Ocean Nutrient Analyzer

San Josė State University
College of Engineering
April 6, 2022

SJSU

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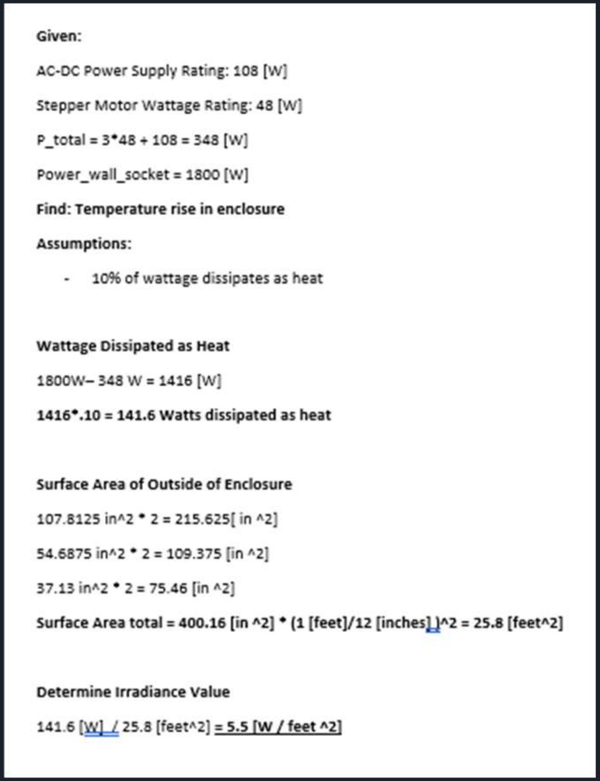
Introduction and Presentation Overview

We are presenting updates on the following:

- Thermal Analysis
- Gantt Chart
- Port control
- Pump control
- Sequence control
- Reagent housing design
- Final enclosure design
- Data collection

Cameron

Thermal Analysis Update: We’re going to be ok!



Given:

AC-DC Power Supply Rating: 108 [W]

Stepper Motor Wattage Rating: 48 [W]

P_total = 3*48 + 108 = 348 [W]

Power_wall_socket = 1800 [W]

Find: Temperature rise in enclosure

Assumptions:

- 10% of wattage dissipates as heat

Wattage Dissipated as Heat

1800W– 348 W = 1416 [W]

1416*.10 = 141.6 Watts dissipated as heat

Surface Area of Outside of Enclosure

107.8125 in^2 * 2 = 215.625[in ^2]

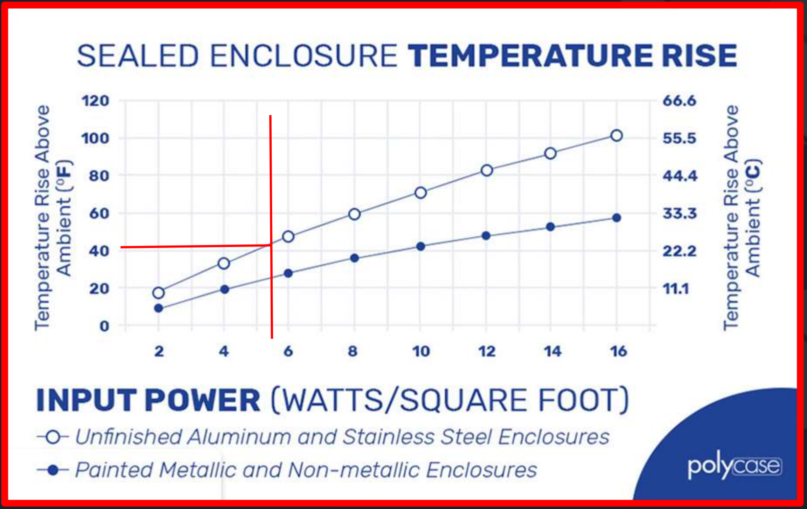
54.6875 in^2 * 2 = 109.375 [in ^2]

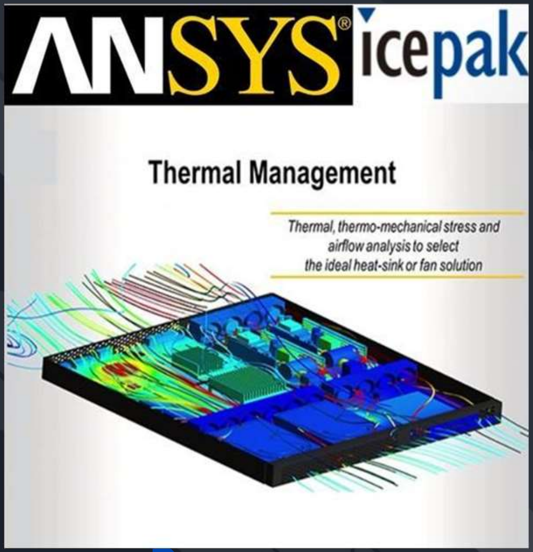
37.13 in^2 * 2 = 75.46 [in ^2]

Surface Area total = 400.16 [in ^2] * (1 [feet]/12 [inches])^2 = 25.8 [feet^2]

Determine Irradiance Value

141.6 [W] / 25.8 [feet^2] = 5.5 [W / feet ^2]



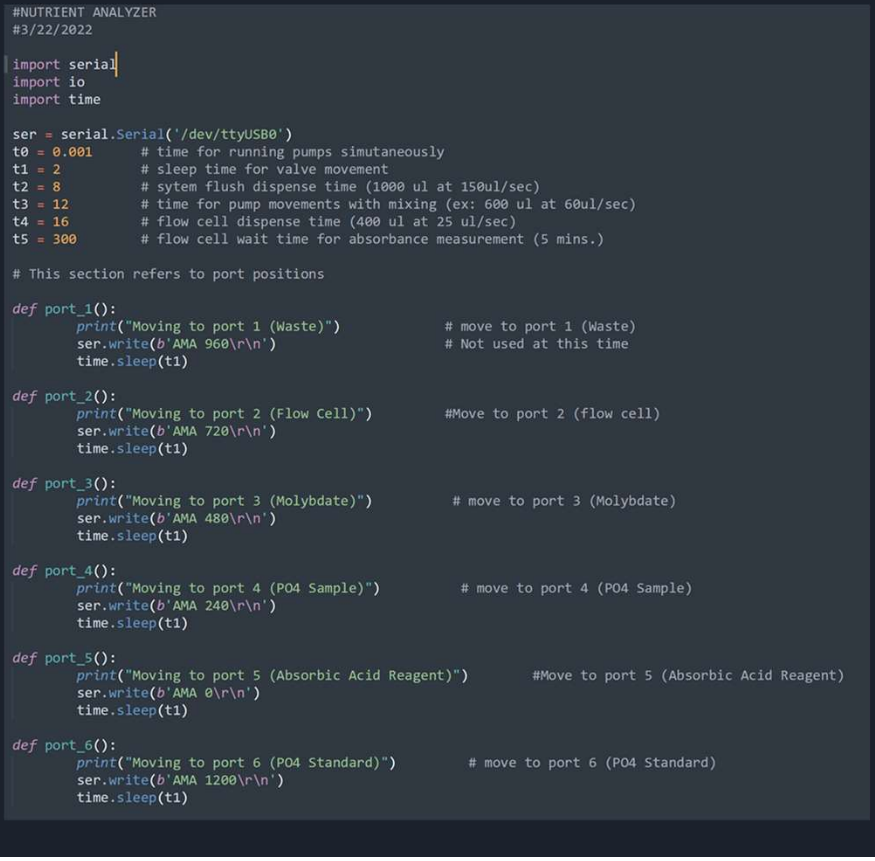

ANSYS® icepak
Thermal Management
Thermal, thermo-mechanical stress and airflow analysis to select the ideal heat-sink or fan solution

Extreme case +40 degrees Fahrenheit Temperature with respect to ambient

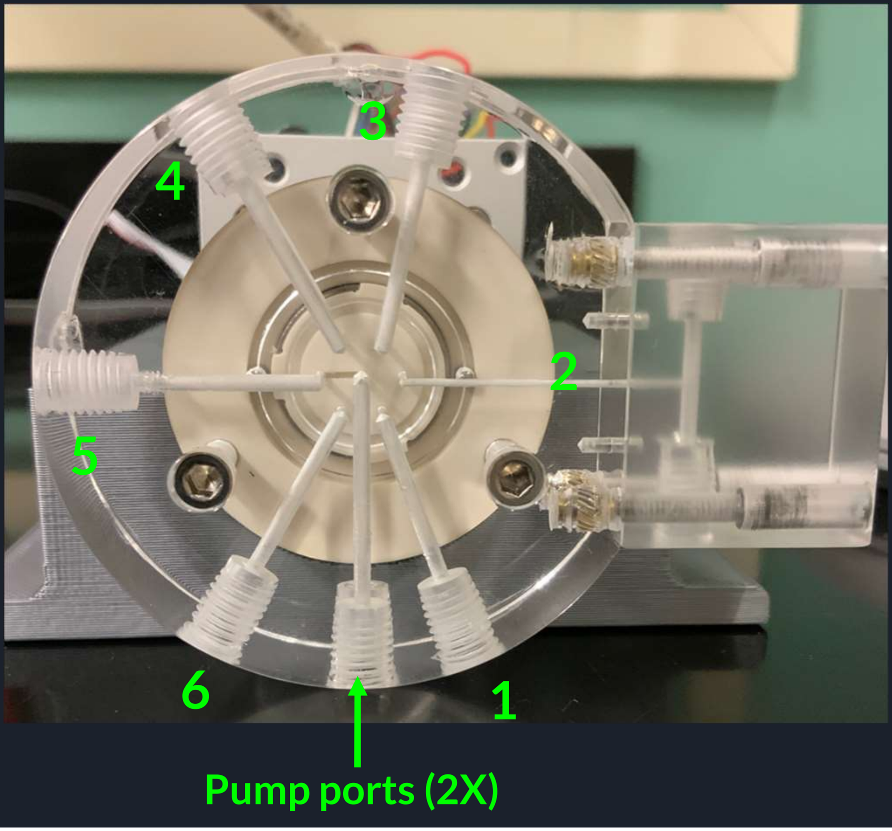
- Conservative estimate
- Raspberry Pi has 178 degree Fahrenheit
- ANSYS Icepack for variable thermal loading
- No need to retrofit enclosure with cooling solutions
- Current analysis is undergoing final review from sponsoring professors

