IP-EIGHTEEN

Final Project Presentation

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Objective:

To create a device that accurately measures the specific gravity of the wort for Beyond The Pale Brewing.

Target Specifications

#	Design Specifications	Relation	Value	Units	Importance (5>1)	Verification Method
1	Precision	>	1.01	-	5	testing
2	Log data	=	yes	-	5	testing
3	Update intervals	>	5-10	sec	5	testing
4	Store data	=	-	Excel	5	testing
5	Closed system	=	-	Excel	5	testing
6	Graph data	=	-	Excel	5	testing

- Precision
- Log data
- Update Intervals
- Storage
- Closed System
- Data Display

Our Chosen Concept

I. In line ultrasonic density meter that will calculate the density of the sugar water

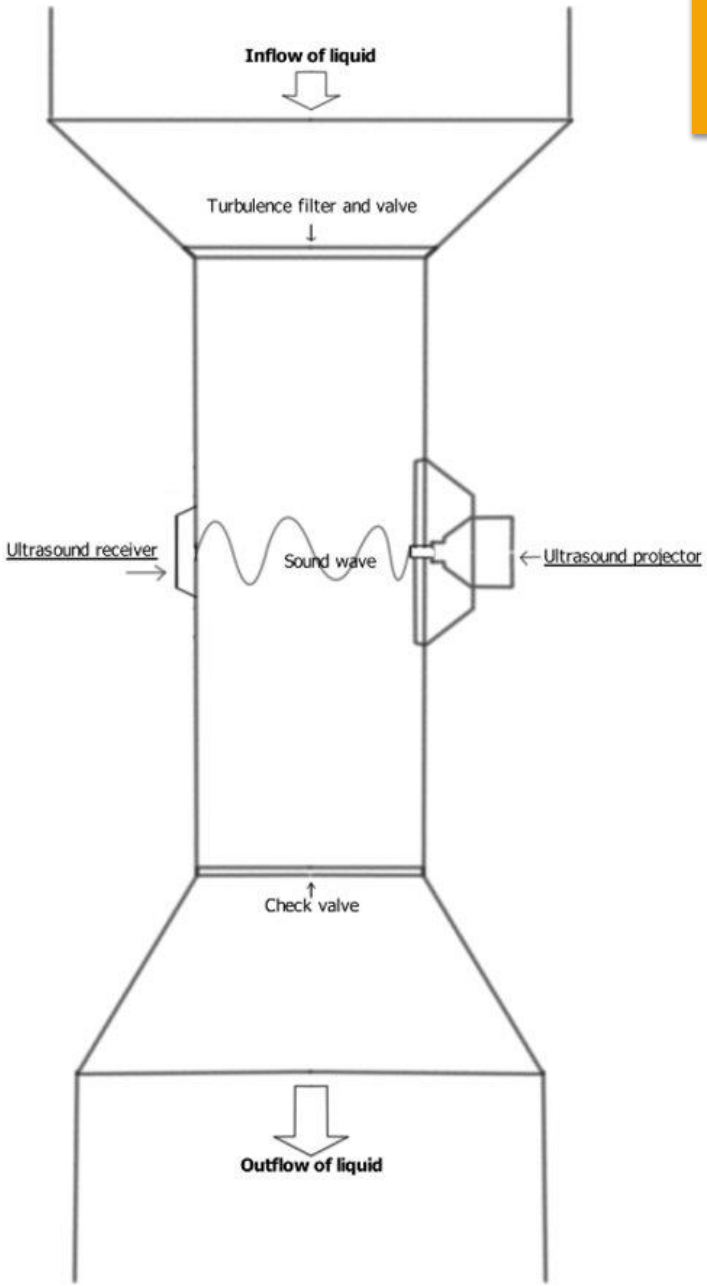
II. Arduino Uno microcontroller and density to specific gravity computation

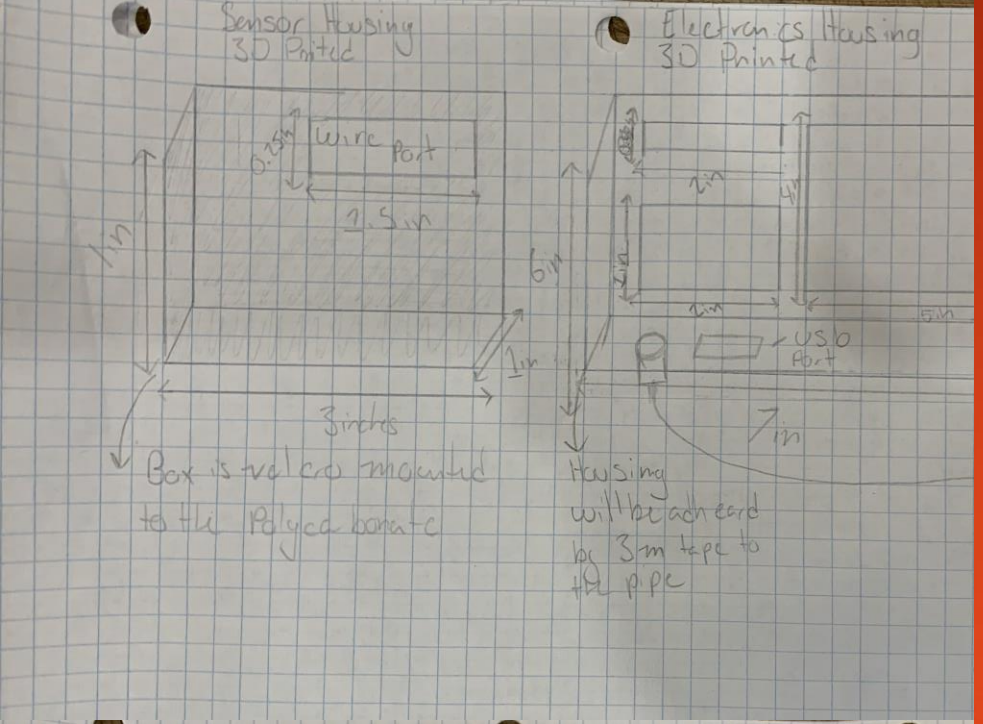
III. Clamp style mount featuring windows on either side of the pipe to transmit and receive signals

