




# **N SOLID PROPULSION PROGRESS**

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**Week 3**

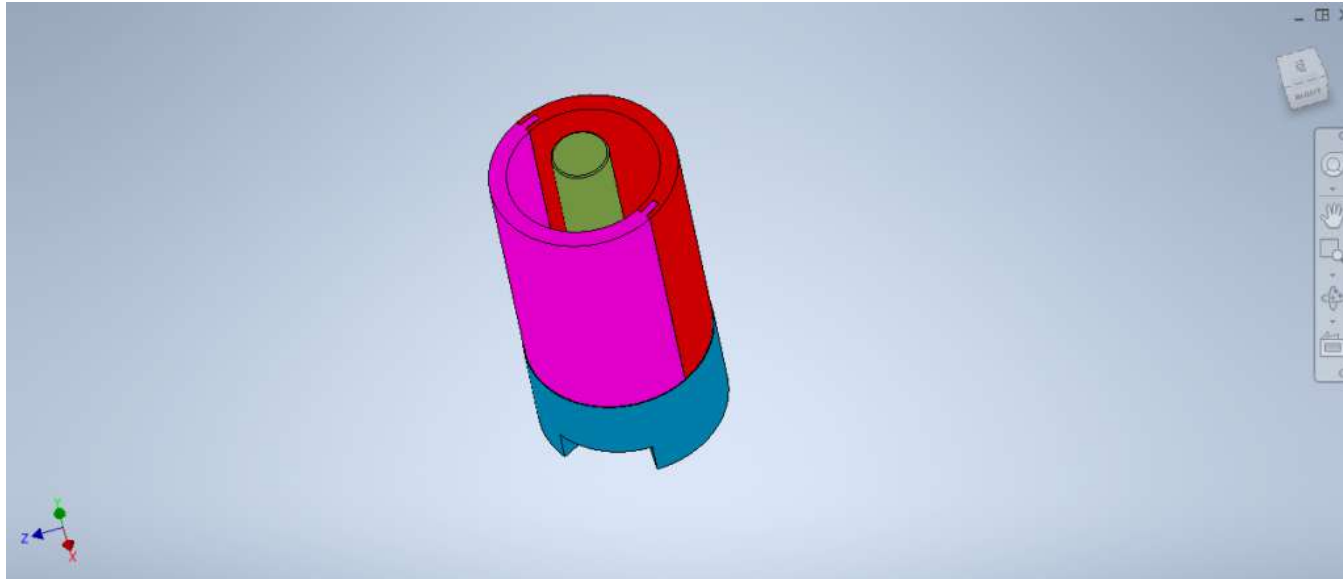
# A. WEEK OBJECTIVES

1. Design and 3D printing of Casting tools
2. Nozzle simulation  ANSYS 
3. Motor casing design
-  4. Research on grain storage
5. Bill of material
6. Redesign of ignition circuit

## B. TASKS DONE

### 1. Design and 3D printing of the casting tools

#### a. Design of the casting tools using SOLIDWORKS



## b. Slicing of the casting tools using PRUSA

The screenshot displays the Prusa Slicer software interface. The main 3D view shows a brown, textured 3D model of a casting tool being sliced. The model is positioned on a black base labeled "ORIGINAL PRUSA MK4 by Josef Prusa". The slicing process is visualized with a vertical orange line and a horizontal orange line indicating the current slice position. The vertical axis is labeled from 0.20 to 165.00 (825). The horizontal axis is labeled from 552069 to 552409.

**Legend**

| Feature type       | Time  | Percentage | Used filament   |
|--------------------|-------|------------|-----------------|
| Perimeter          | 1h36m | 26.4%      | 18.77 m 57.34 g |
| External perimeter | 52m   | 14.1%      | 9.52 m 29.09 g  |
| Internal infill    | 3h4m  | 50.5%      | 24.27 m 74.14 g |
| Solid infill       | 5m    | 1.4%       | 0.70 m 2.14 g   |
| Top solid infill   | 53s   | 0.2%       | 0.08 m 0.26 g   |
| Bridge infill      | 59s   | 0.3%       | 0.12 m 0.38 g   |
| Custom             | 6s    | 0.0%       | 0.02 m 0.06 g   |

