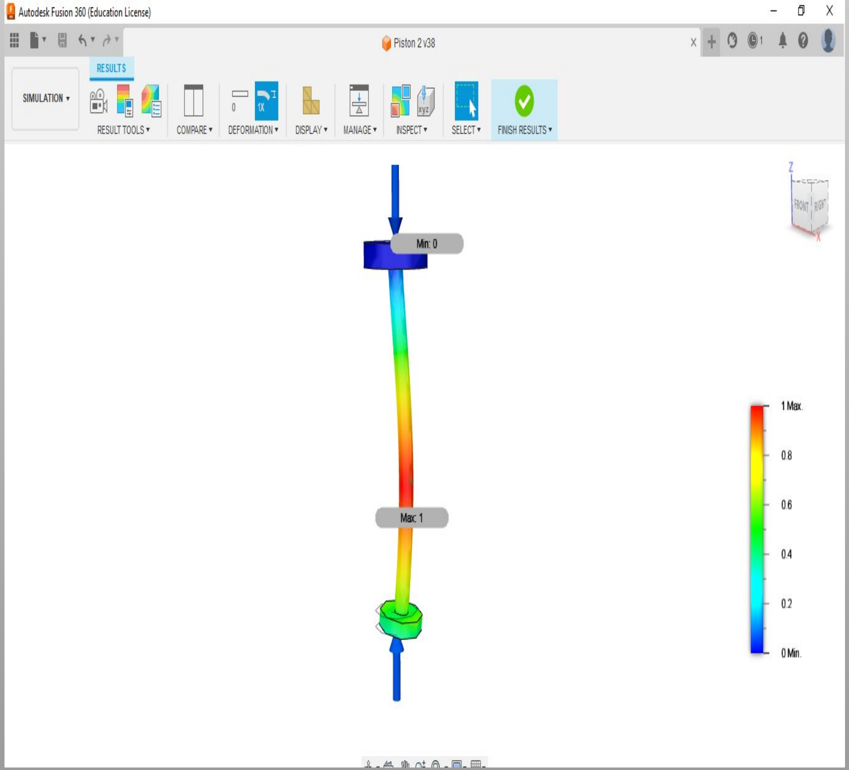
$$P_{cr} = \frac{\pi^2 \times 68.9 \times 10^9 \times \cancel{1.7960 \times 10^{-6}}\ 2.624 \times 10^{-16}}{4 \times 152 \times 10^{-3}}$$

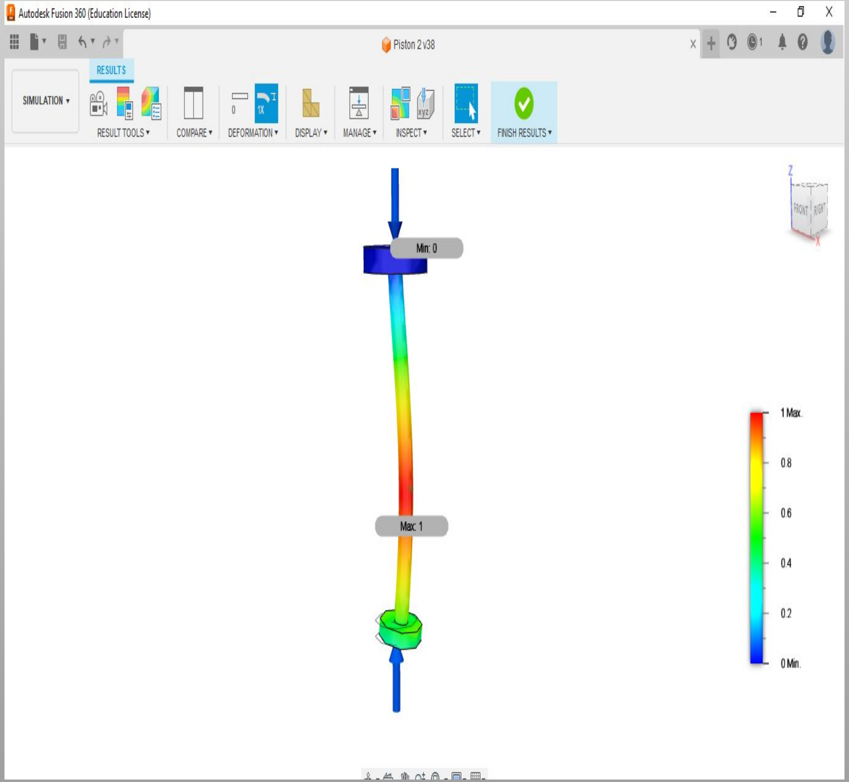
$$= \cancel{2.0087 \times 10^{10}} \qquad 2.9348 \times 10^6\, Pa$$