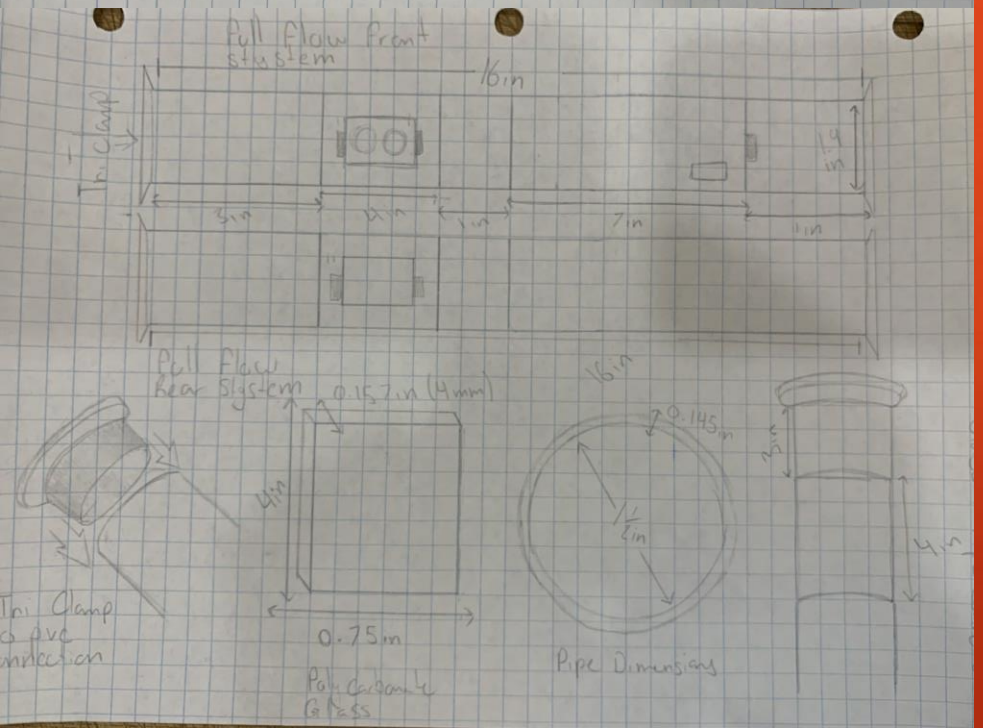
IV. Excel based live data streaming for accurate and timely monitoring of specific gravity

Prototype Sketches

- Shown at the second client meeting
- Offred a visual representation of how our device would appear