Estimated printing times:  
First layer: 2m  
Total: 6h4m

**Print settings:**

- 0.20mm SPEED @MK4IS 0.4 - Copy
- Filament: Generic PETG
- Printer: Original Prusa MK4 Input Shaper 0.4 nozzle
- Supports: None
- Infill: 30%
- Brim: ☐

**Sliced Info**

|                                  |           |
|----------------------------------|-----------|
| Used Filament (g)                | 163.39    |
| Used Filament (m)                | 53.49     |
| Used Filament (mm <sup>3</sup> ) | 128655.86 |
| Cost                             | 4.55      |
| Estimated printing time:         |           |
| - normal mode                    | 6h4m      |

Export G-code

### c. 3D Printing of the casting tools

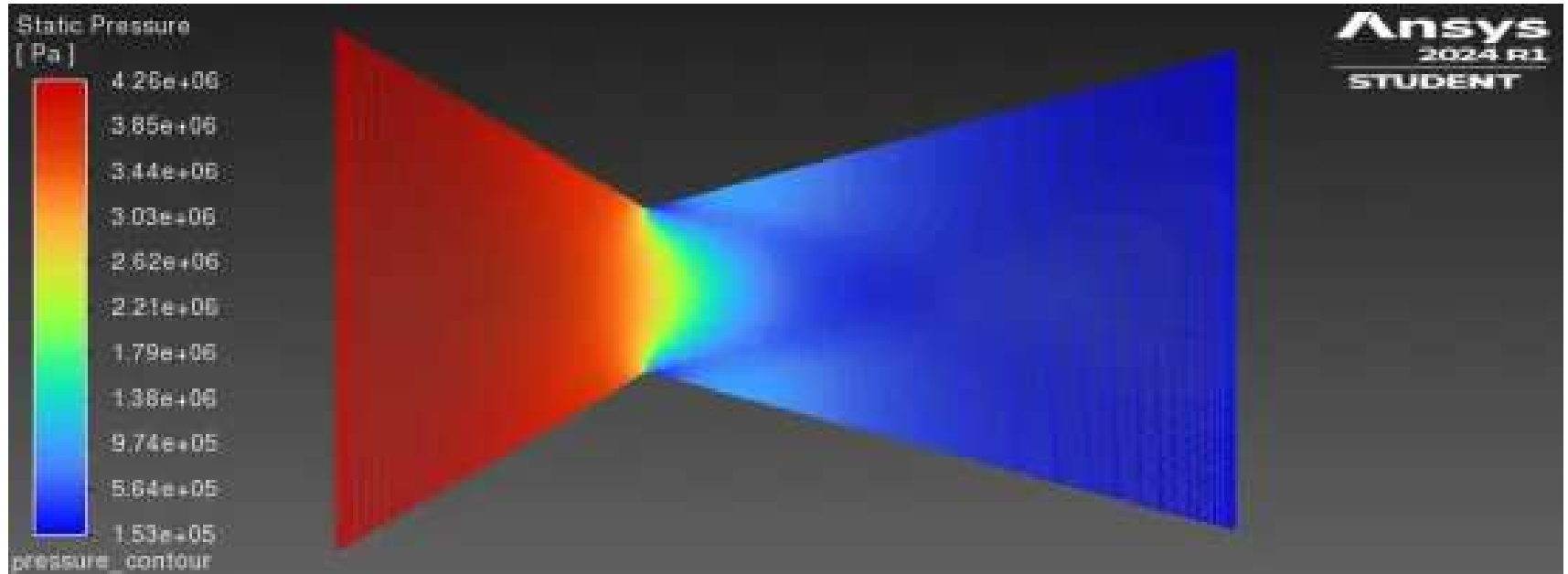


### ONE PART DONE



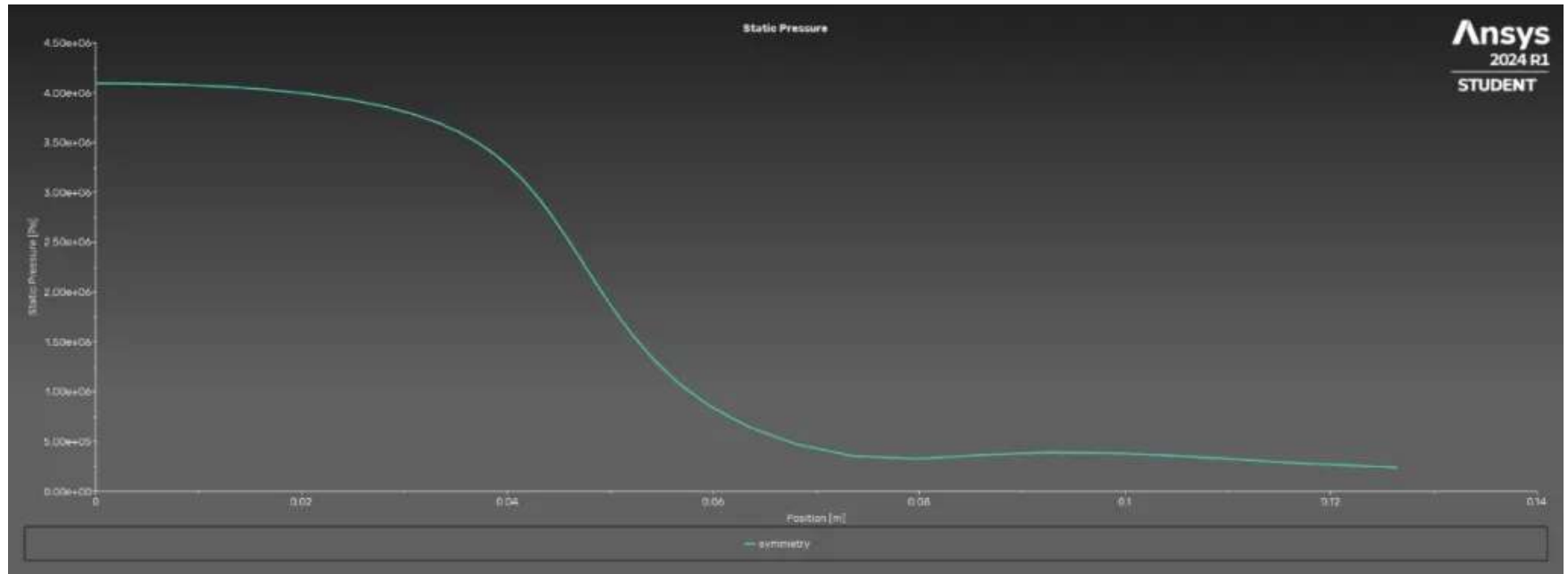
## 2. Nozzle simulation

### a. Pressure



## 2. Nozzle simulation

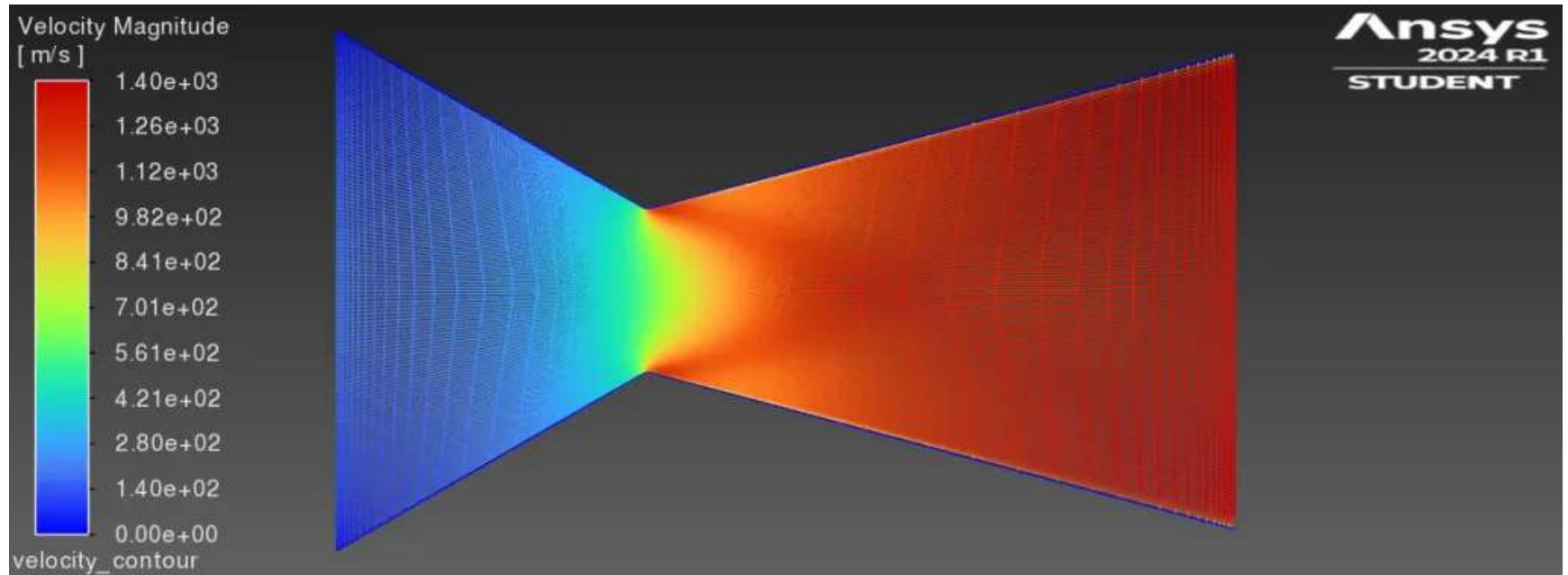
