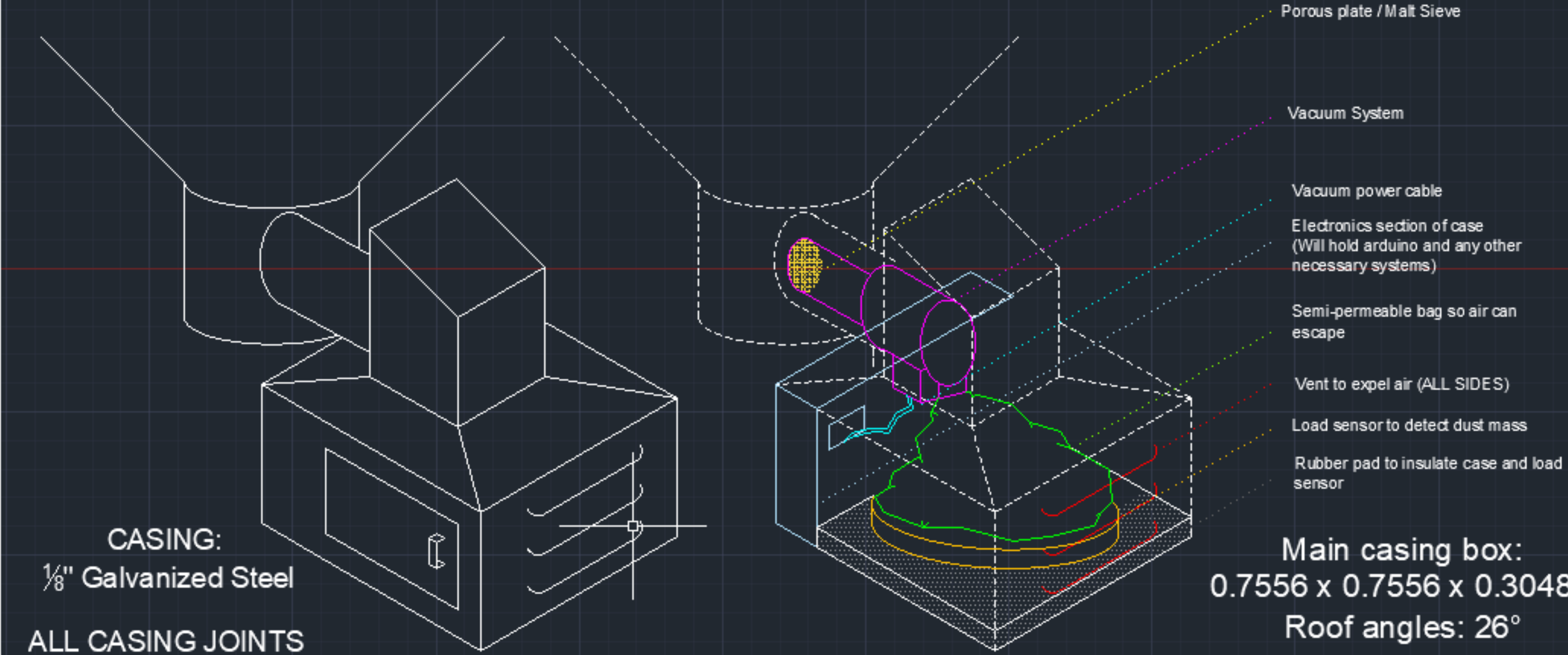
DUST DETECTION

GROUP C9

PROBLEM STATEMENT

- A need exists for a safe, cost-effective dust detection system that can pre-emptively measure varying industrial quantities of both organic and sedimentary dust and record this information periodically. This process should be easily maintained without substantial risks or changes to brewery operations.

Design Concept #4


Porous plate / Malt Sieve
Vacuum System
Vacuum power cable
Electronics section of case (Will hold arduino and any other necessary systems)
Semi-permeable bag so air can escape
Vent to expel air (ALL SIDES)
Load sensor to detect dust mass
Rubber pad to insulate case and load sensor