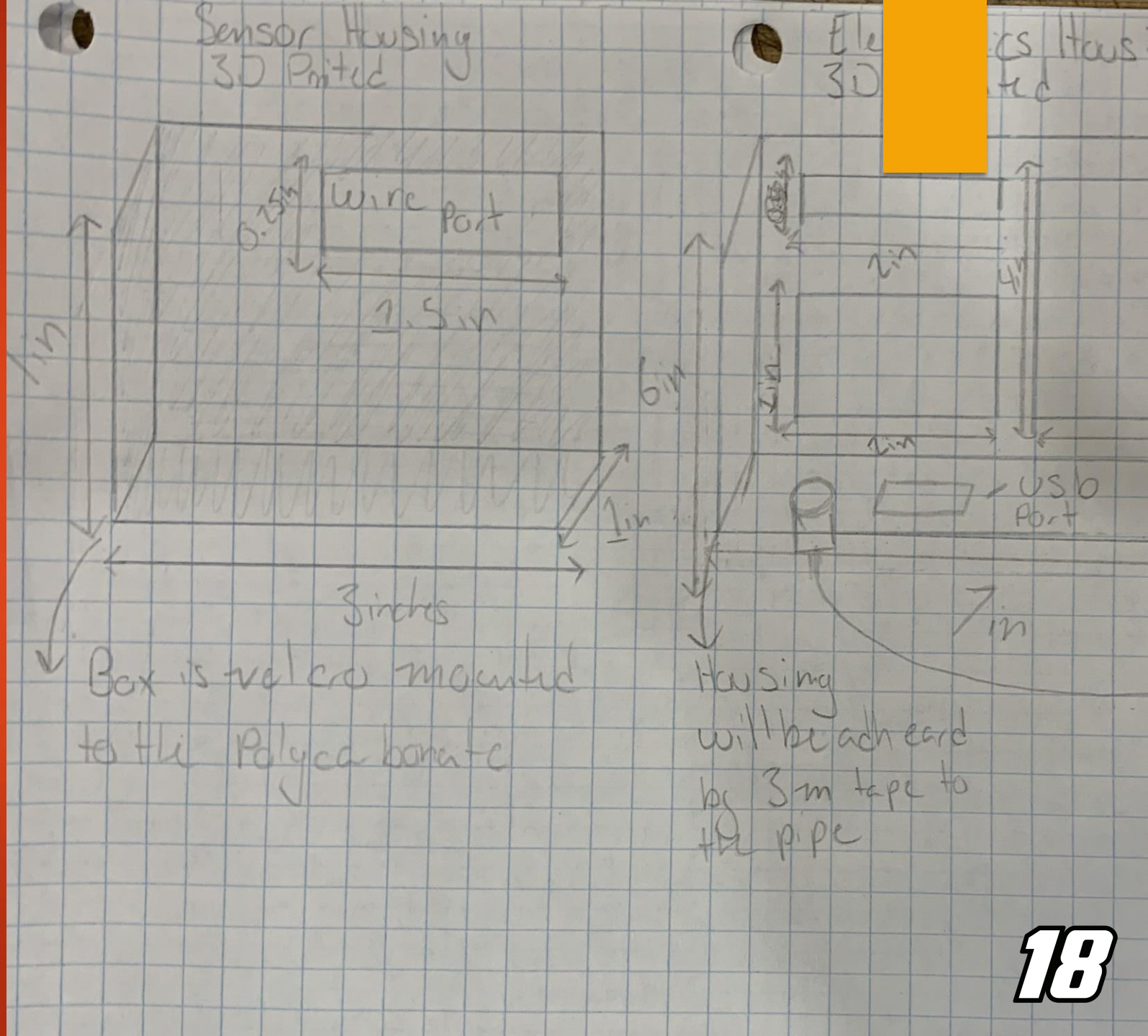




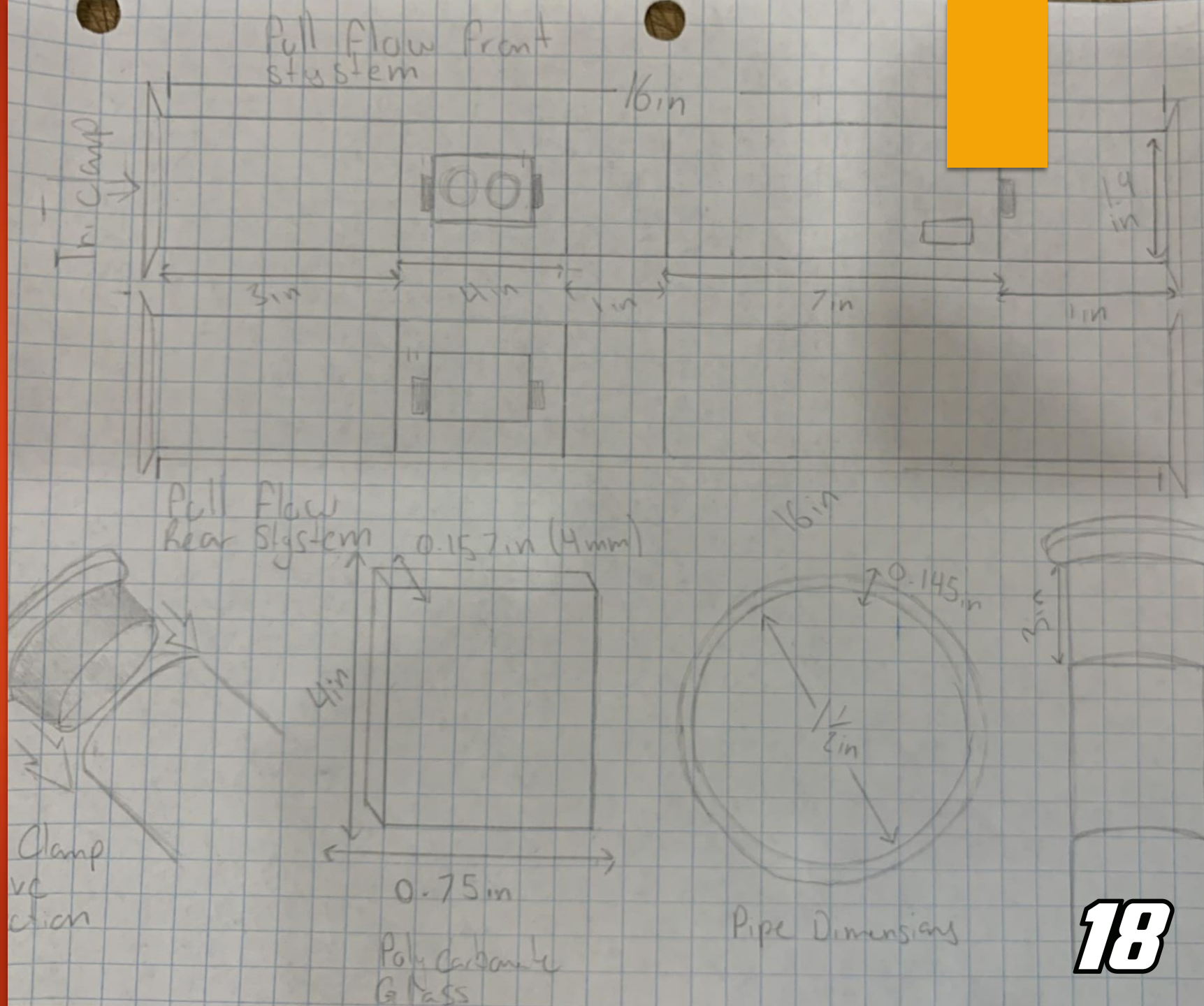
Technical Drawings

- These technical drawings were the basis of our prototypes
- They feature a similar design to our existing prototype
- They take into account the clamps and fittings that BTP Brewing Uses

Housing Sketch

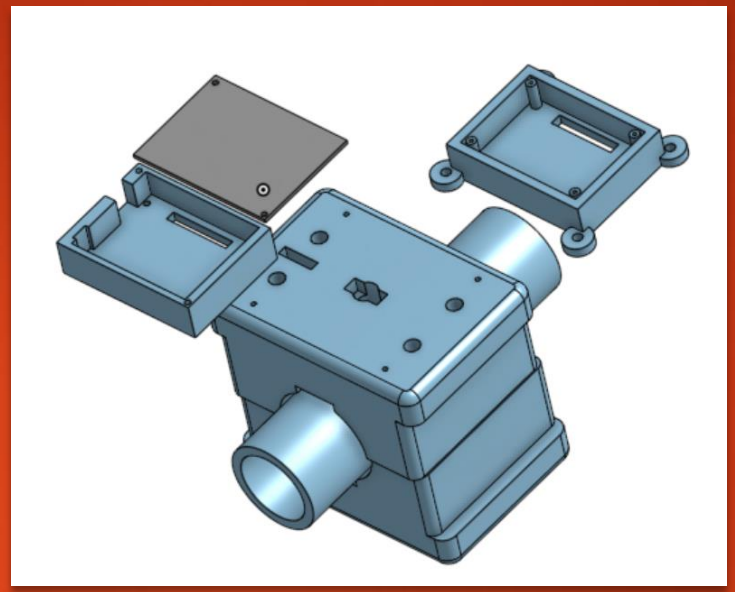


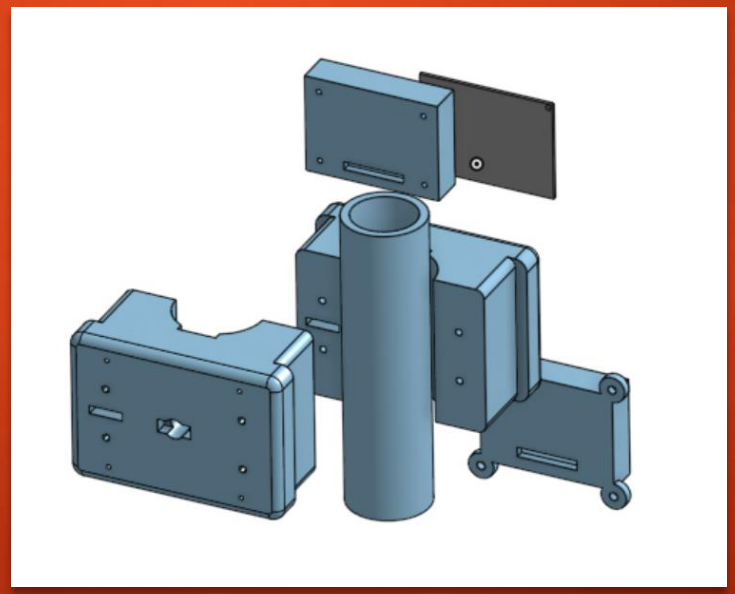
Pipe Sketch


Pull Flow Front system
1/16 in
Tri Clamp
3 in
1 in
7 in
1 in
1.9 in
Pull Flow Rear System
0.157 in (4mm)
1 in
0.75 in
Clamp
Polycarbonate Glass
1/16 in
0.145 in
2 in
1/2 in
Pipe Dimensions