### a. Pressure



Map

## 2. Nozzle simulation

### b. Velocity

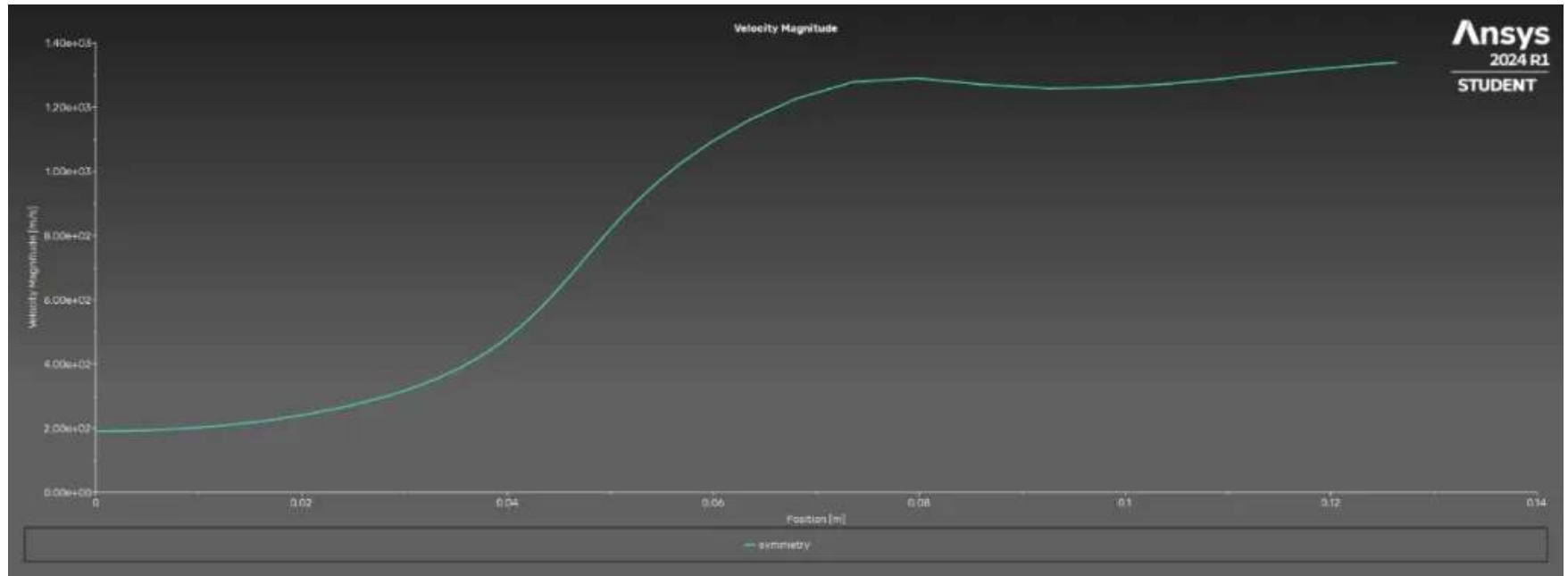


Map



## 2. Nozzle simulation

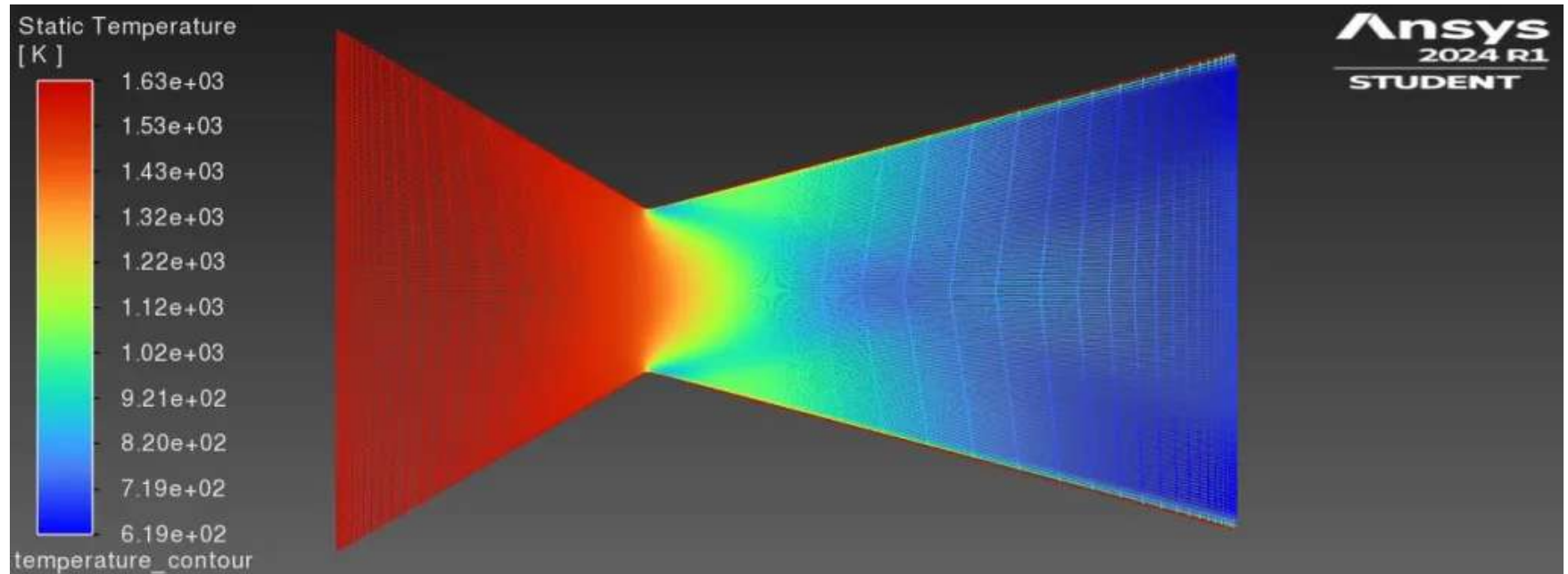
### b. Velocity



Plot

## 2. Nozzle simulation

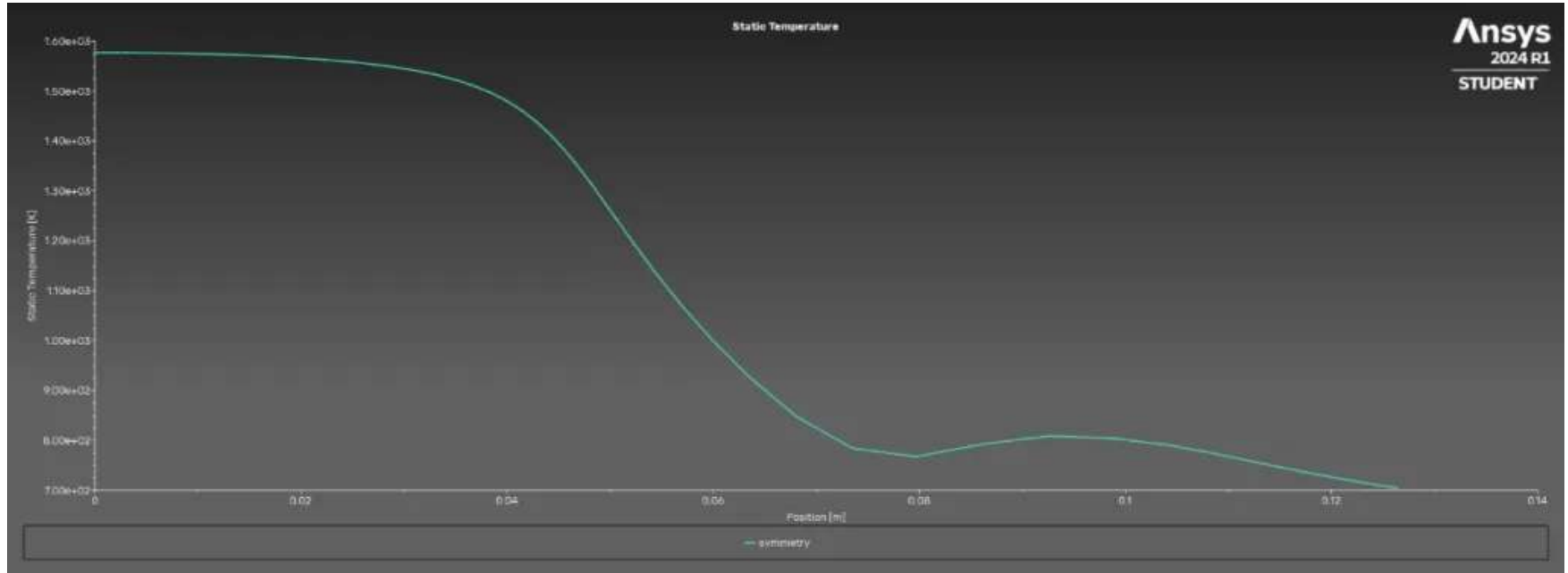
### c. Temperature



Map

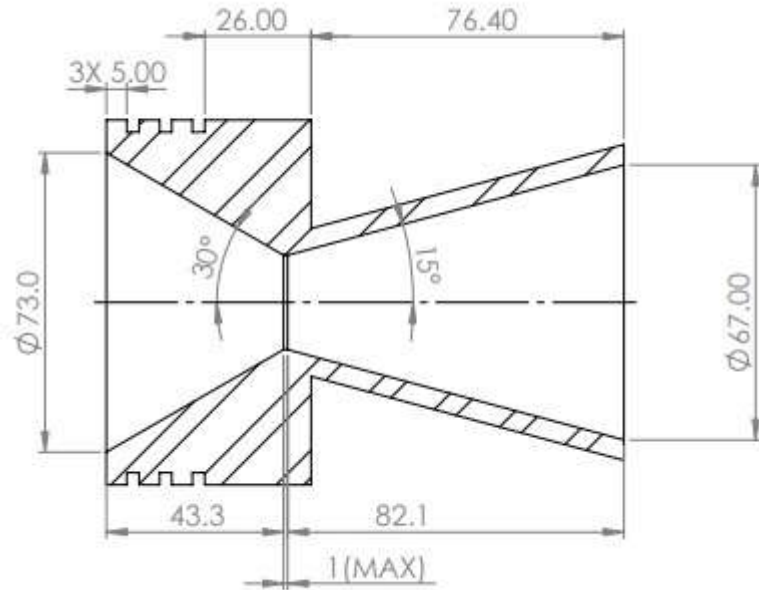
## 2. Nozzle simulation

### c. Temperature

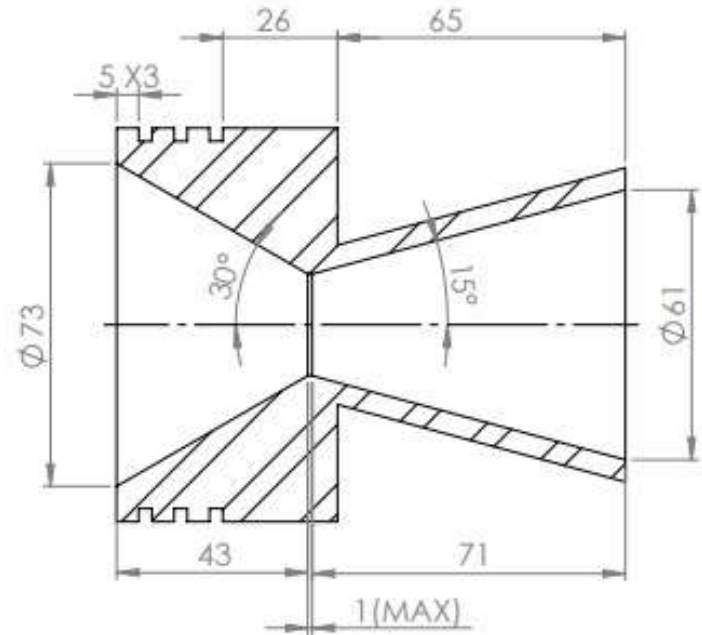


Plot