$$= \cancel{20.087\, Pa} \qquad 2.9348\, MPa$$

Structural buckling







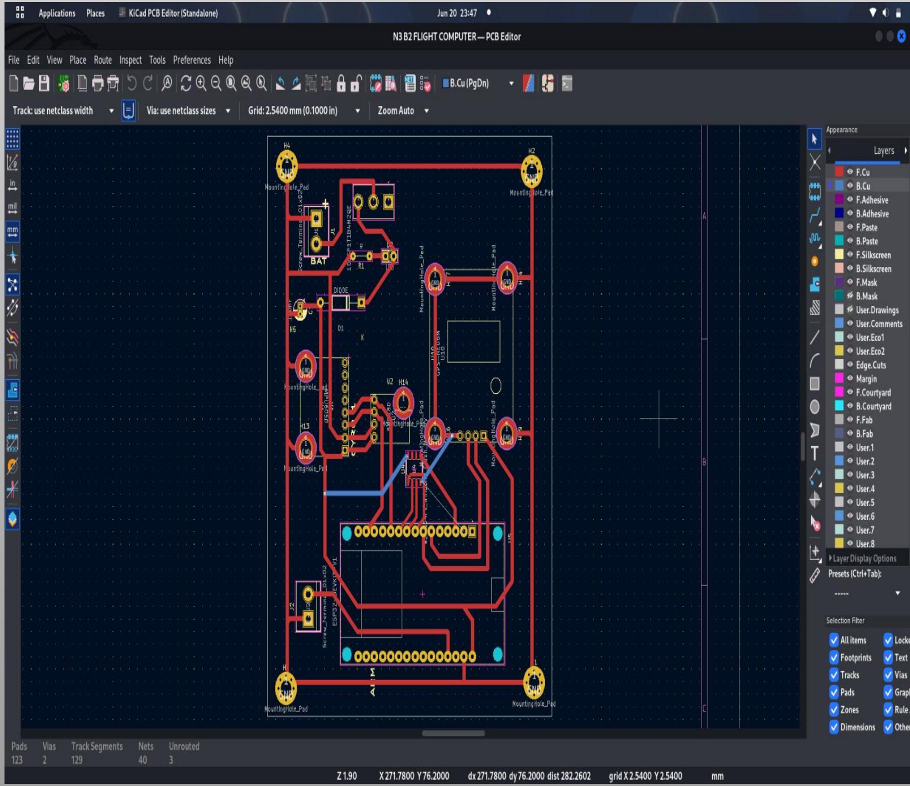
- The Buckling load factors given for each iteration were:

1. 5.068
2. 5.107
3. 47.43

- Except for the last iteration, the buckling factor is lower than the safety factor under static test.
- The applied load is therefore below critical load as the factors are greater than 1.
- We may need to change aluminium as our material as it seems to be too strong.

4. PCB etching

- Alignment of the PCBs during etching was an issue.
- We managed to reroute the PCB paths onto one side to prevent misalignment.



5. Challenges faced this week

1. Misalignment of etched PCBs
2. We were not able to acquire HCL for etching.
3. 3D printing the piston parts due to uncertainty in simulation.

Next Week’s Tasks

1. Soldering components onto the PCB board.
2. 3D printing of the piston and its casing.
3. Piston test.

THANK YOU!