Physical Construction

- Low Cost
- Manipulable/Adaptable
- Modular
- Easily Replaceable
- Easily Editable



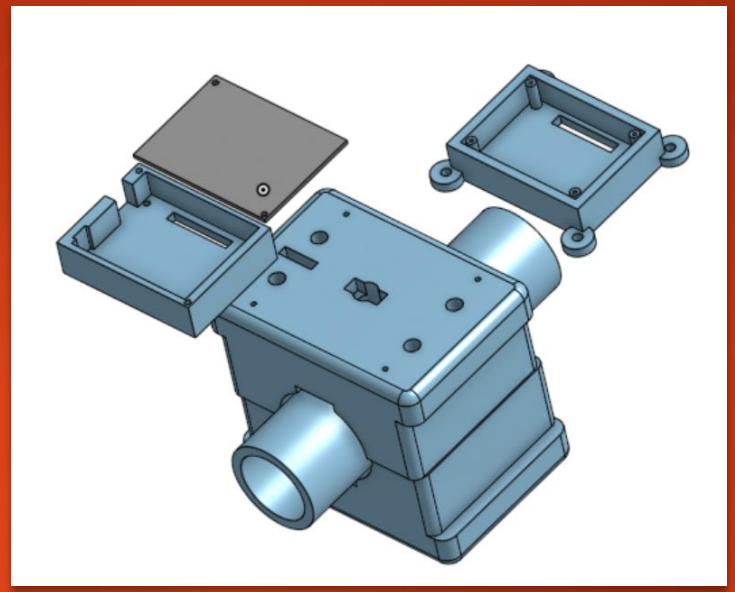


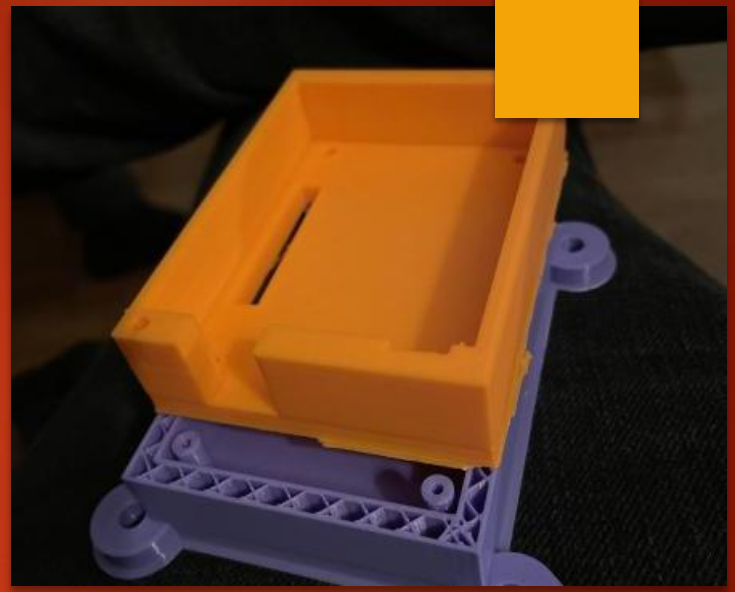
ABS Fluid Pipe

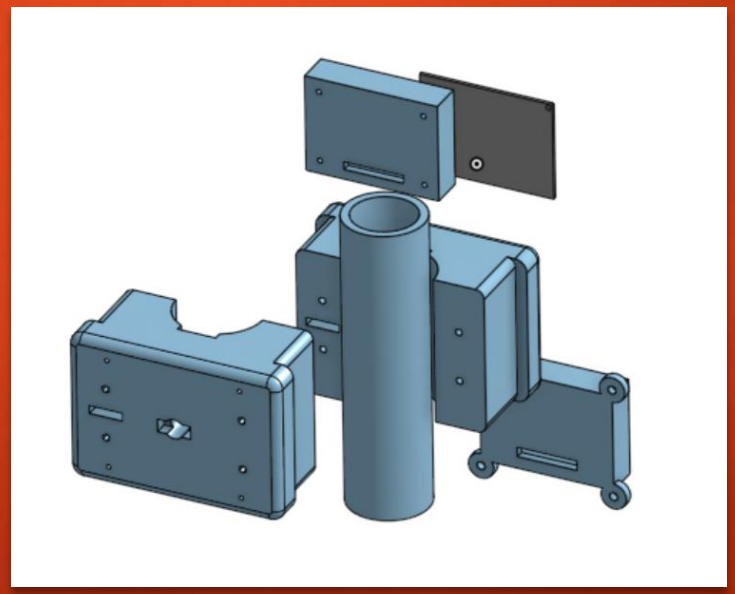
- Low Cost
- ABS Plastic and Lexan Glass Constuction
- Easily Modifiable
- Features Two Transmission Windows
- Food Grade Components

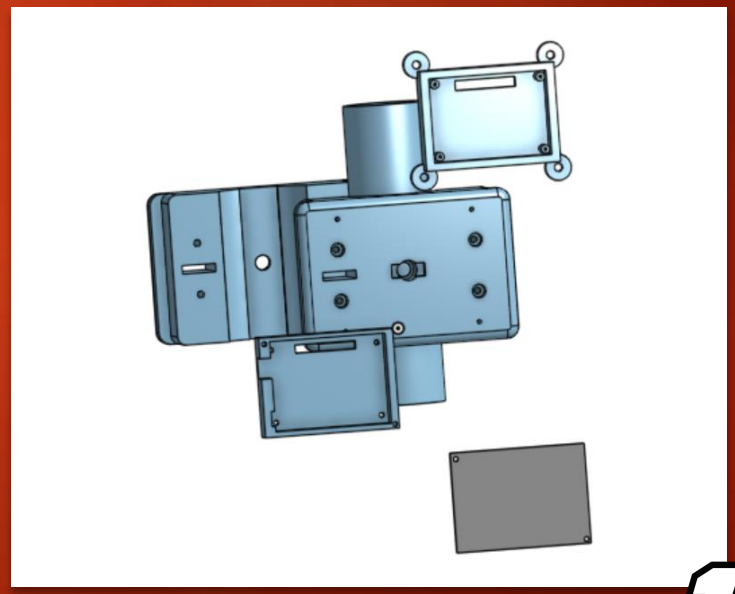
Electronics Case and Clamp assembly

- Modular Design
- Easy maintenance
- Compact size, low cost
- Easy to produce, 3D printed PLA plastic