#### d. Nozzle redesigned after simulations



## INITIAL DESIGN



## REDESIGNED NOZZLE

### 3. Motor casing design

The casing is treated as a thin cylinder subjected to an internal pressure  $P_c$

#### Geometric Properties:

Length,  $L = 725$  mm

Thickness,  $t = ?$

Diameter,  $d = 100$  mm

#### Problem specifications

$P_c = 4.26$  MPa

Material: Aluminum 6063-T6

$$\sigma_{yp} = 210 \text{ MPa}$$

$$\sigma_{uts} = 240 \text{ MPa}$$

$$E = 68900 \text{ MPa}$$

$$\nu = 0.33$$

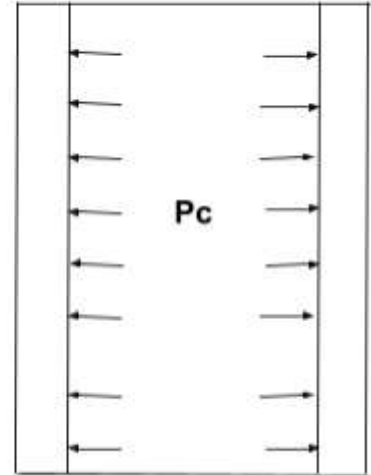
Safety factor,  $S_f = 2$

#### Minimum Thickness

Considering the hoop stress,

$$t = \frac{P_c * d * S_f}{2 * \sigma_{yp}} = \frac{4.26 * 100 * 2}{2 * 210} = 2.02857 \text{ mm}$$

A thickness of 3mm is selected as it is readily available and meets the design requirements





# Grain storage

**Molecular Sieves-** effectively at low humidity levels, expensive

**Activated Alumina( $\text{Al}(\text{OH})_3$ )-** porous, good