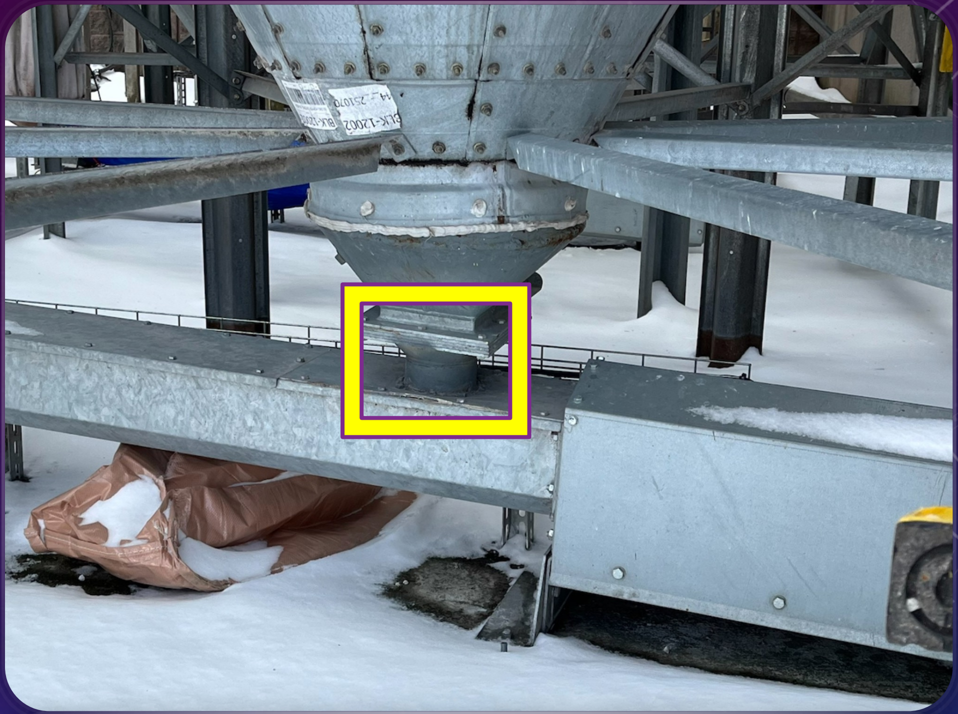
CASING:
⅛" Galvanized Steel

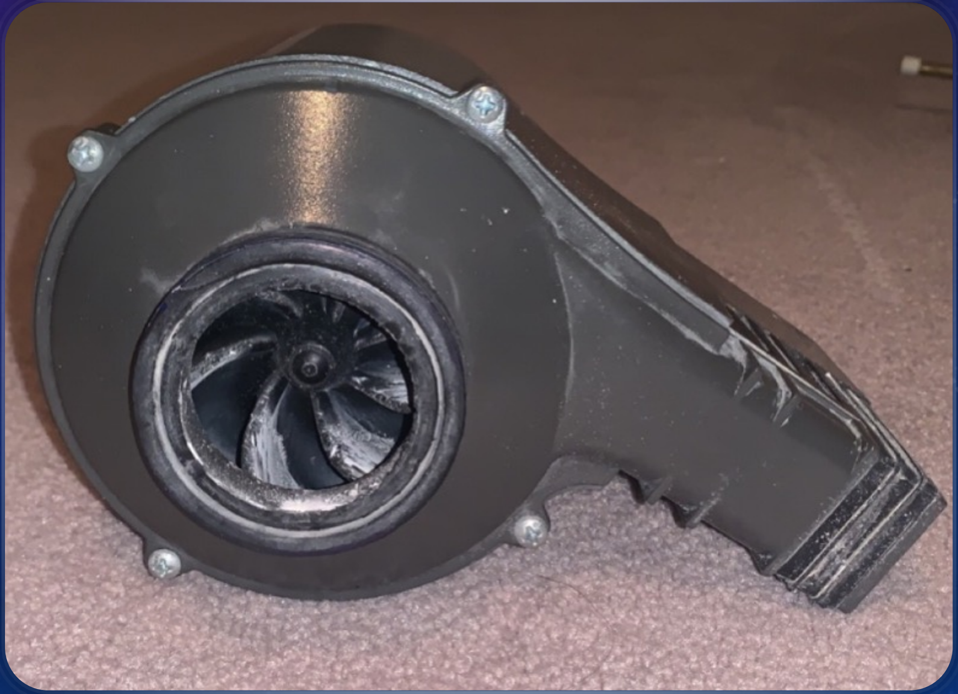
ALL CASING JOINTS
ARE WELDED

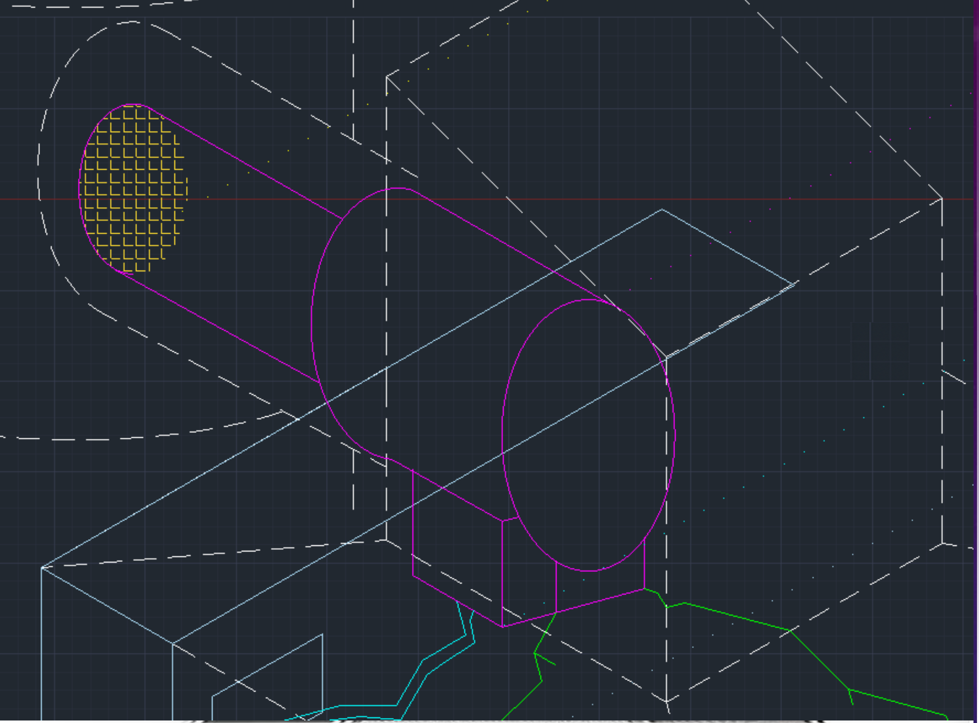
Main casing box:
0.7556 x 0.7556 x 0.3048 m
Roof angles: 26°

DUST SENSOR

- Motor turns fan and creates partial vacuum inside pipe
- Occurs in straight, vertical pipe connecting silo to auger





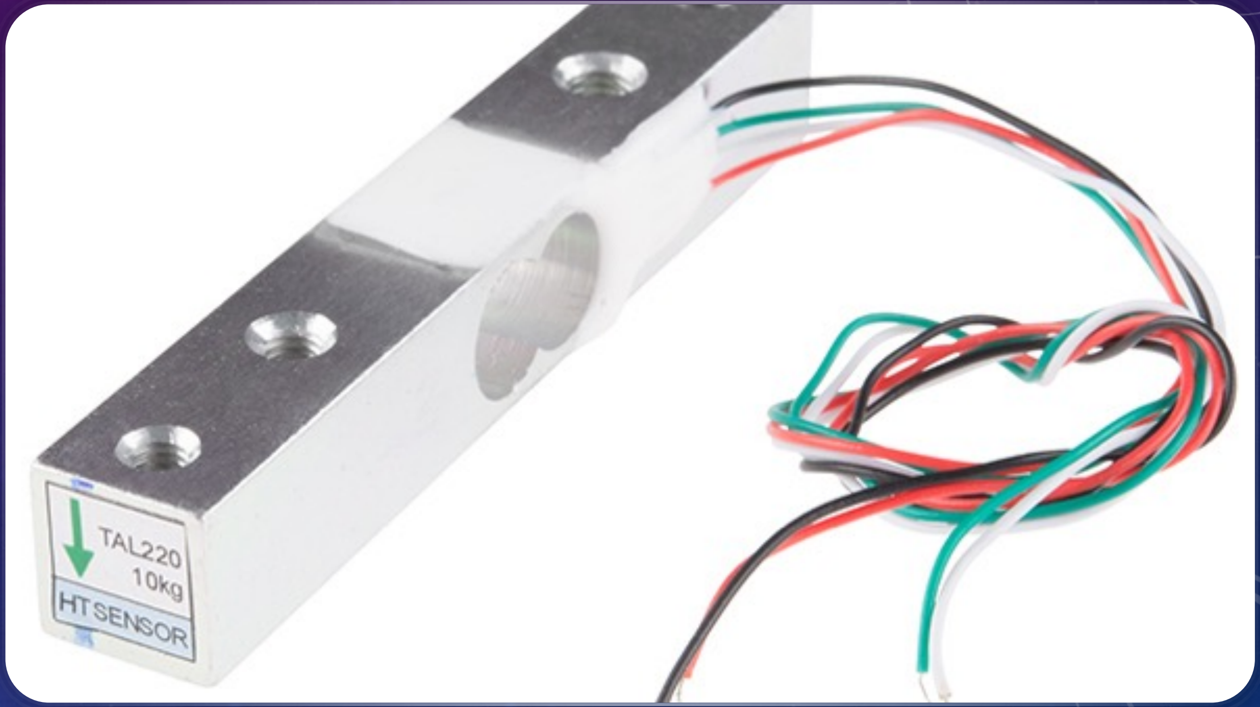


DUST SENSOR

- Sieve 60 filter is attached at end of vacuum
- Malt dust sucked in by the vacuum is separated from the malt

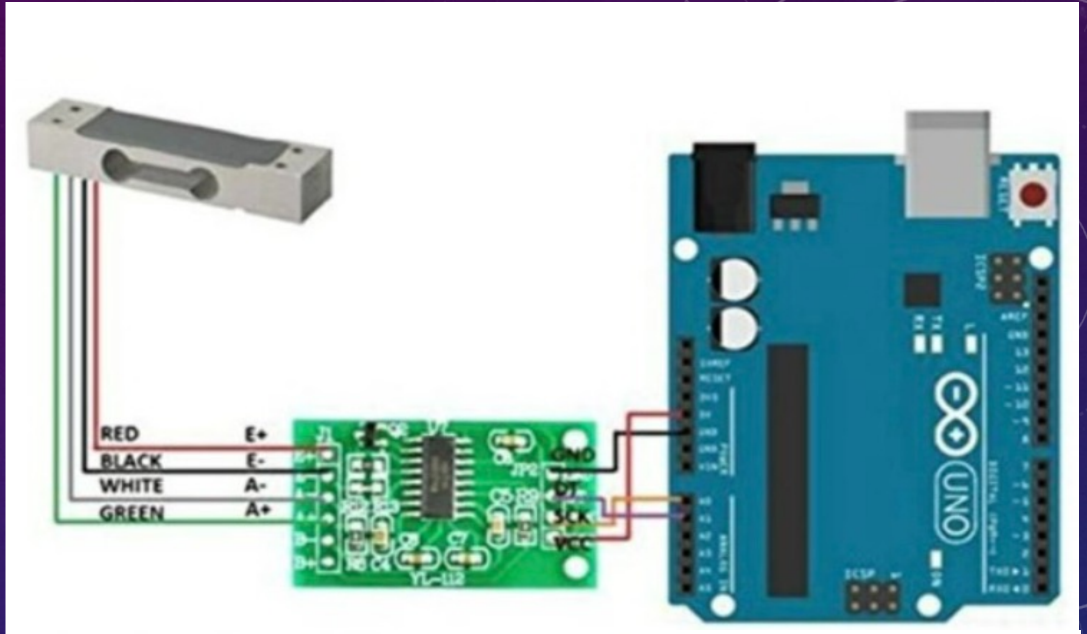
DUST SENSOR

- Load cell measures mass of extracted dust
- System extracts approximately 22 kg of dust each day
- Requires load capacity of 35 kg for ~60% safety factor