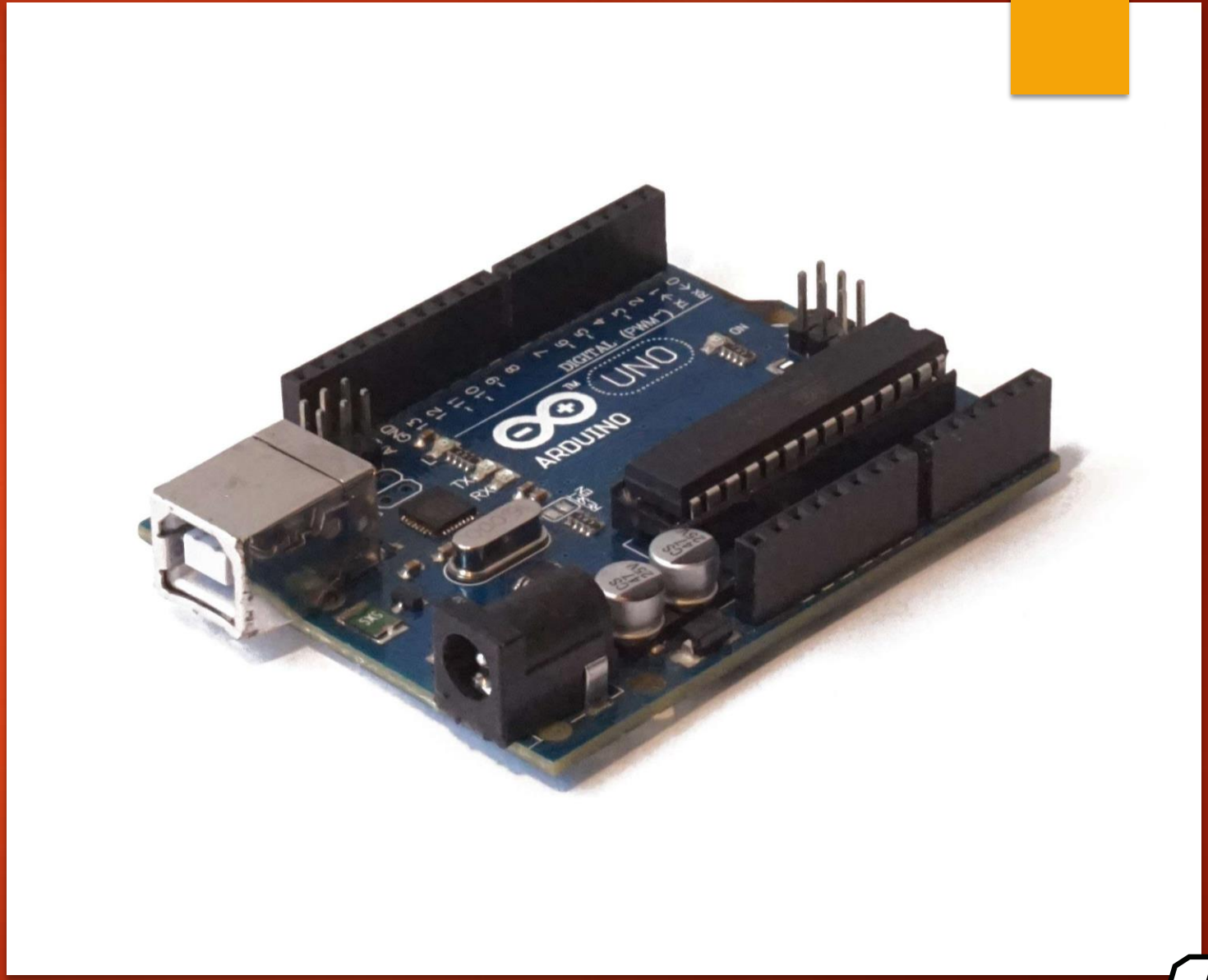


Assembly

- Total Cost to Produce: $18.79
- Hand Removable Hardware
- Sturdy 3D Printed Components
- Easily Separated Design for Ease of Maintenace and Cleaning

Arduino and code

- Arduino Uno microcontroller
- C language
- The wonderful thing about Arduino



Arduino and code

Code used for testing

- Sends signal
- Waits for echo
- Gives delay
- Find MACH by plugging distance

```
int trigPin = 13; // set pin 13 as trig pin
int echoPin = 7; // set pin 7 as echo pin
int time;
int dist=11.2;
float ultrasonic;

void setup() {

  Serial.begin(9600);

pinMode(trigPin, OUTPUT);  // set trig pin as output, we send pulse through this

pinMode(echoPin,INPUT);  // set echo pin as input, we detect echo through this pin

  }
void loop() {
 //sending 10 microsecond width pulses, frequency ~ 40KHz

  digitalWrite(trigPin, LOW);
  delayMicroseconds(2000);

digitalWrite(trigPin,HIGH); //trig pin delayMicroseconds(10);  //pulse width 10 microseconds
digitalWrite(trigPin, LOW); //trig pin off
time = pulseIn(echoPin, HIGH);  //pulseIn(), function return time in microseconds

//print time on the serial monitor



  Serial.print(" Time taken for the pulse to travel:  ");
  Serial.print(time);
  Serial.println(" microseconds");

  Serial.println(20000*(float)(dist)/(time));
  delay(2000);
}
```