Cameron

CONTROLLING THE PORTS

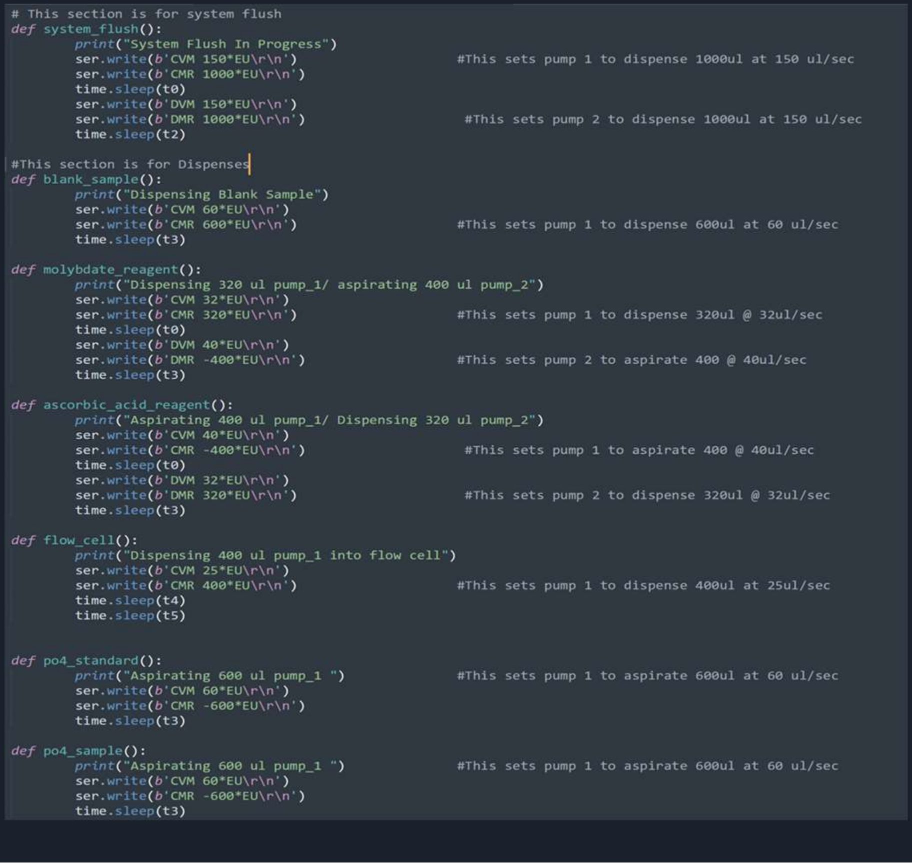


```
#NUTRIENT ANALYZER
#3/22/2022

import serial
import io
import time

ser = serial.Serial('/dev/ttyUSB0')
t0 = 0.001      # time for running pumps simutaneously
t1 = 2          # sleep time for valve movement
t2 = 8          # sytem flush dispense time (1000 ul at 150ul/sec)
t3 = 12         # time for pump movements with mixing (ex: 600 ul at 60ul/sec)
t4 = 16         # flow cell dispense time (400 ul at 25 ul/sec)
t5 = 300        # flow cell wait time for absorbance measurement (5 mins.)

# This section refers to port positions

def port_1():
        print("Moving to port 1 (Waste)")             # move to port 1 (Waste)
        ser.write(b'AMA 960\r\n')                     # Not used at this time
        time.sleep(t1)

def port_2():
        print("Moving to port 2 (Flow Cell)")         #Move to port 2 (flow cell)
        ser.write(b'AMA 720\r\n')
        time.sleep(t1)

def port_3():
        print("Moving to port 3 (Molybdate)")          # move to port 3 (Molybdate)
        ser.write(b'AMA 480\r\n')
        time.sleep(t1)

def port_4():
        print("Moving to port 4 (PO4 Sample)")          # move to port 4 (PO4 Sample)
        ser.write(b'AMA 240\r\n')
        time.sleep(t1)

def port_5():
        print("Moving to port 5 (Absorbic Acid Reagent)")        #Move to port 5 (Absorbic Acid Reagent)
        ser.write(b'AMA 0\r\n')
        time.sleep(t1)

def port_6():
        print("Moving to port 6 (PO4 Standard)")         # move to port 6 (PO4 Standard)
        ser.write(b'AMA 1200\r\n')
        time.sleep(t1)
```

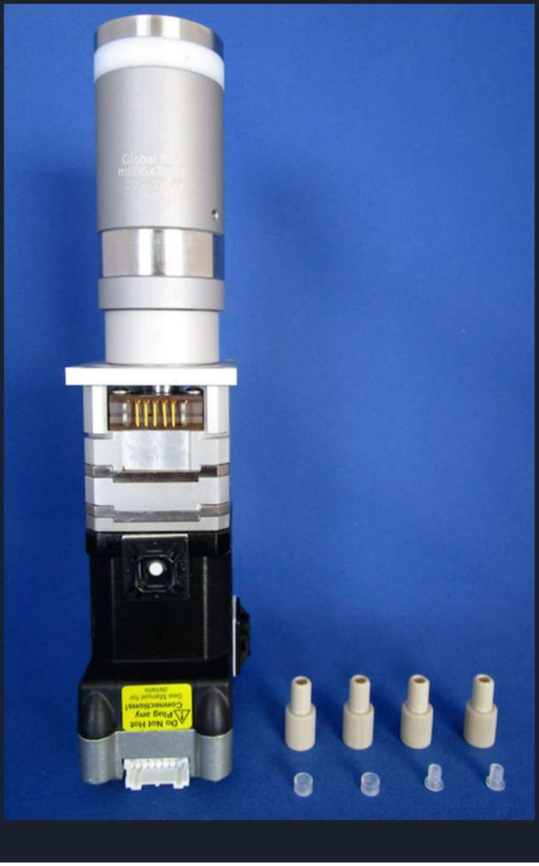


Tracy Hunter

CONTROLLING THE PUMPS



```
# This section is for system flush
def system_flush():
        print("System Flush In Progress")
        ser.write(b'CVM 150*EU\r\n')                    #This sets pump 1 to dispense 1000ul at 150 ul/sec
        ser.write(b'CMR 1000*EU\r\n')
        time.sleep(t0)
        ser.write(b'DVM 150*EU\r\n')
        ser.write(b'DMR 1000*EU\r\n')                    #This sets pump 2 to dispense 1000ul at 150 ul/sec
        time.sleep(t2)

#This section is for Dispenses
def blank_sample():
        print("Dispensing Blank Sample")
        ser.write(b'CVM 60*EU\r\n')
        ser.write(b'CMR 600*EU\r\n')                    #This sets pump 1 to dispense 600ul at 60 ul/sec
        time.sleep(t3)

def molybdate_reagent():
        print("Dispensing 320 ul pump_1/ aspirating 400 ul pump_2")
        ser.write(b'CVM 32*EU\r\n')
        ser.write(b'CMR 320*EU\r\n')                    #This sets pump 1 to dispense 320ul @ 32ul/sec
        time.sleep(t0)
        ser.write(b'DVM 40*EU\r\n')
        ser.write(b'DMR -400*EU\r\n')                   #This sets pump 2 to aspirate 400 @ 40ul/sec
        time.sleep(t3)

def ascorbic_acid_reagent():
        print("Aspirating 400 ul pump_1/ Dispensing 320 ul pump_2")
        ser.write(b'CVM 40*EU\r\n')
        ser.write(b'CMR -400*EU\r\n')                    #This sets pump 1 to aspirate 400 @ 40ul/sec
        time.sleep(t0)
        ser.write(b'DVM 32*EU\r\n')
        ser.write(b'DMR 320*EU\r\n')                     #This sets pump 2 to dispense 320ul @ 32ul/sec
        time.sleep(t3)

def flow_cell():
        print("Dispensing 400 ul pump_1 into flow cell")
        ser.write(b'CVM 25*EU\r\n')
        ser.write(b'CMR 400*EU\r\n')                    #This sets pump 1 to dispense 400ul at 25ul/sec
        time.sleep(t4)
        time.sleep(t5)


def po4_standard():
        print("Aspirating 600 ul pump_1 ")              #This sets pump 1 to aspirate 600ul at 60 ul/sec
        ser.write(b'CVM 60*EU\r\n')
        ser.write(b'CMR -600*EU\r\n')
        time.sleep(t3)

def po4_sample():
        print("Aspirating 600 ul pump_1 ")              #This sets pump 1 to aspirate 600ul at 60 ul/sec
        ser.write(b'CVM 60*EU\r\n')
        ser.write(b'CMR -600*EU\r\n')
        time.sleep(t3)
```