moisture absorption capacity. fragile and prone to crushing

**$\text{CaSO}_4$ -** does not form liquid when saturated, low moisture absorption capacity.

**$\text{CaCl}_2$ -** (suggested in Richard Nakka). absorb moisture effectively, quite reactive, forms liquid brine with moisture. Concentrated solution is corrosive

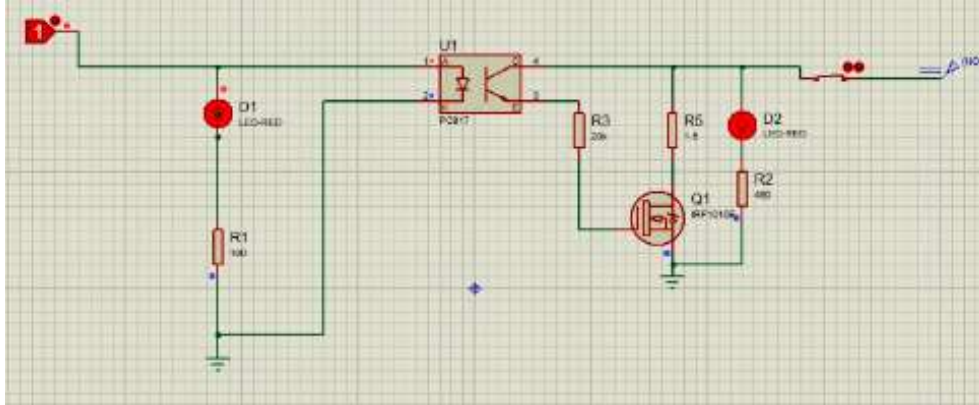
**Silica Gel-** Inert, effective moisture absorption, no liquid formation, easy to handle, non-toxic