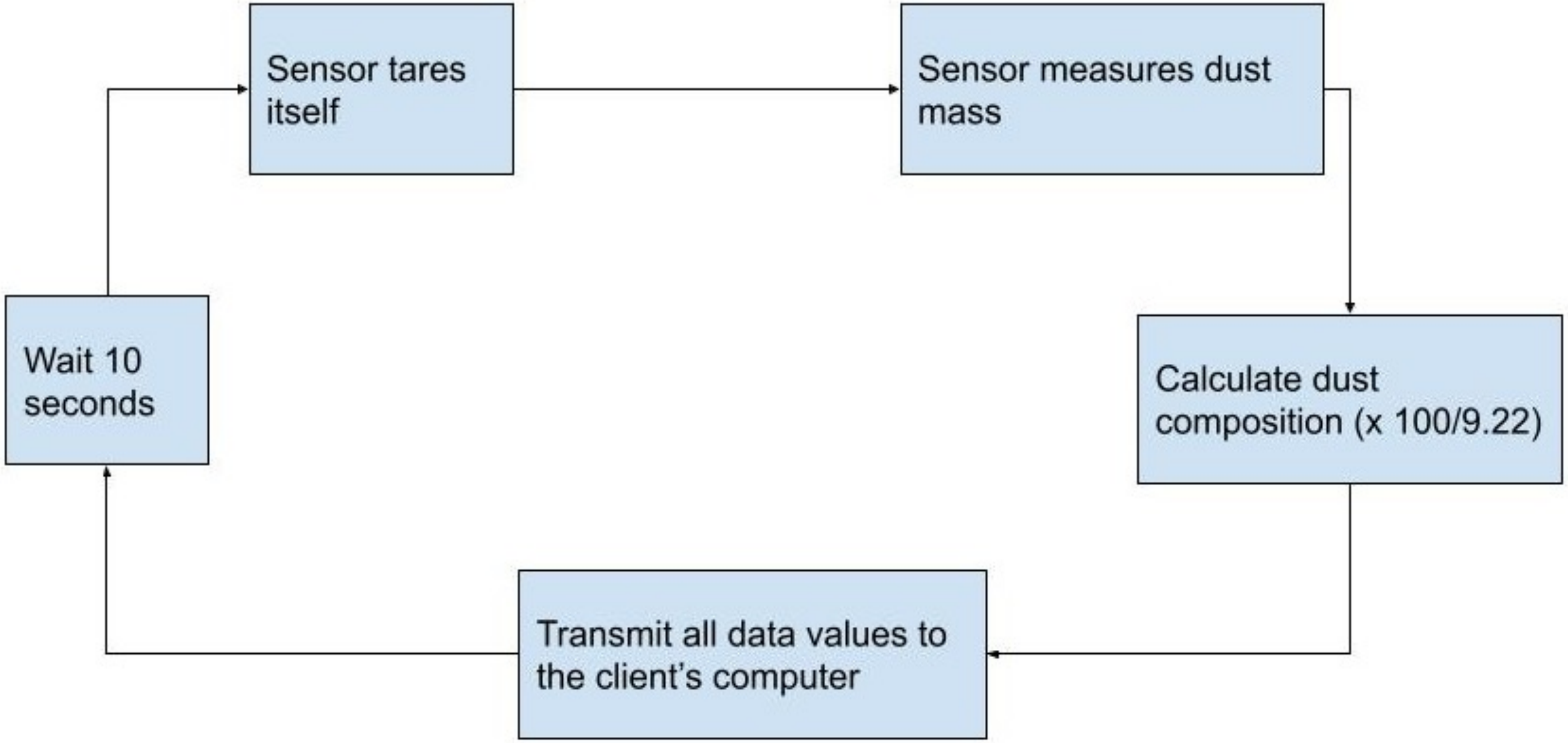
ARDUINO CONTROLLERS

- Used for the software component of the detection system
- Is connected to computer display
- Collects data and starts/stops system periodically



ARDUINO SENSOR

- Will be the method by which dust mass data is collected



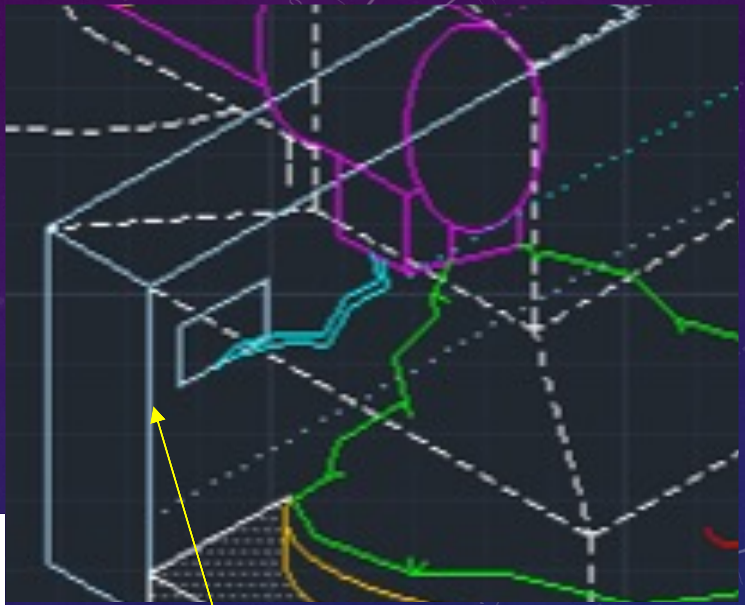
Sensor tares itself

Sensor measures dust mass

Calculate dust composition (x 100/9.22)