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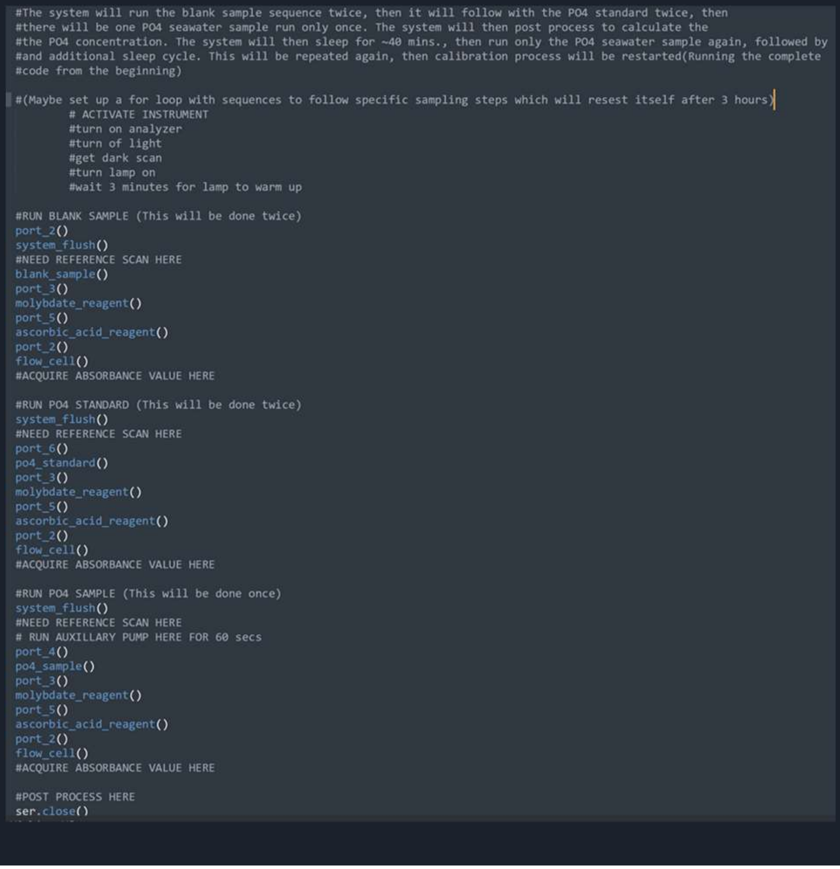
SEQUENCE OF CONTROL



```
#The system will run the blank sample sequence twice, then it will follow with the PO4 standard twice, then
#there will be one PO4 seawater sample run only once. The system will then post process to calculate the
#the PO4 concentration. The system will then sleep for ~40 mins., then run only the PO4 seawater sample again, followed by
#and additional sleep cycle. This will be repeated again, then calibration process will be restarted(Running the complete
#code from the beginning)

#(Maybe set up a for loop with sequences to follow specific sampling steps which will resest itself after 3 hours)
        # ACTIVATE INSTRUMENT
        #turn on analyzer
        #turn of light
        #get dark scan
        #turn lamp on
        #wait 3 minutes for lamp to warm up

#RUN BLANK SAMPLE (This will be done twice)
port_2()
system_flush()
#NEED REFERENCE SCAN HERE
blank_sample()
port_3()
molybdate_reagent()
port_5()
ascorbic_acid_reagent()
port_2()
flow_cell()
#ACQUIRE ABSORBANCE VALUE HERE

#RUN PO4 STANDARD (This will be done twice)
system_flush()
#NEED REFERENCE SCAN HERE
port_6()
po4_standard()
port_3()
molybdate_reagent()
port_5()
ascorbic_acid_reagent()
port_2()
flow_cell()
#ACQUIRE ABSORBANCE VALUE HERE

#RUN PO4 SAMPLE (This will be done once)
system_flush()
#NEED REFERENCE SCAN HERE
# RUN AUXILLARY PUMP HERE FOR 60 secs
port_4()
po4_sample()
port_3()
molybdate_reagent()
port_5()
ascorbic_acid_reagent()
port_2()
flow_cell()
#ACQUIRE ABSORBANCE VALUE HERE

#POST PROCESS HERE
ser.close()
```

This sequence is for one cycle only. Currently working to implement continuous application.

On 4/4/2022 there was an additional change to sequence by MLML.

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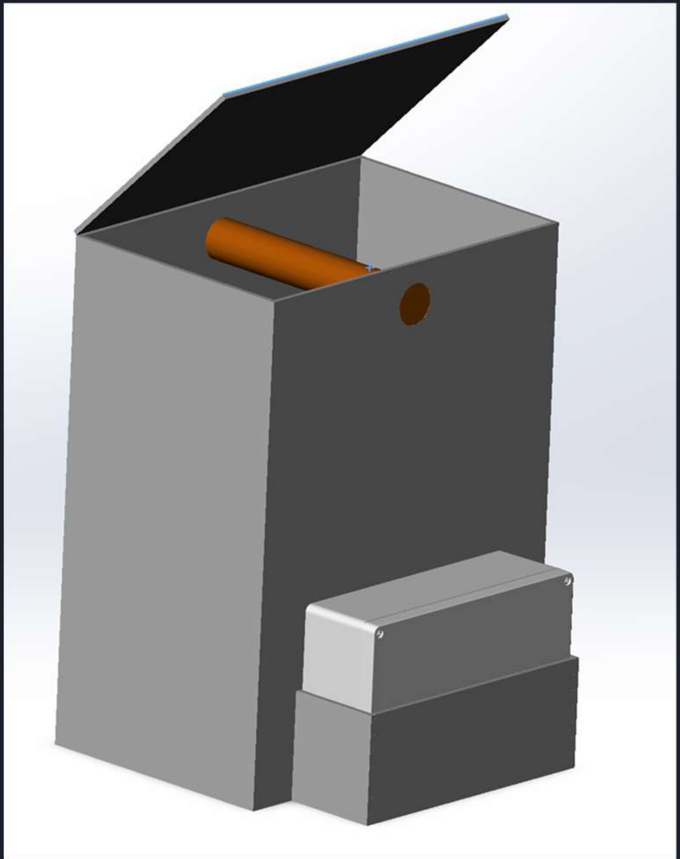
Reagent Storage Design



Reagent storage specs changed

Initially: Reagents would be hung from a bar separate from the electronics housing

Scope change: reagents need to be in the dark and submerged in water

Internal Dimension needed

Width - 18”
Depth - 12”
Height - 22”

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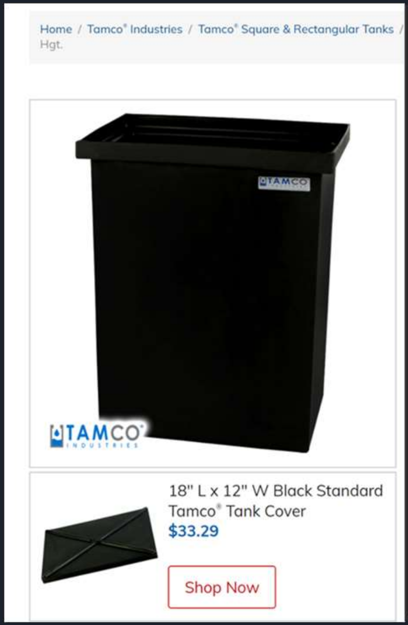
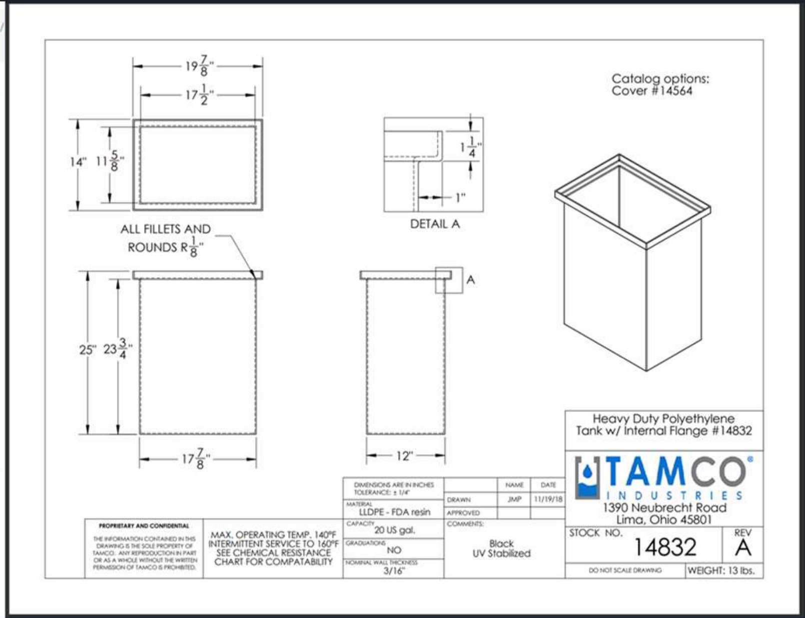
Container Solution



Home / Tamco® Industries / Tamco® Square & Rectangular Tanks /
Hgt.

18" L x 12" W Black Standard Tamco® Tank Cover
$33.29



19 7/8"
17 1/2"
14"
11 5/8"
ALL FILLETS AND ROUNDS R 1/8"
1 1/4"
1"
DETAIL A
Catalog options:
Cover #14564
A
25"
23 3/4"
17 7/8"
12"
Heavy Duty Polyethylene Tank w/ Internal Flange #14832
TAMCO INDUSTRIES
1390 Neubrecht Road
Lima, Ohio 45801
STOCK NO. 14832
REV A
DO NOT SCALE DRAWING
WEIGHT: 13 lbs.
DIMENSIONS ARE IN INCHES TOLERANCE: ± 1/4"
MATERIAL LLDPE - FDA resin
CAPACITY 20 US gal.
GRADUATIONS NO
NOMINAL WALL THICKNESS 3/16"
NAME
DATE
DRAWN
JMP
11/19/18
APPROVED
COMMENTS:
Black UV Stabilized
MAX. OPERATING TEMP. 140°F INTERMITTENT SERVICE TO 160°F SEE CHEMICAL RESISTANCE CHART FOR COMPATABILITY
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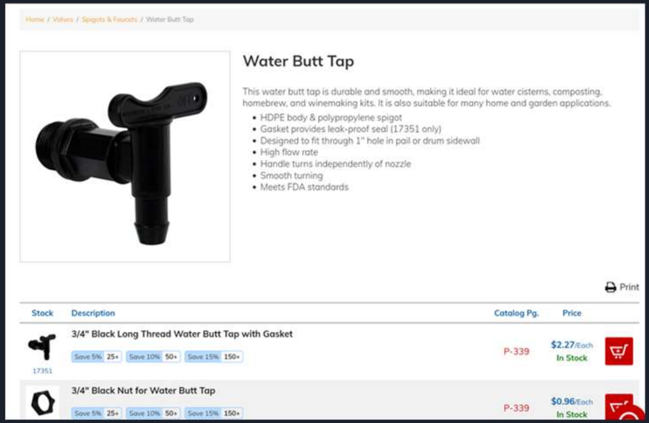
[20 Gallon Black Polyethylene Tank - 18" L x 12" W x 24" Hgt. | U.S. Plastic Corp. (usplastic.com)]



Home / Valves / Spigots & Faucets / Water Butt Tap

Water Butt Tap

This water butt tap is durable and smooth, making it ideal for water cisterns, composting, homebrew, and winemaking kits. It is also suitable for many home and garden applications.