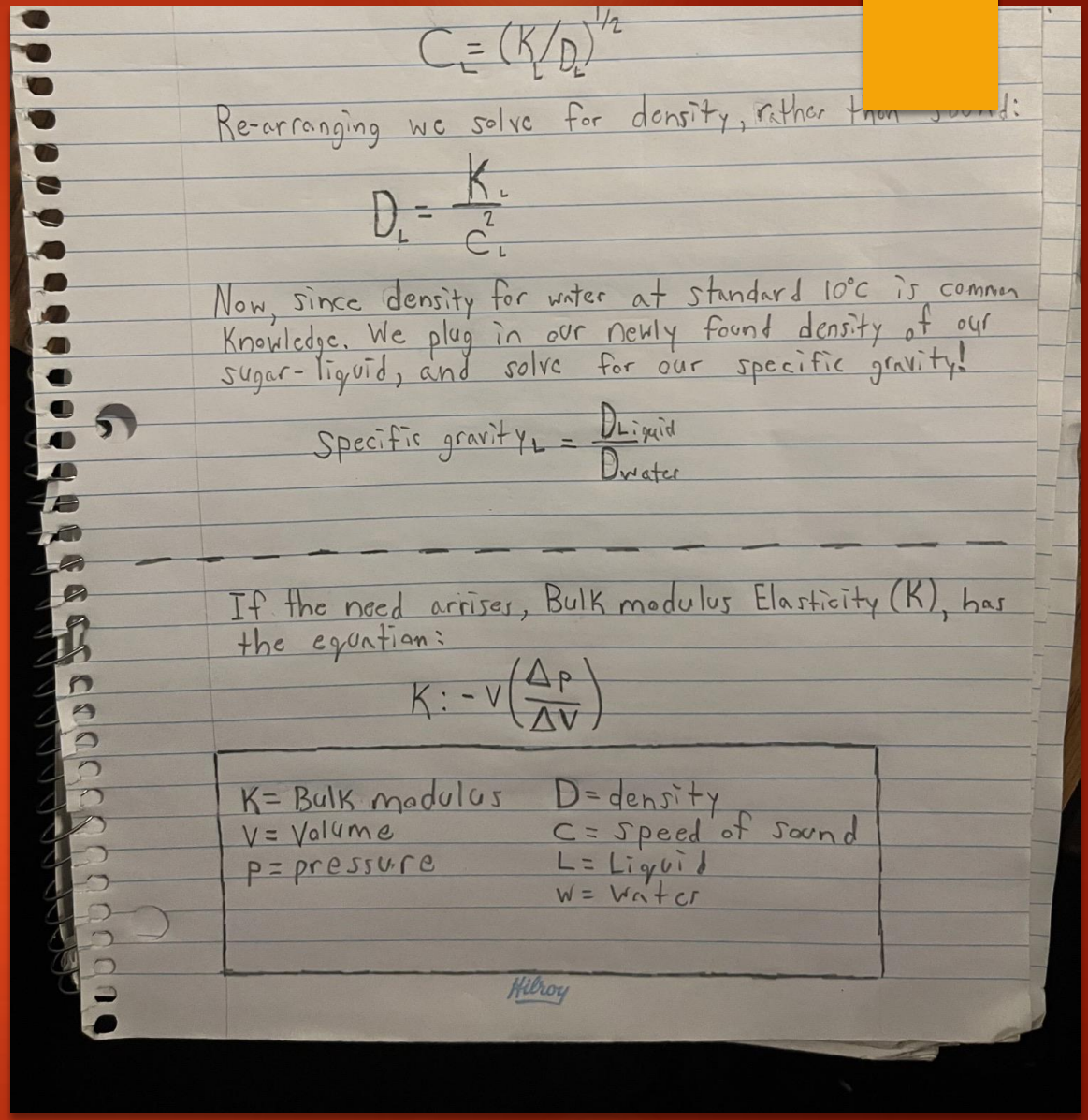
Code components sourced from:
https://www.instructables.com/Measuring-the-speed-of-sound-with-Arduino-microcon/

Mathematical Computation

- The formula for SOS:
- sqrt(Bulk Modulus/Density)

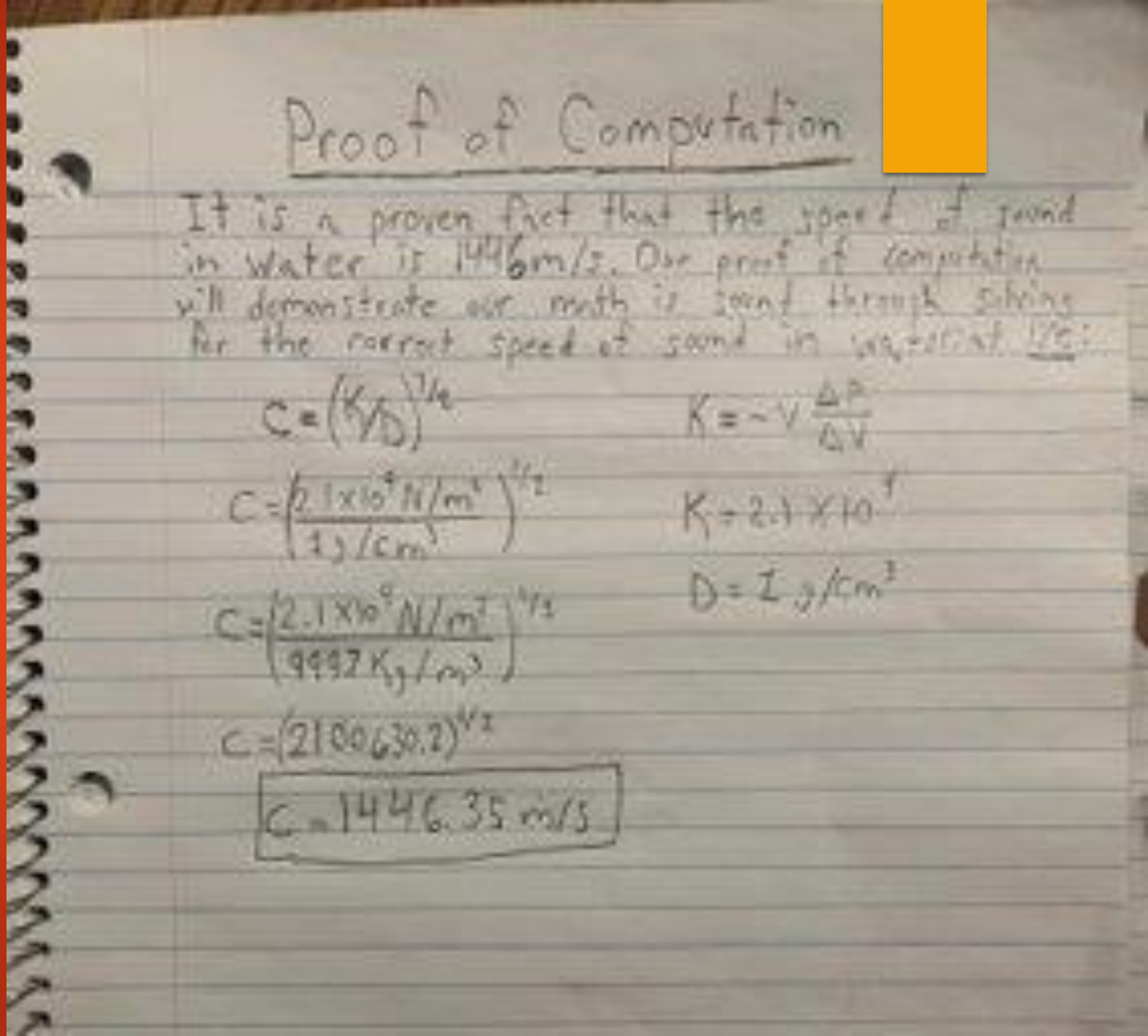
- Isolate for Density:
- Bulk Modulus/SOS^2