Transmit all data values to the client's computer

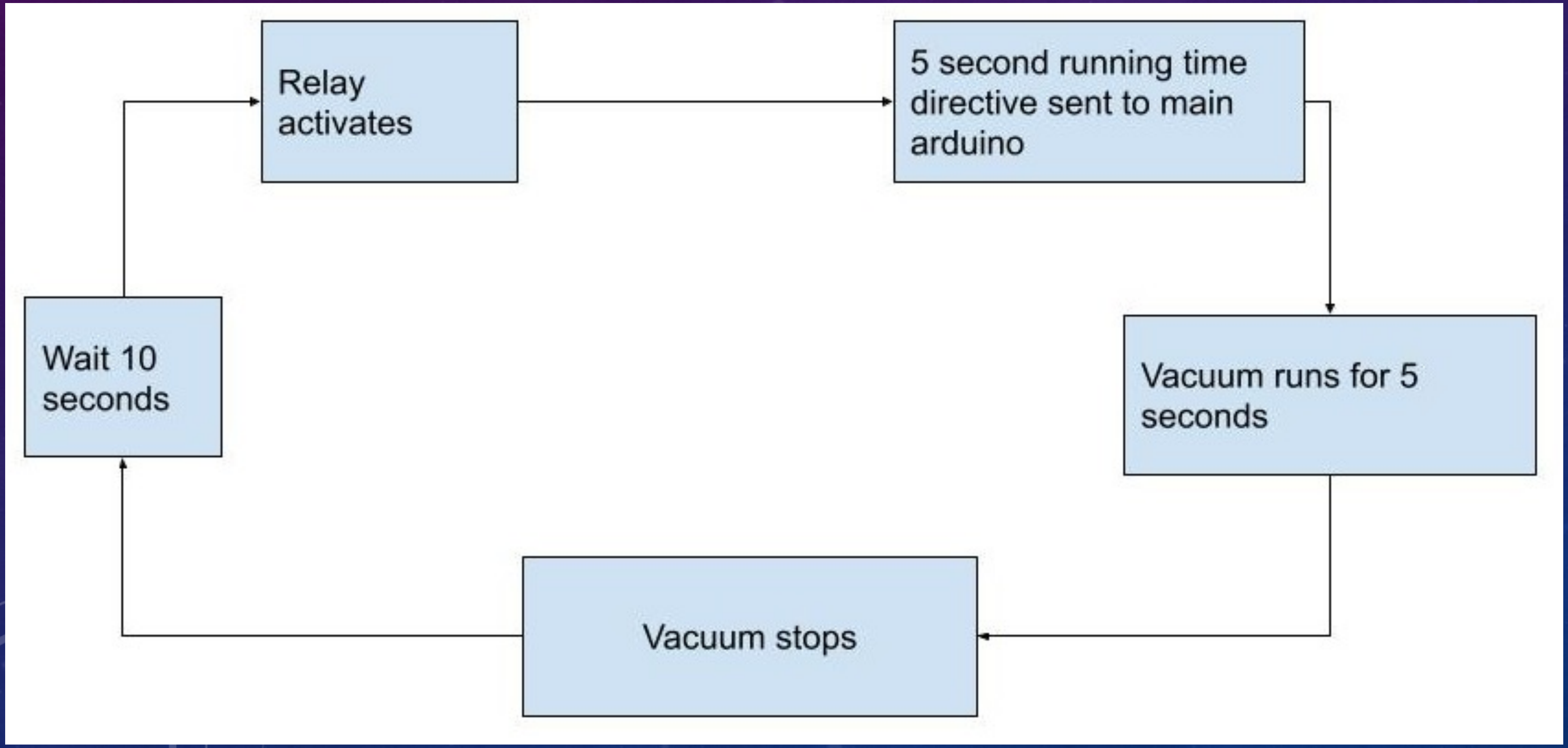
Wait 10 seconds



Storage area

ARDUINO ON/OFF

- Method for Turning the Vacuum on and off
- Time delay of 10 seconds and running time of 5 seconds