- HDPE body & polypropylene spigot
- Gasket provides leak-proof seal (17351 only)
- Designed to fit through 1" hole in pail or drum sidewall
- High flow rate
- Handle turns independently of nozzle
- Smooth turning
- Meets FDA standards

Stock	Description	Catalog Pg.	Price
17351	3/4" Black Long Thread Water Butt Tap with Gasket Save 5% 25+ Save 10% 50+ Save 15% 150+	P-339	$2.27/Each In Stock
	3/4" Black Nut for Water Butt Tap Save 5% 25+ Save 10% 50+ Save 15% 150+	P-339	$0.96/Each In Stock

[Water Butt Tap | U.S. Plastic Corp. (usplastic.com)]

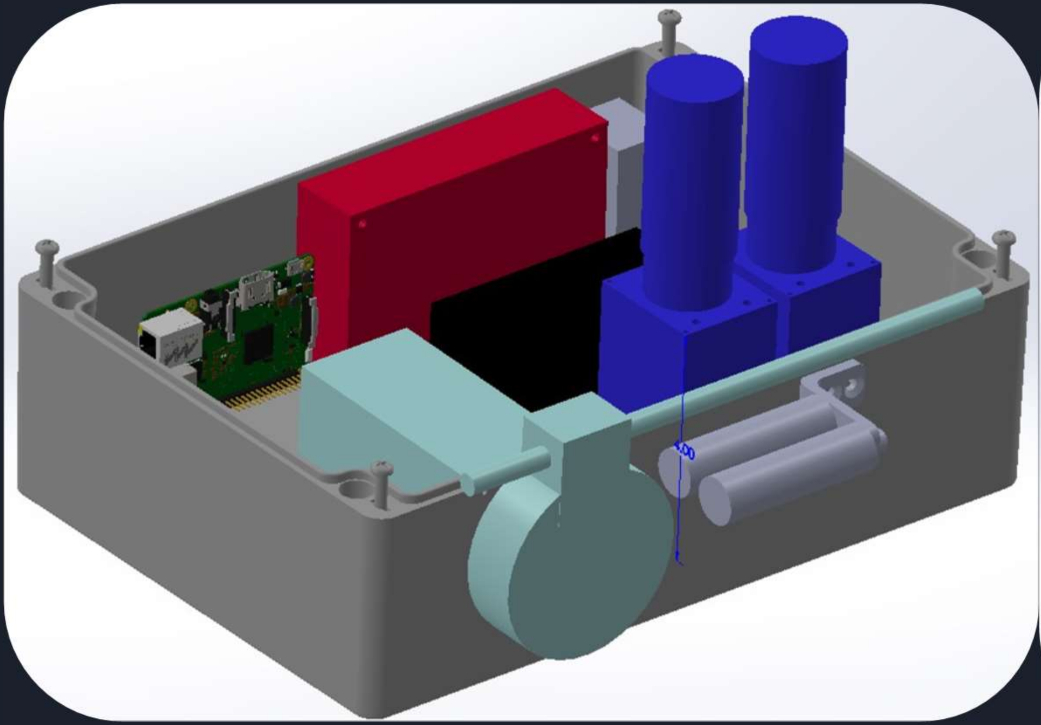
Tracy Hunter

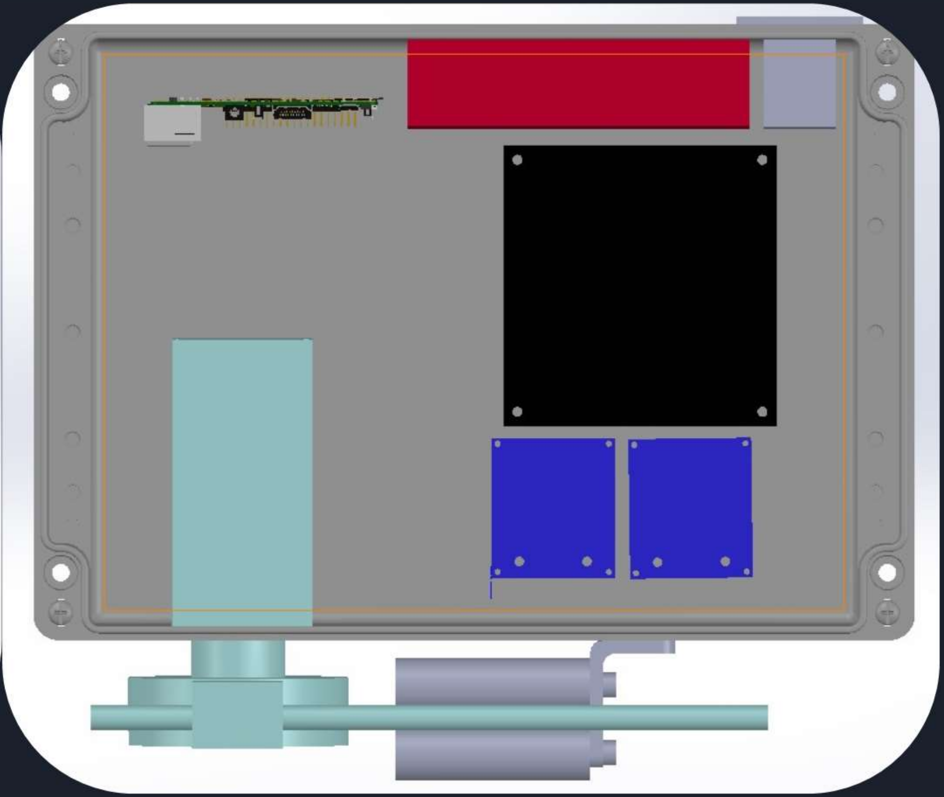
Item	Price
.375 X 48” X 96” HDPE SHEET	344.35
.375 X 54” X 96” Seaboard Marine Grade Sheet	404.32
375 X 48” X 96” ABS Sheet	241.68

Item	Price
20 Gallon Tank	120.67
Lid	33.29
Water Tap	2.67
Nut & Washer	0.97
Total	157.60