[https://1drv.ms/w/s!Aq\\_-ZEYiFHccsRXqFwWScMQ3fxAJ?e=92ZWR1](https://1drv.ms/w/s!Aq_-ZEYiFHccsRXqFwWScMQ3fxAJ?e=92ZWR1)

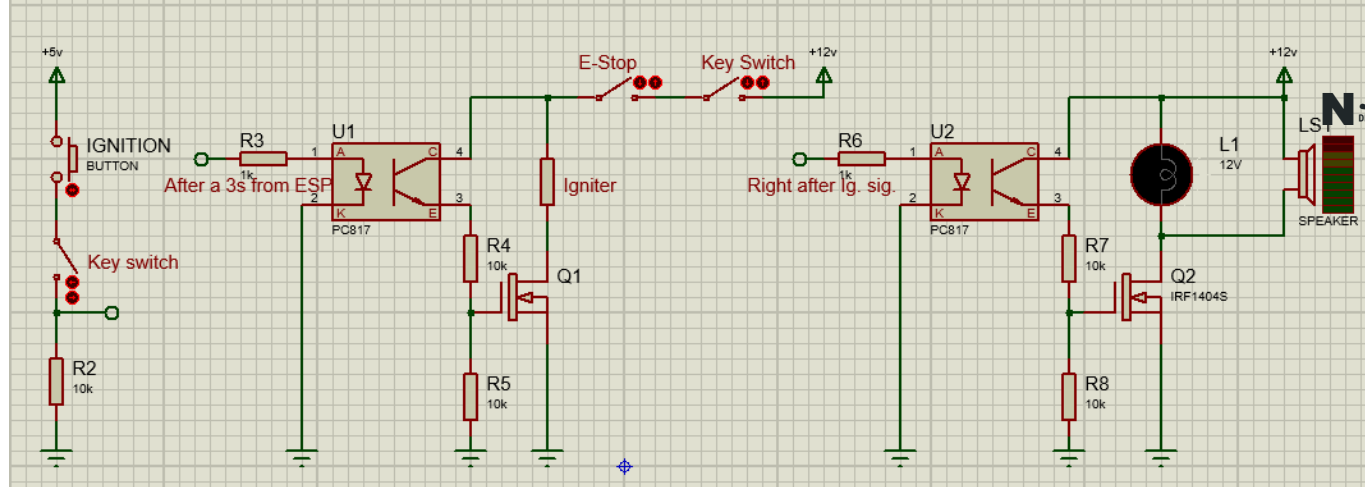
## 5. Bill of material

| 43 |                         |                         |                     |            |             |   |                 |
|----|-------------------------|-------------------------|---------------------|------------|-------------|---|-----------------|
|    | A                       | B                       | C                   | D          | E           | F                                       | G               |
| 1  | Item                    | Use Case                | Quantity            | Unit price | Total price | Vendor Info                             | Status          |
| 2  | 6mm 6063 T6 aluminum    | Casing material         | 6.4m                | 13950      | 13950       | HydroAluminium   0740193126             | To be purchased |
| 3  | 100mm 7025 Aluminum rod | Bulkhead material       | 1 m                 | 43000      | 43000       | Kens Metal   0733914173                 | To be purchased |
| 4  | 100 mm Mild Steel Rod   | Nozzle material         | 1 m                 | 19100      | 19100       | Kens Metal +254733914173                | To be purchased |
| 5  | 200x4.8 mm Cable ties   | Securing casting moulds | 1 pack (100 pieces) | 816        | 816         | Pipe Manufacturers Limited   0702655368 | To be purchased |
| 6  | Silica Gel              | Storing grains          | 3kg                 | 1000       | 3000        | Shine solutions  0707290921             | To be pu...     |
| 7  | TOTAL                   |                         |                     |            | 79866       |   |                 |

# 6. Ignition Circuit Improved



**IGN CRCT N3.5**



**IGN CRCT**



## C. CHALLENGES

**3D printing failures due to unclean printer nozzle and power**




**Result due to unclean nozzle**



**Result due to power interruptions**

## **D. NEXT WEEK OBJECTIVES**

- 1. Procurement of the materials**
- 2. Machining of the nozzle, the bulkhead and the motor casing**
- 3. Cooking of the grain**
-  **4. Fabrication of the ignition circuit**
- 5. Complete the test stand design and its fabrication**

**Arigatō** 🙏