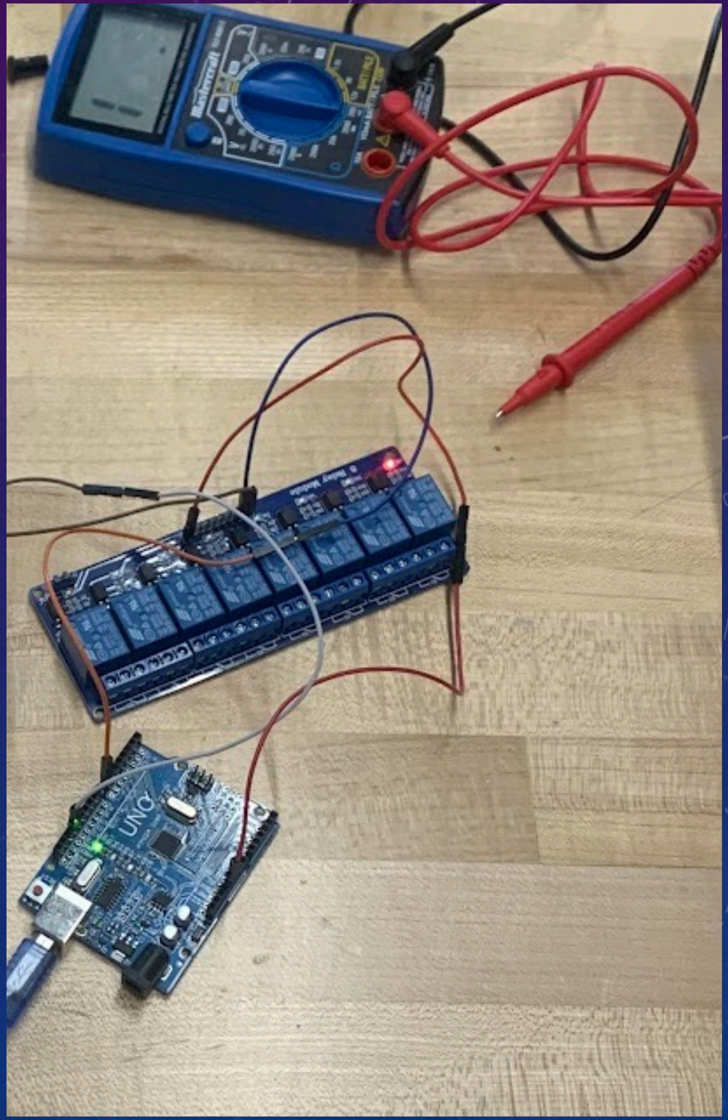
Relay activates

5 second running time directive sent to main arduino

Vacuum runs for 5 seconds

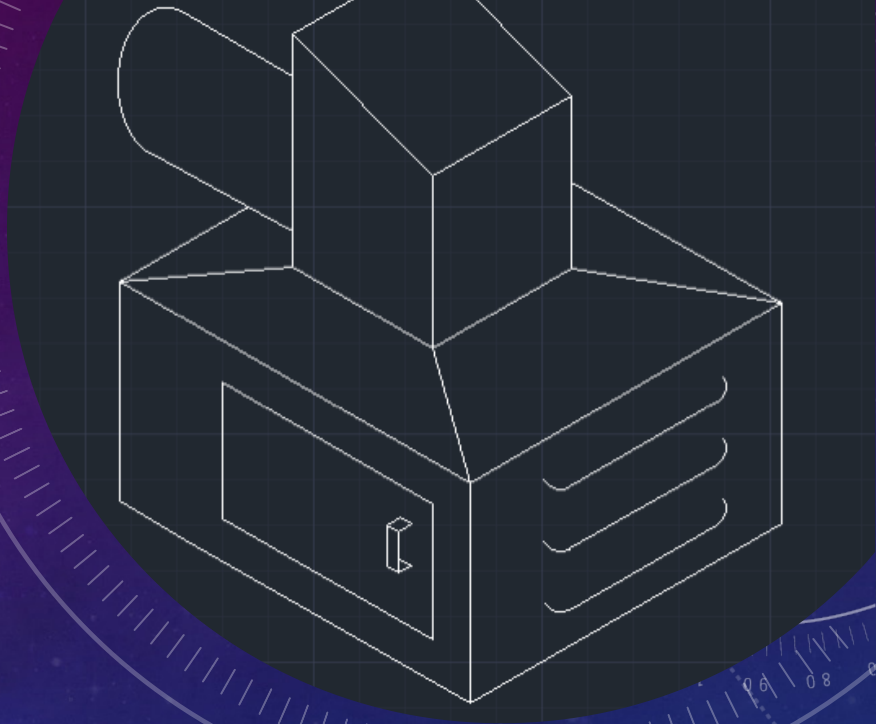
Vacuum stops

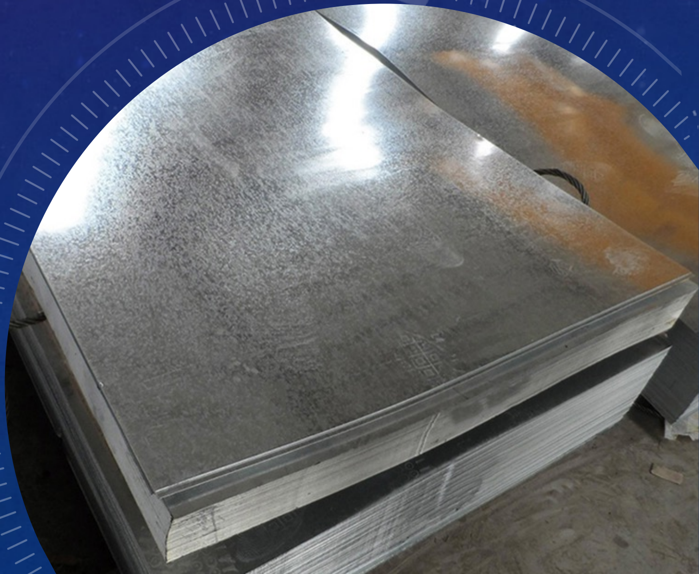
Wait 10 seconds

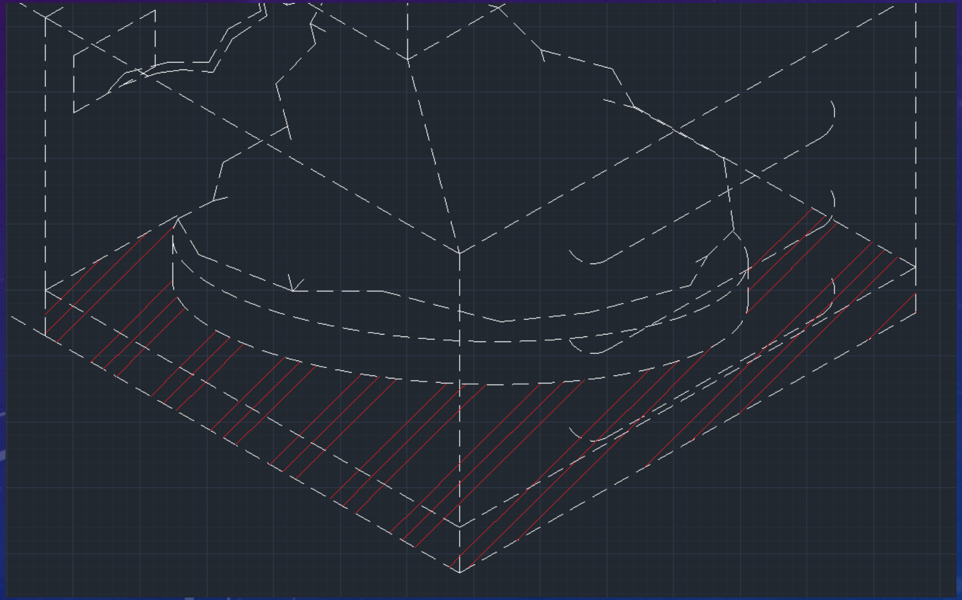


MATERIALS: CASING

- Outer casing protects entirety of system from extreme weather conditions
- ¼" Galvanized steel chosen as the best material in resistance and cost-effectiveness
- Cut pieces will be joined by welding







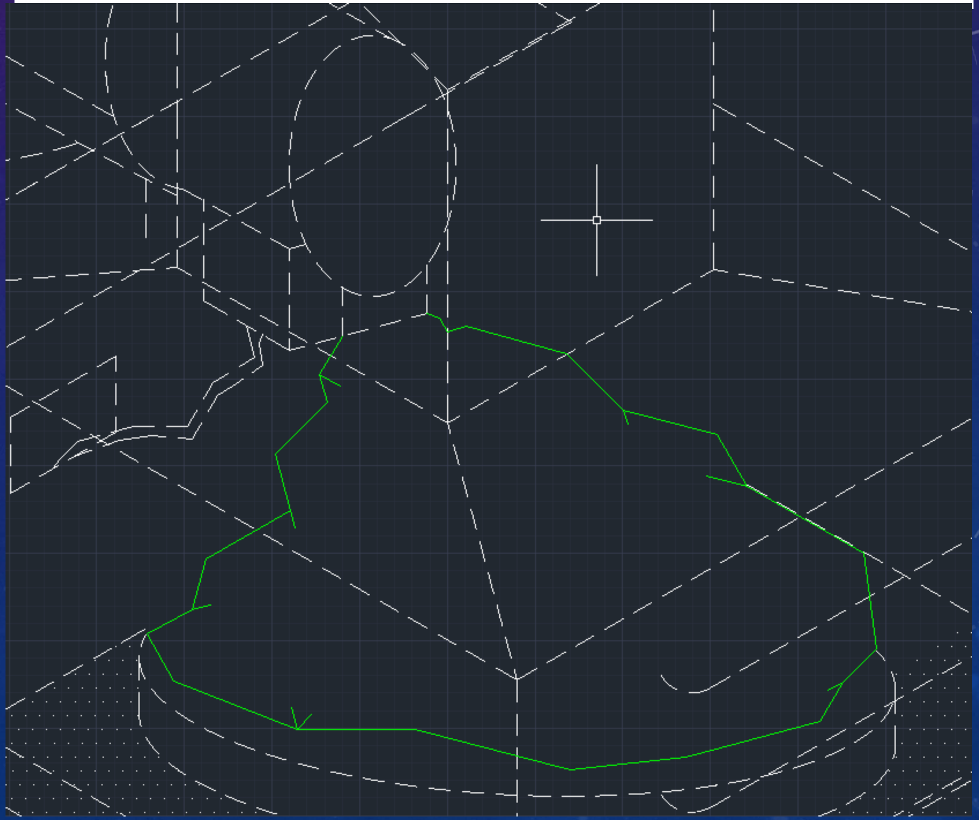
MATERIALS: INSULATION

- Load sensor and electronics require protection from the most extreme temperatures
- 1/8" Silicone rubber pad will line the bottom of the casing.