- The bulk modulus is a fluid constant that depicts how much a fluids volume changes over a certain increase or decrease in pressure.
- Once you solve for the Density, plug it into the equation Specific Gravity= DL/DW and solve for specific gravity



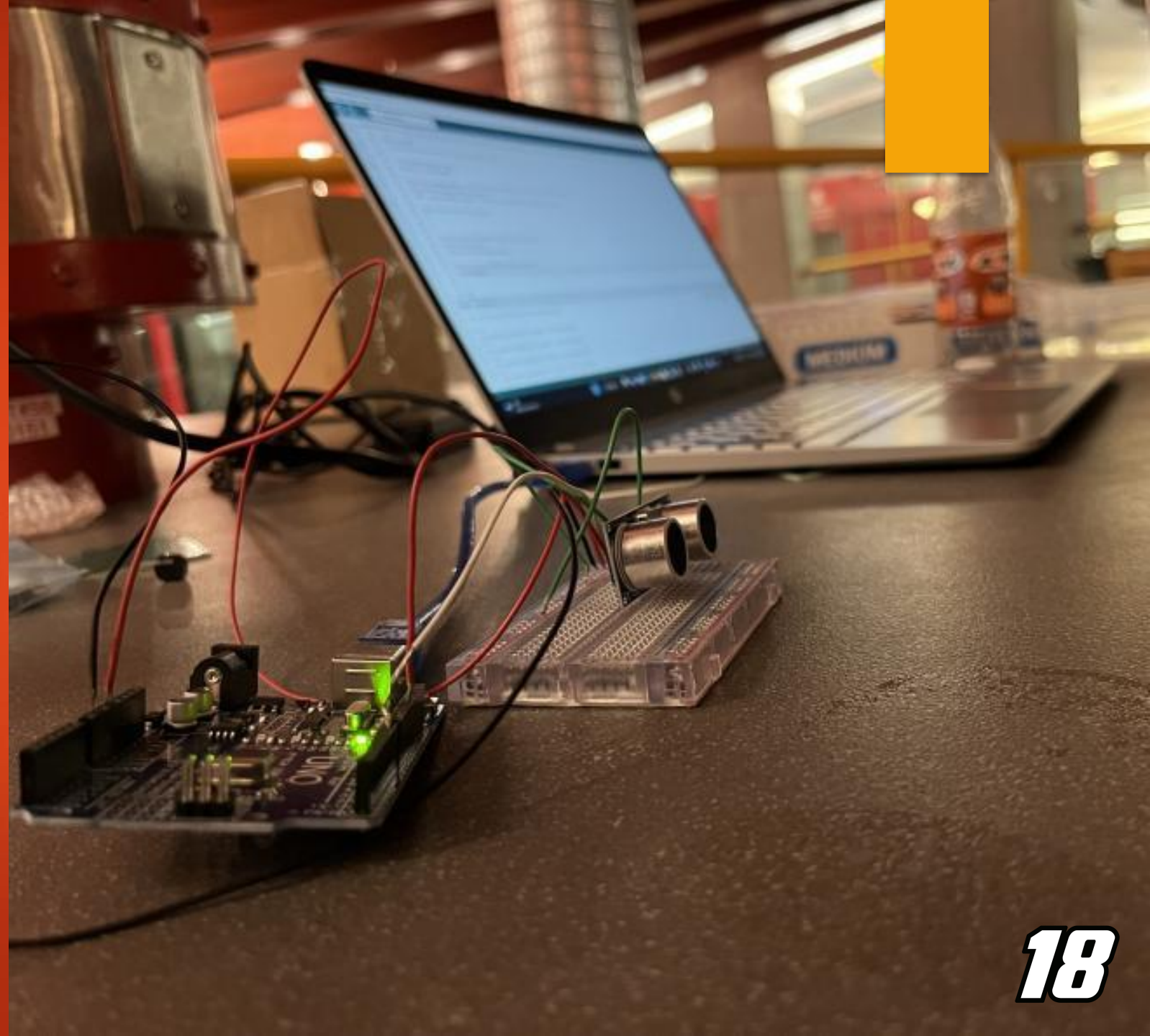
Proof of Mathematical computation

- SOS= (Bulk Modulus/Density)^1/2
- Here we test to see if we get an accurate SOS in water, just to prove our mathematical concepts. With our process we obtained 1446.35 m/s
- The internet can never seem to agree on anything, but most sights list the SOS of water as 1447 m/s at 10*C.



Sensor/Circuit testing

- Original sensors proved inefficient
- HC-SR04 used for testing
- Tested with empty cup (air), cater, and concentrated sugar water.



Test Results

- Accurate speed of sound in air; theoretical 343, Calculated avg 342.5
- Inaccurate in water; 30% error.