Tracy Hunter

Enclosure Design





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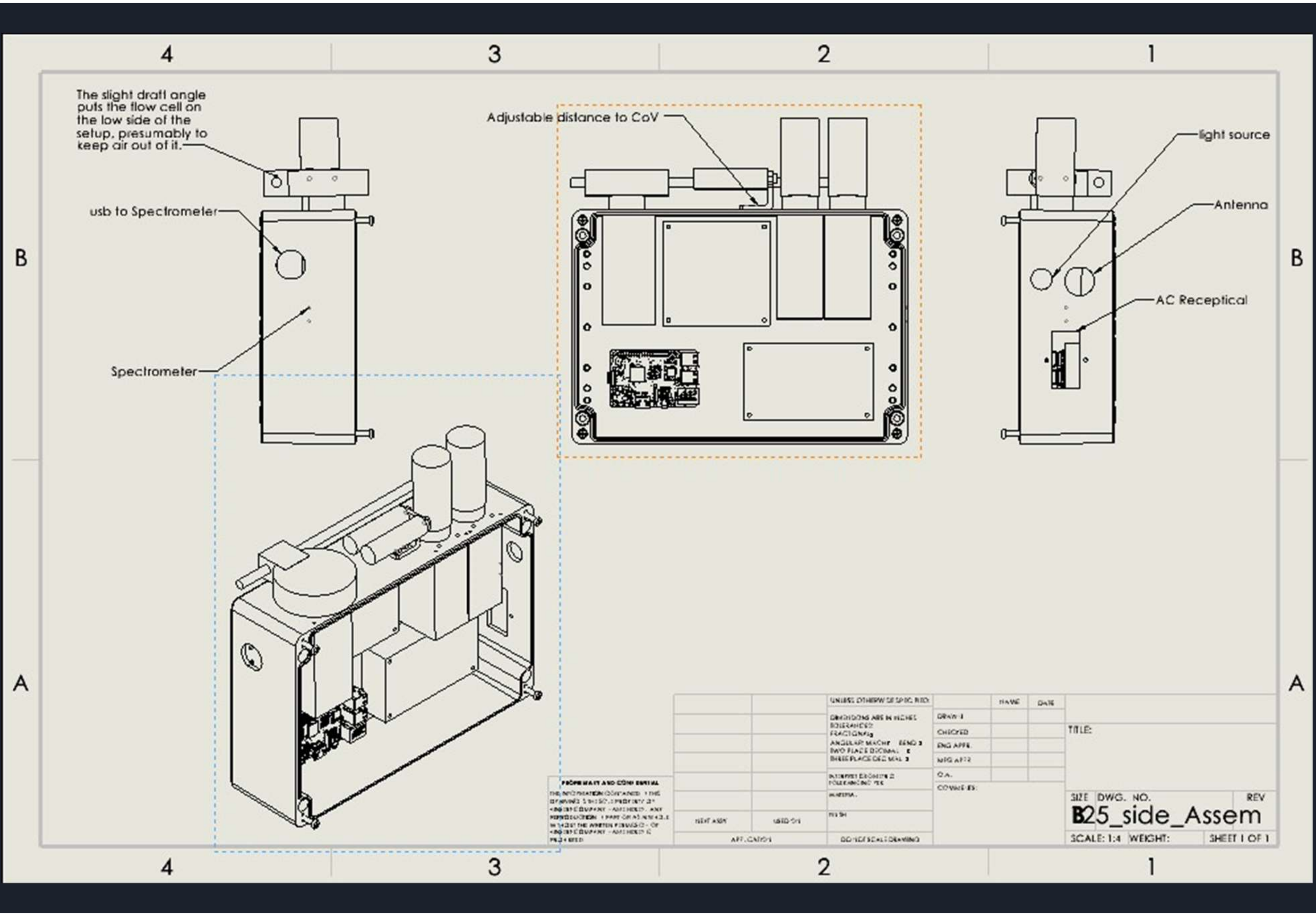
4
3
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B
A
The slight draft angle puts the flow cell on the low side of the setup, presumably to keep air out of it.
usb to Spectrometer
Spectrometer
Adjustable distance to CoV
light source
Antenna
AC Receptical
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL
ANGULAR: MACH BEND
TWO PLACE DECIMAL
THREE PLACE DECIMAL
NAME
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MFG APPR.
Q.A.
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DO NOT SCALE DRAWING
PROPRIETARY AND CONFIDENTIAL
TITLE:
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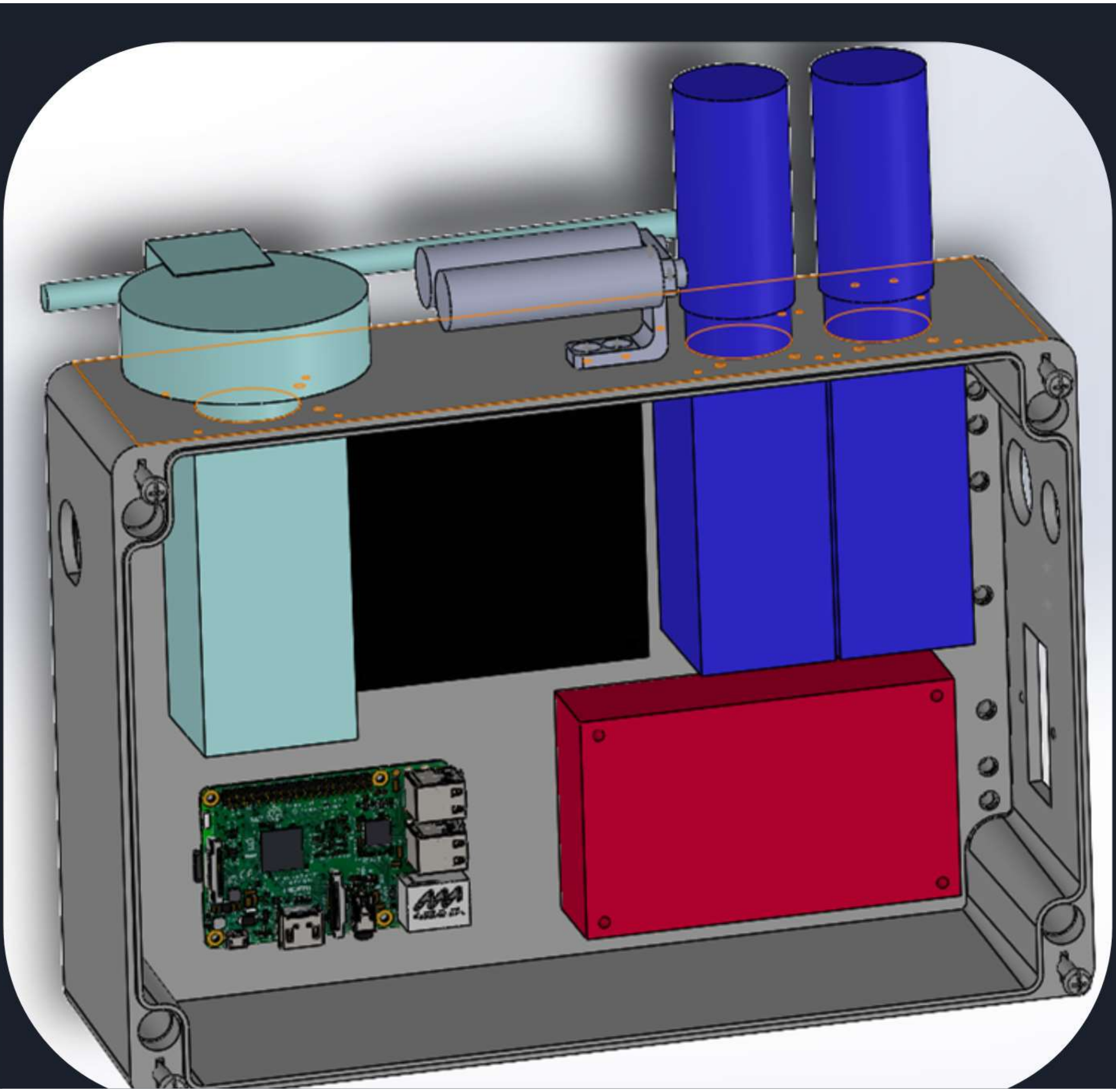
WEIGHT:
SHEET 1 OF 1



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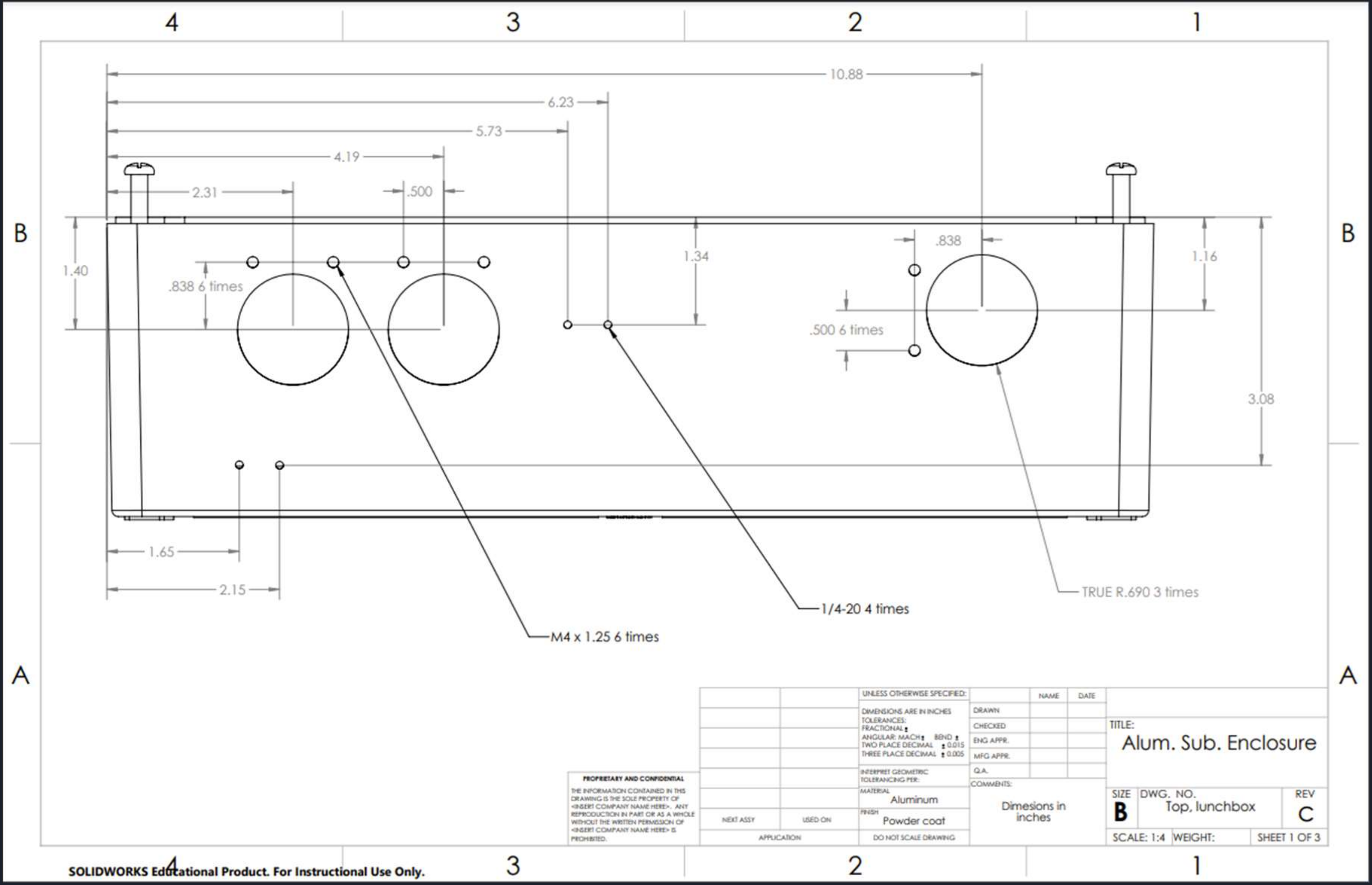

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DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ± 0.015
THREE PLACE DECIMAL ± 0.005

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL Aluminum

FINISH Powder coat

DO NOT SCALE DRAWING

	NAME	DATE
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ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS: Dimesions in inches