MATERIALS: DUST BAG

- Polyamide bag will be used to allow air released by the vacuum to escape

- Easy to empty and clean

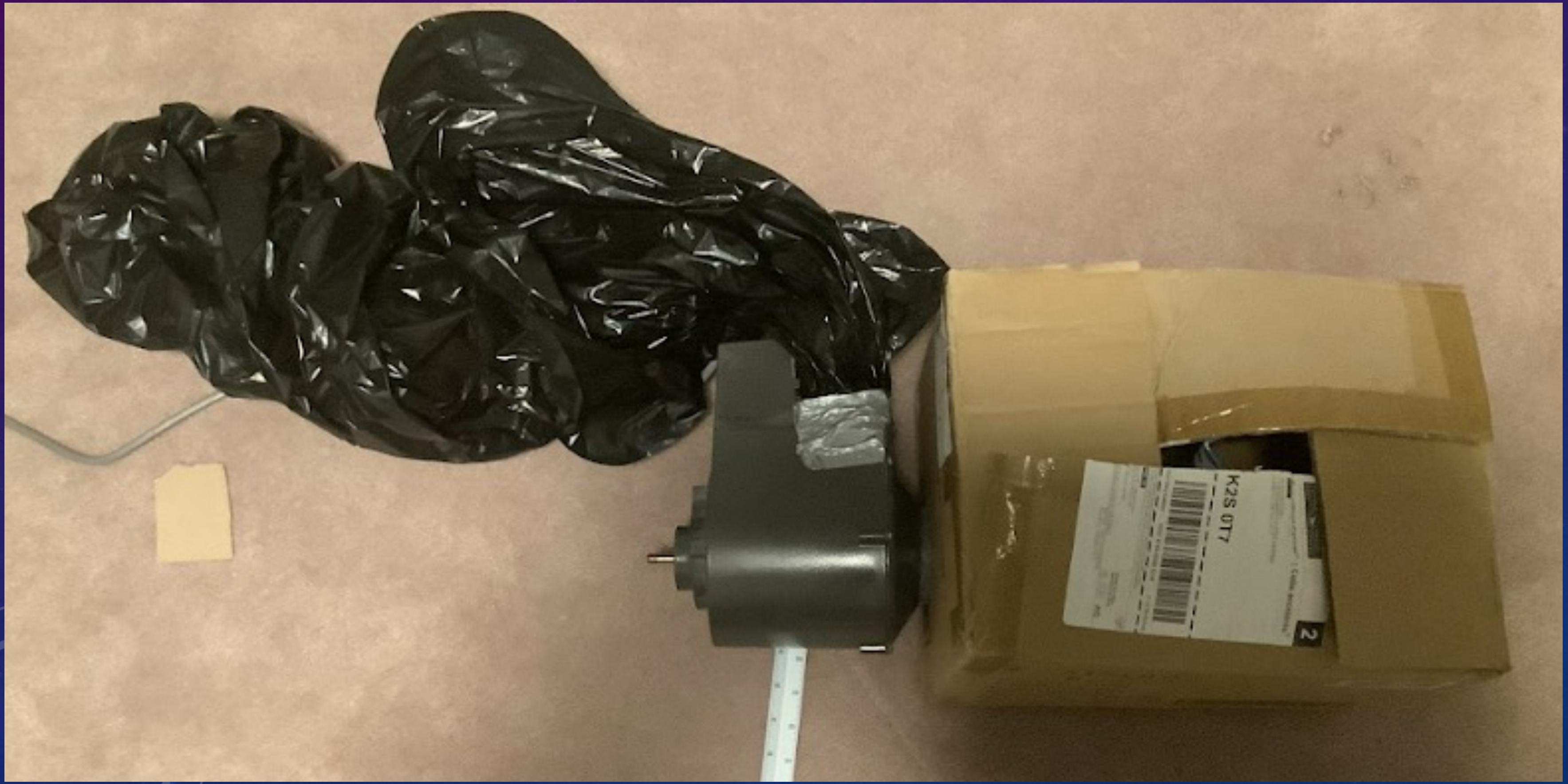


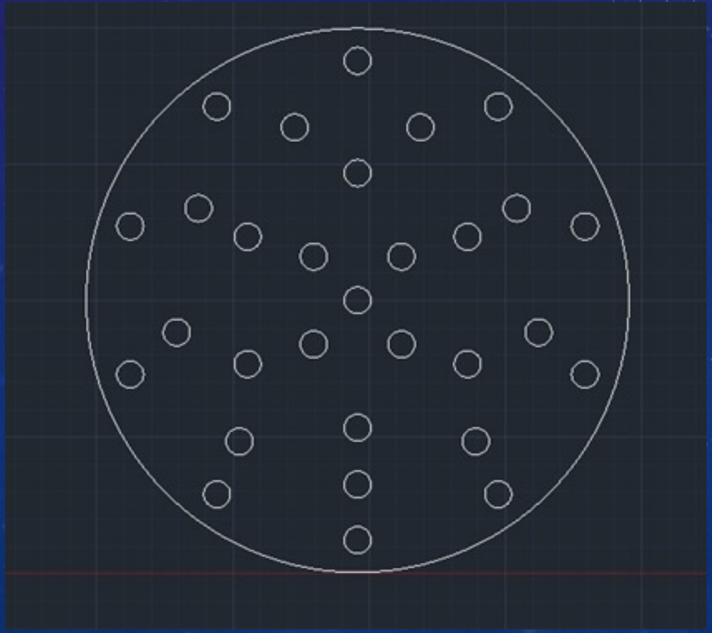
OUR CURRENT PROGRESS

Dust Sensor	**Arduino Controller**	**Materials**
- We have a functional vacuum that extracts 9.22% of dust - We have a custom-made porous sheet to imitate the Sieve 60 - We have an Arduino compatible load cell	- Directs the vacuum to start and stop - Records mass data - On/Off function performed through a relay cycle - Load sensor works via Arduino transmitting to computer	- Galvanized steel casing resistant to extreme weather conditions - Silicone rubber pad lining insulates system against -35 – 45°C temperature - Polyamide bag allows for easy vacuum airflow

PROTOTYPE 1

- Was used to test effectiveness of vacuum at pulling dust
- Flour and popcorn approximation
- Relatively unsophisticated, but yielded important information





PROTOTYPE 1 CONT'D.

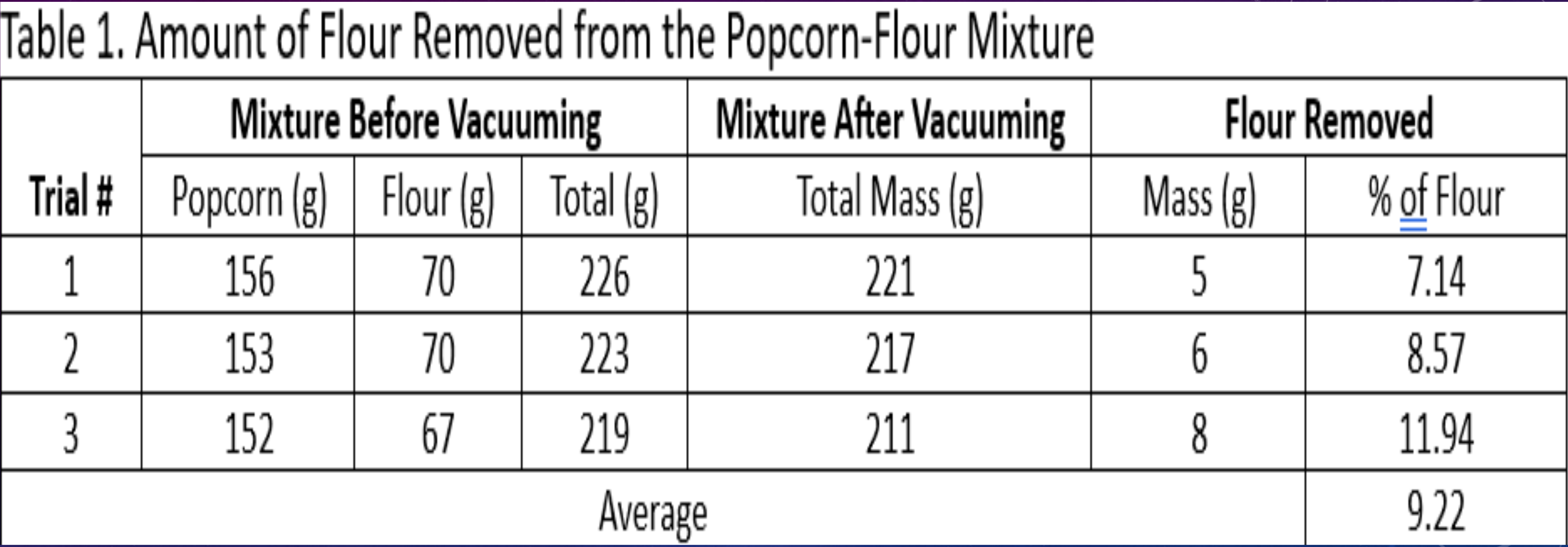


Table 1. Amount of Flour Removed from the Popcorn-Flour Mixture

Trial #	Mixture Before Vacuuming			Mixture After Vacuuming	Flour Removed	
	Popcorn (g)	Flour (g)	Total (g)	Total Mass (g)	Mass (g)	% of Flour
1	156	70	226	221	5	7.14
2	153	70	223	217	6	8.57
3	152	67	219	211	8	11.94
Average						9.22