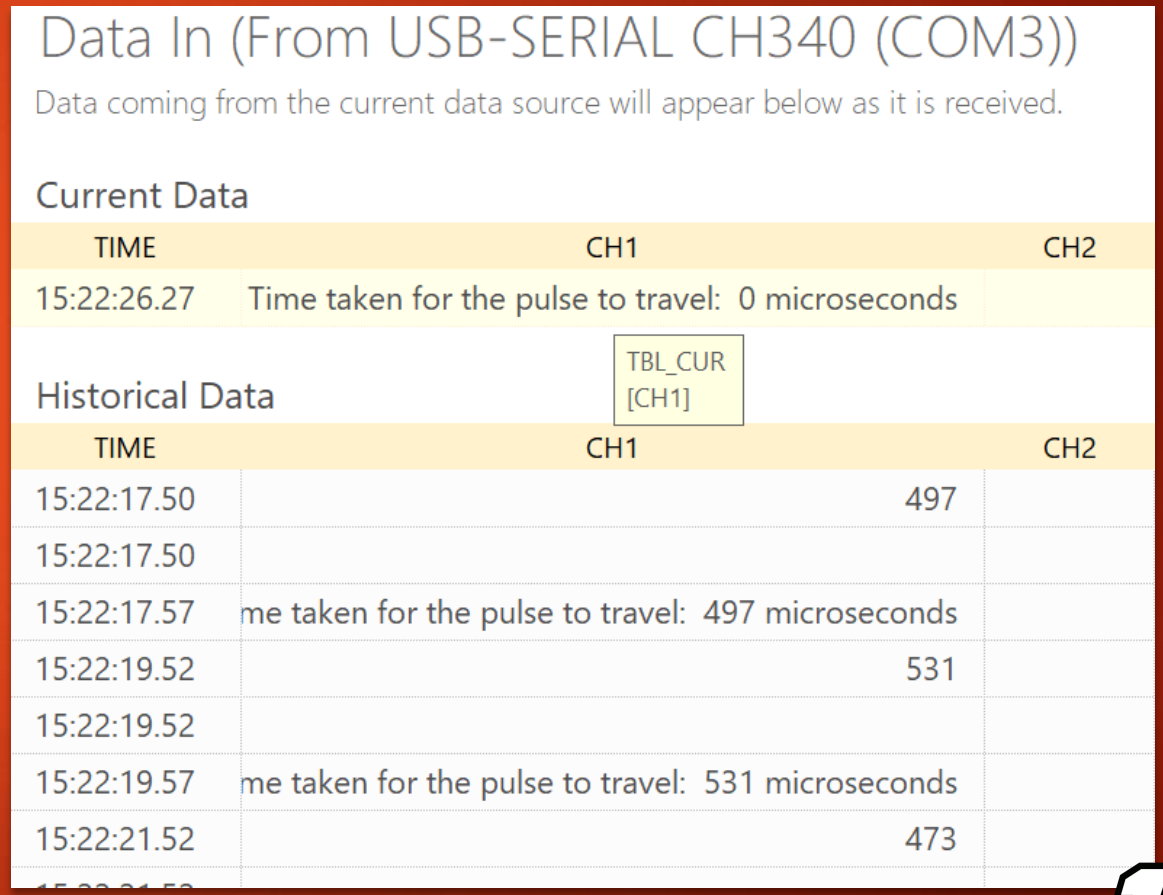
medium	distance	time	speed
water	11.2	317	
		244	
		238	
		287	
		219	
		130.5	858.2375479
air	11.2	672	
		638	
		665	
		641	
		327	
			342.5076453
sugar water	11.2	184	
		184	
		92	
			1217.391304

Findings/Theories

- Sound bouncing off of water surface
- Trav elling through different mediums
- Lexan window cannot be used; Sensor cannot read through it
- Tried using Polyethene food wrap to waterproof but inaccurate results.
- Sensor needs to be submerged in medium to be tested

Live Display

- Excel used to display live data
- Wireless connectivity if enough time.



Data In (From USB-SERIAL CH340 (COM3))

Data coming from the current data source will appear below as it is received.

Current Data

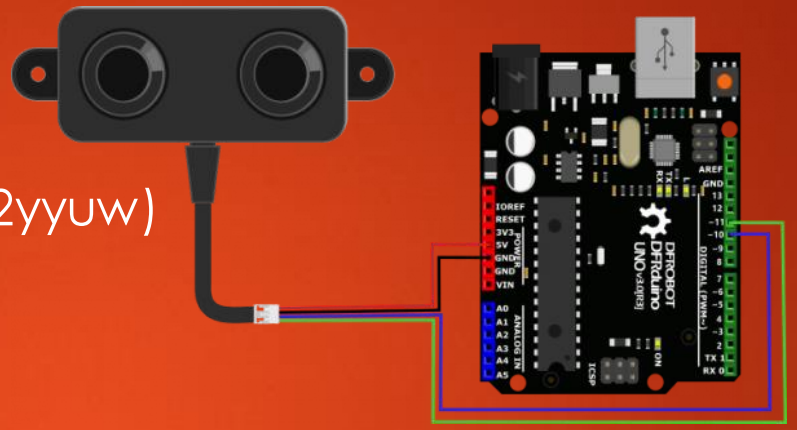
TIME	CH1	CH2
15:22:26.27	Time taken for the pulse to travel: 0 microseconds	

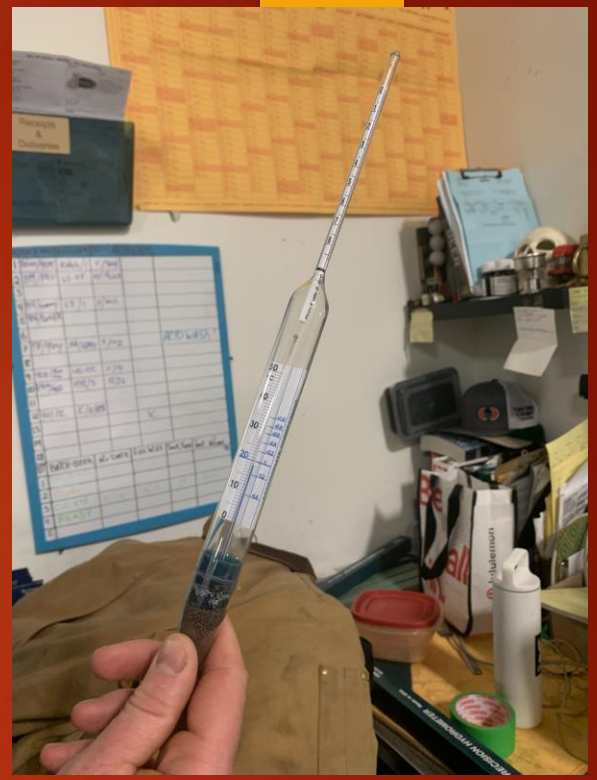
Historical Data

TBL_CUR [CH1]

TIME	CH1	CH2
15:22:17.50	497	
15:22:17.50		
15:22:17.57	me taken for the pulse to travel: 497 microseconds	
15:22:19.52	531	
15:22:19.52		
15:22:19.57	me taken for the pulse to travel: 531 microseconds	
15:22:21.52	473	

Future Objectives





- Waterproof Ultrasonic sensor(a02yyuw)
- Refine Physical Appearance
- Refine Data Display UI
- Assemble Disassemble and Test for Durability/Longevity
- Collect data online and transform it into the computer in the factory, next to the tanks which resolve the problem of the pipe connecting to the tank and there is stuff stacking up which could be a trouble for them to look for the reading on the unit

Unforeseen Obstacles

- Parts Arriving Late
- Materials being compromised
- Limited Access to 3D Printers
- Group Commuinication

Questions?

- Accuracy
- Cost
- Construction