TITLE: Alum. Sub. Enclosure

SIZE B | DWG. NO. Top, lunchbox | REV C

SCALE: 1:4 | WEIGHT: | SHEET 1 OF 3

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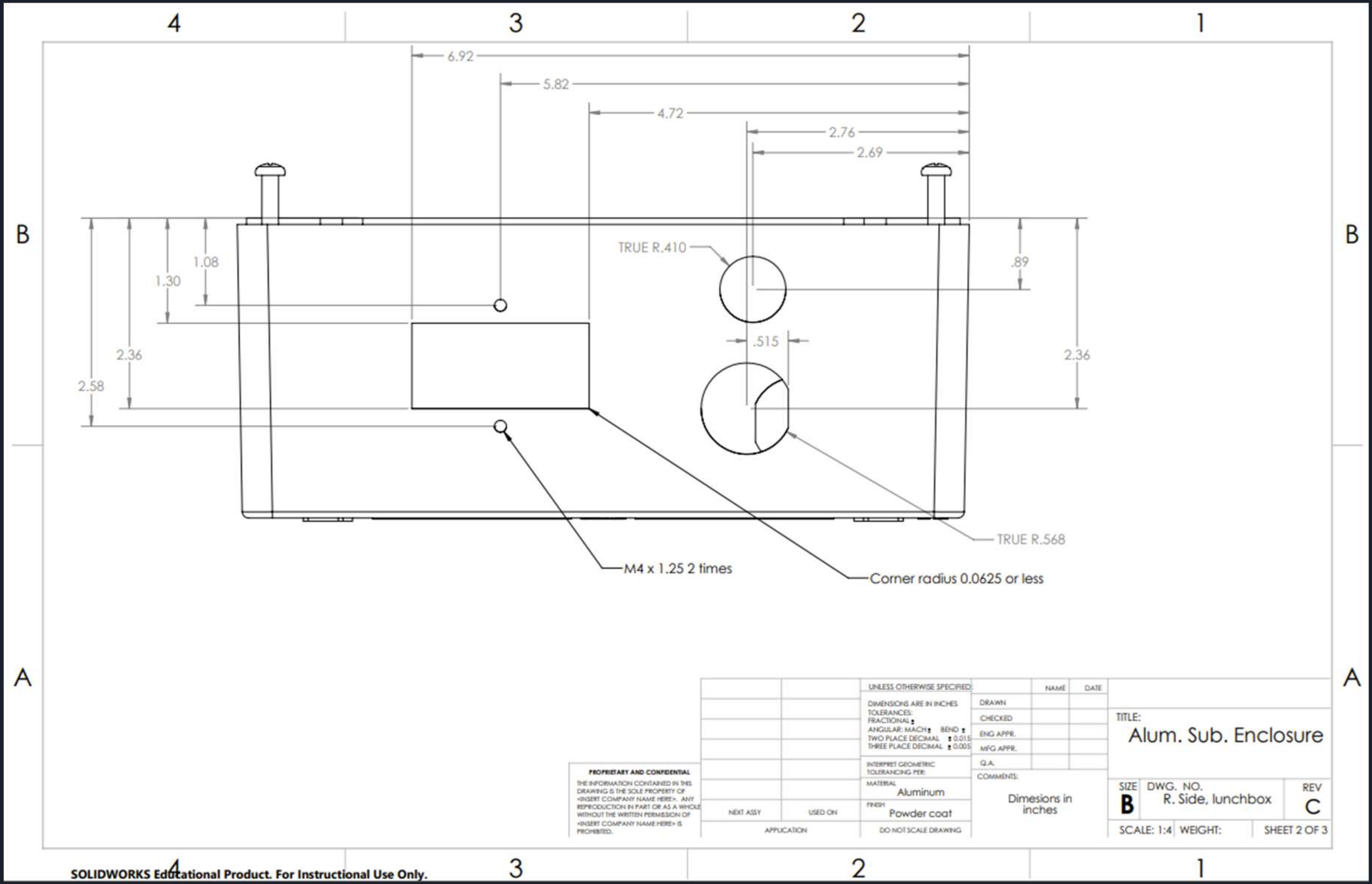

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FINISH
Powder coat

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CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