- This is where the multiplicity of 100/9.22 was developed for the mass conversion

PROTOTYPE 2

- Was an analytical model
- Demonstrated weight and temperature characteristics

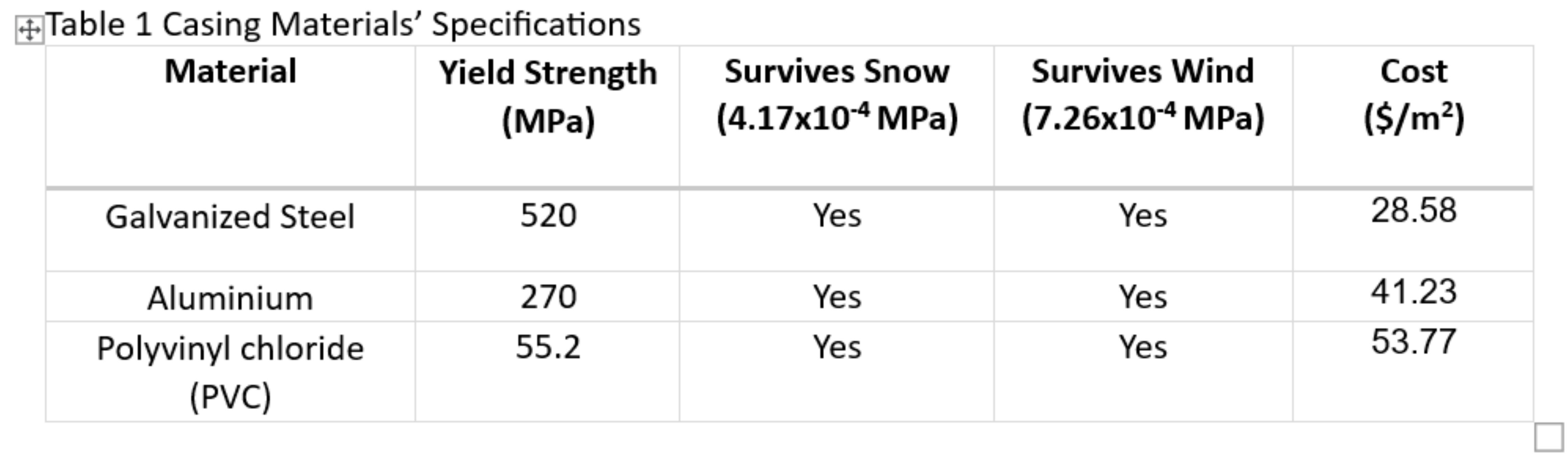
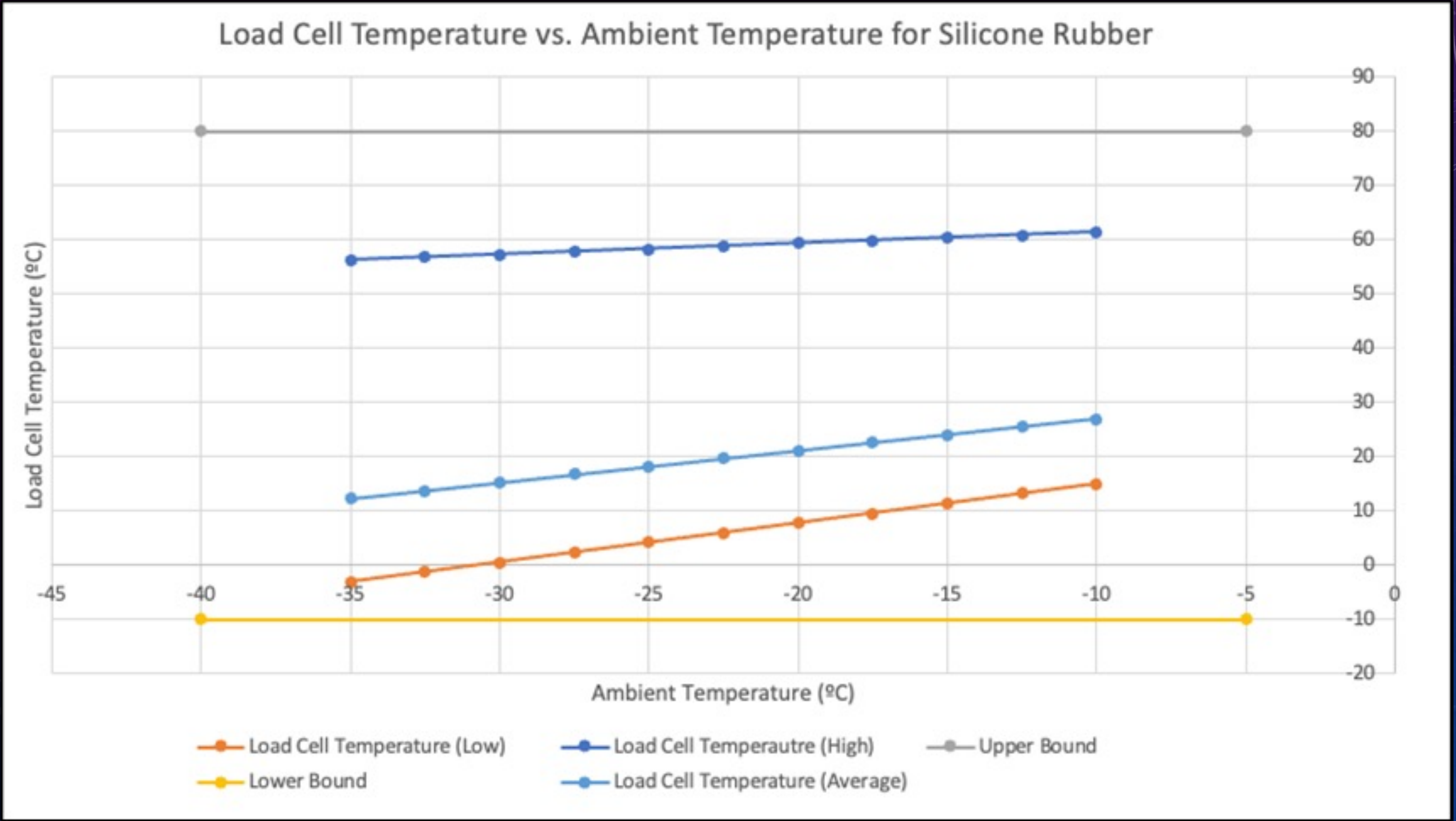


Table 1 Casing Materials' Specifications

Material	**Yield Strength (MPa)**	**Survives Snow ($4.17\text{x}10^{-4}$ MPa)**	**Survives Wind ($7.26\text{x}10^{-4}$ MPa)**	**Cost ($\$/m^2$)**
Galvanized Steel	520	Yes	Yes	28.58
Aluminium	270	Yes	Yes	41.23
Polyvinyl chloride (PVC)	55.2	Yes	Yes	53.77

- Hence the selection of Galvanized Steel

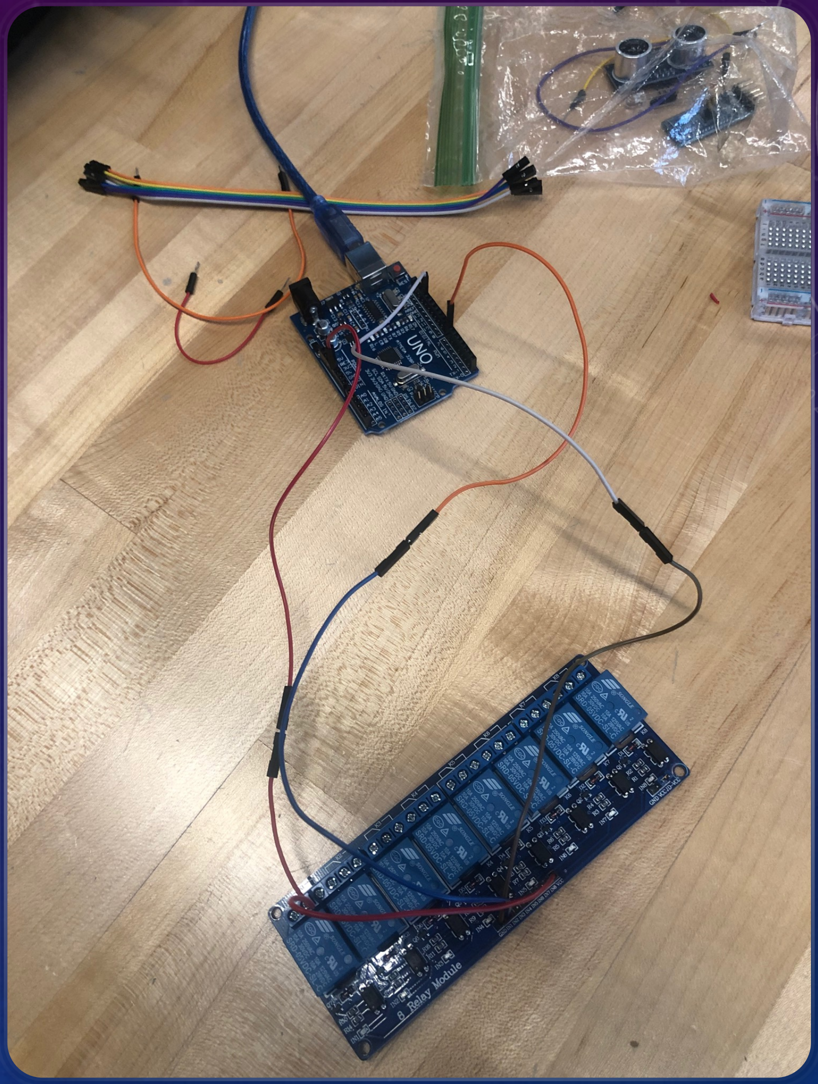
PROTOTYPE 2 CONT'D.



Graphical depiction of Silicone rubber insulating performance as our chosen insulator.

WHAT'S NEXT

- We will be connecting the vacuum to the Arduino by using a relay.
- We will be writing a code with Arduino IDE which will be able to automatically turn on and off the relay
- Load sensor will also be wired to the Arduino and the code will be able calculate the dust mass



WHAT'S NEXT CONT'D.

- Construction of the final prototype
- Testing of entire detection system
- Refinement of individual subsystems
- Lastly, determining clarifying specifications for special cases of device usage that will allow for product demonstration

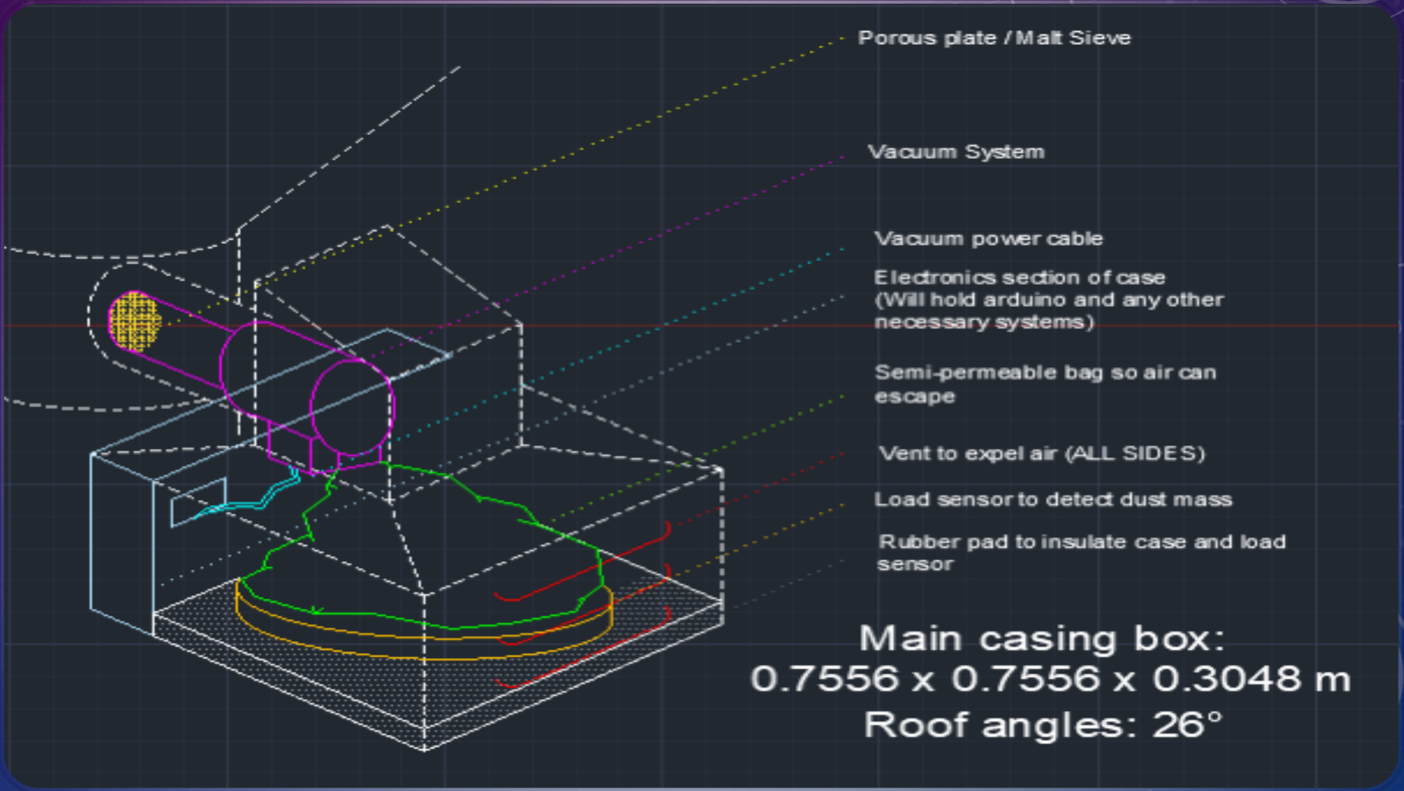
CLIENT COST ESTIMATE

SUBSYSTEM	PART	COST APPROXIMATION
Dust sensor system	Malt Sieve	≈ $ 90
	Vacuum	≈ $ 200
	Dust bag	≈ $ 25
	Load sensor	≈ $ 35
Computer software/hardware	Arduino	≈ $ 55
	Wiring	≈ $ 8
	Relays	≈ $ 20
Protective casing	Outer case	≈ $ 100
	Insulation	≈ $ 67
		≈ $ 600

At our current pace, a final product using high quality items at market value would cost the client approximately $ 600

CONCLUSION

- We’ve constructed a system that can determine the mass of a sample of dust and convert that reading into a dust composition
- This system operates automatically
- The approximate cost of one system unit is $600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