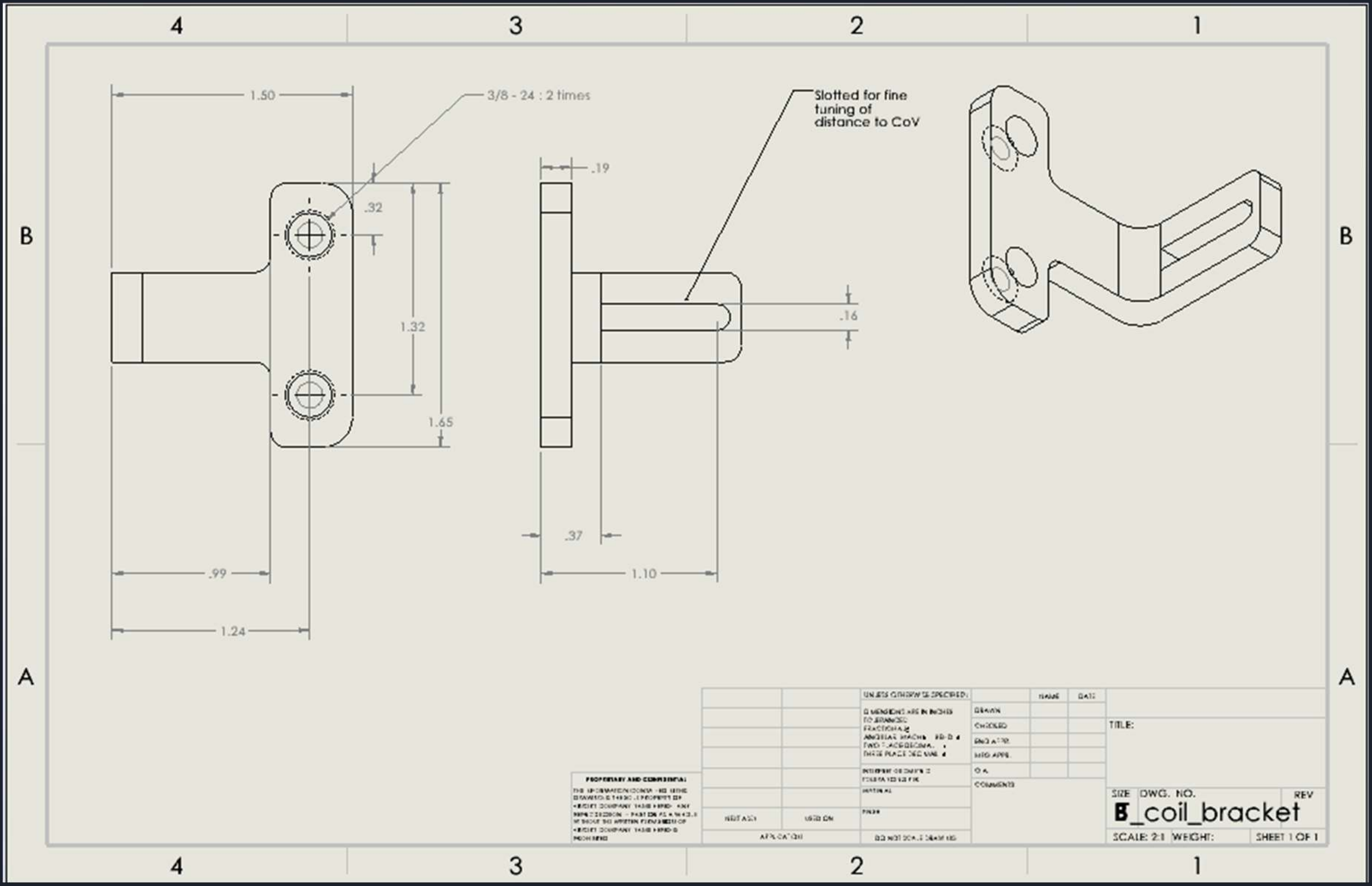
COMMENTS:
Dimesions in inches

TITLE:
Alum. Sub. Enclosure

SIZE B | DWG. NO. R. Side, lunchbox | REV C

SCALE: 1:4 | WEIGHT: | SHEET 2 OF 3

Andrew


4
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3/8 - 24 : 2 times
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1.32
1.65
.99
1.24
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Slotted for fine tuning of distance to CoV
.16
.37
1.10
UNLESS OTHERWISE SPECIFIED:
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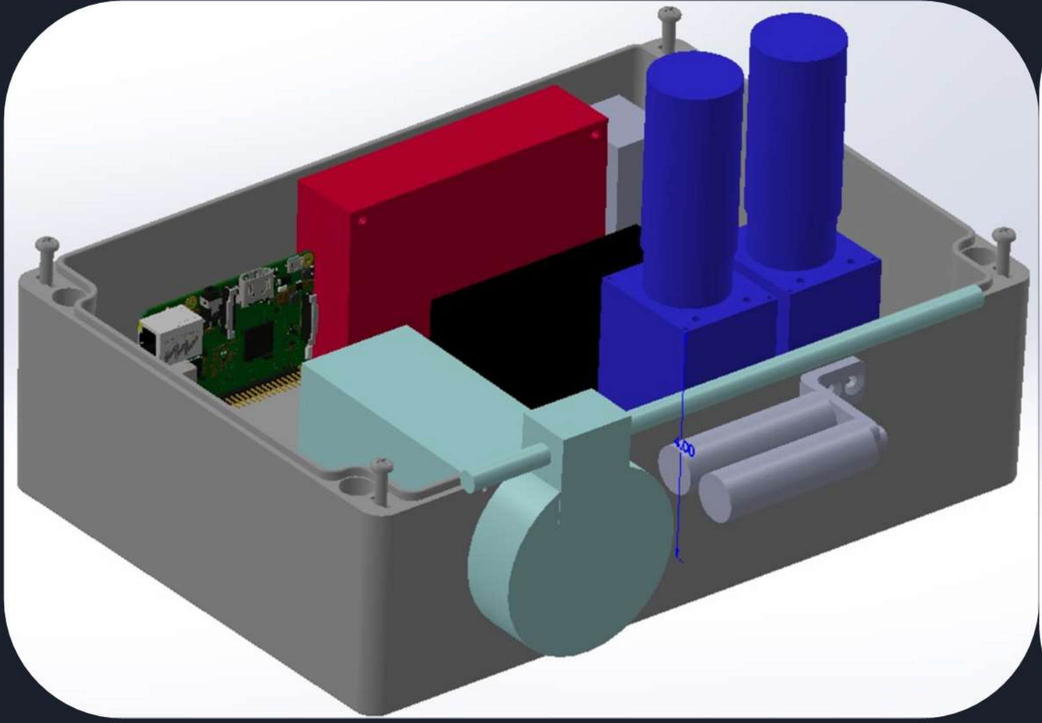
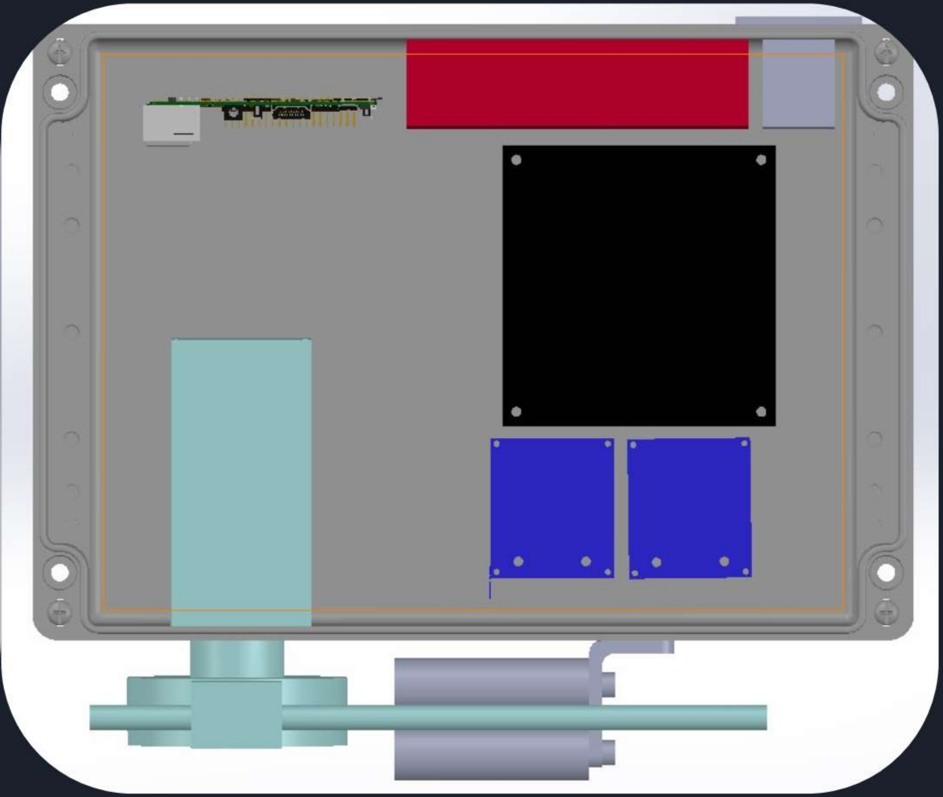
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1

Andrew

Enclosure Design





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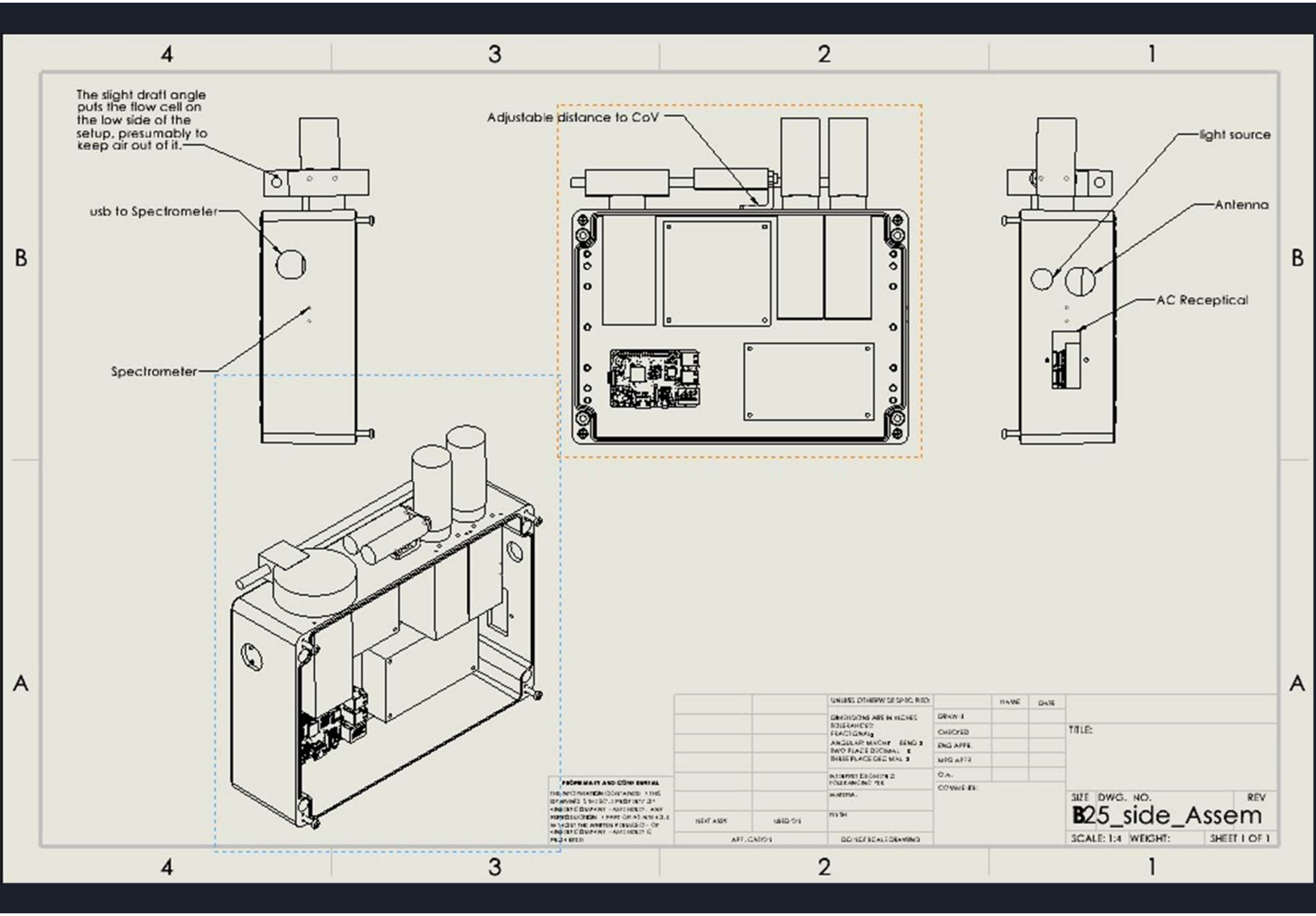
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25_side_Assem
SCALE: 1:4
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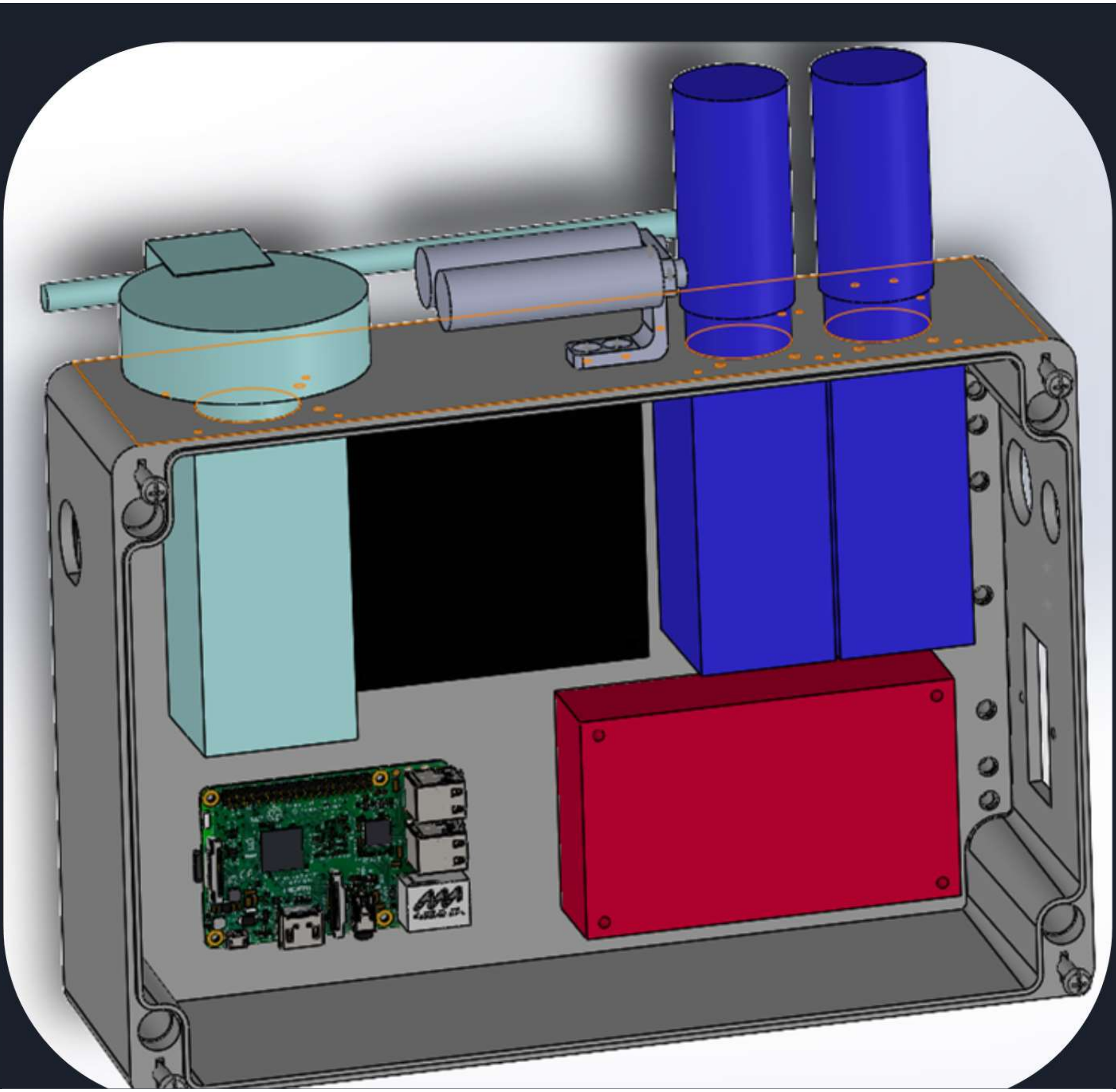
SHEET 1 OF 1



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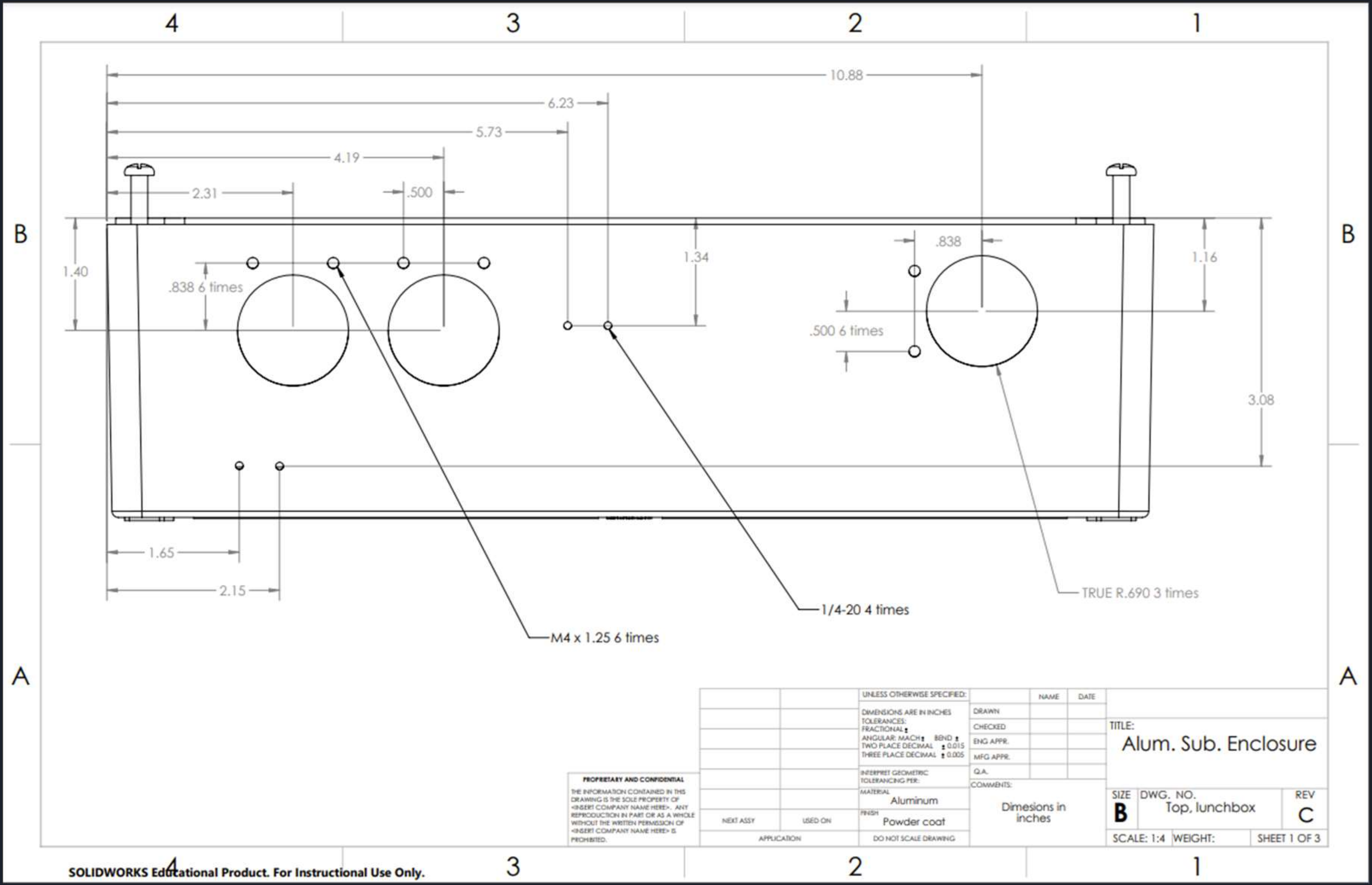

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THREE PLACE DECIMAL ± 0.005

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL Aluminum

FINISH Powder coat

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS: Dimesions in inches

TITLE: Alum. Sub. Enclosure

SIZE B DWG. NO. Top, lunchbox REV C

SCALE: 1:4 WEIGHT: SHEET 1 OF 3

NEXT ASSY USED ON APPLICATION

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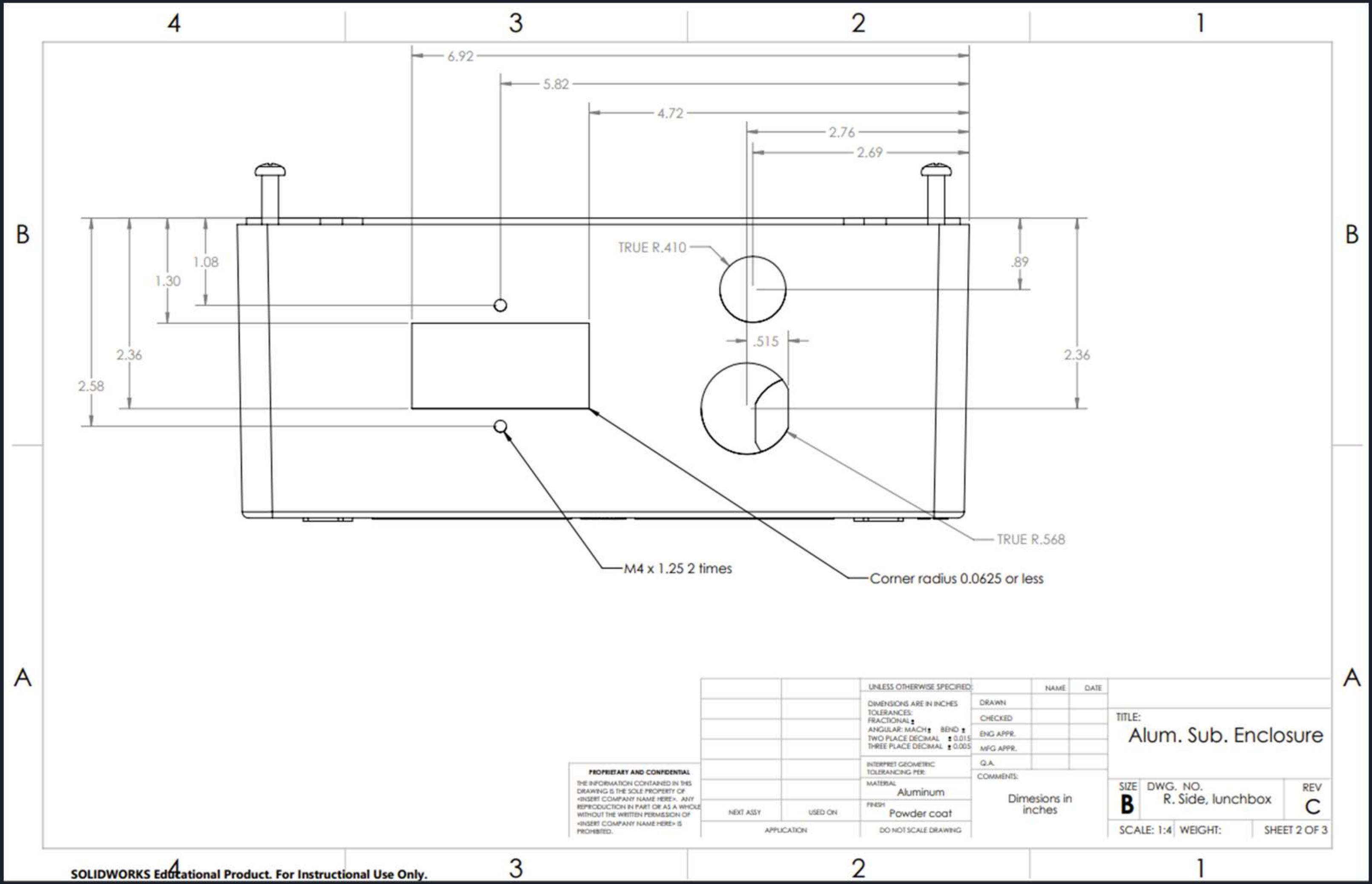

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Q.A.		

COMMENTS:
Dimesions in inches

TITLE:
Alum. Sub. Enclosure

SIZE B

DWG. NO. R. Side, lunchbox

REV C

SCALE: 1:4 WEIGHT: SHEET 2 OF 3

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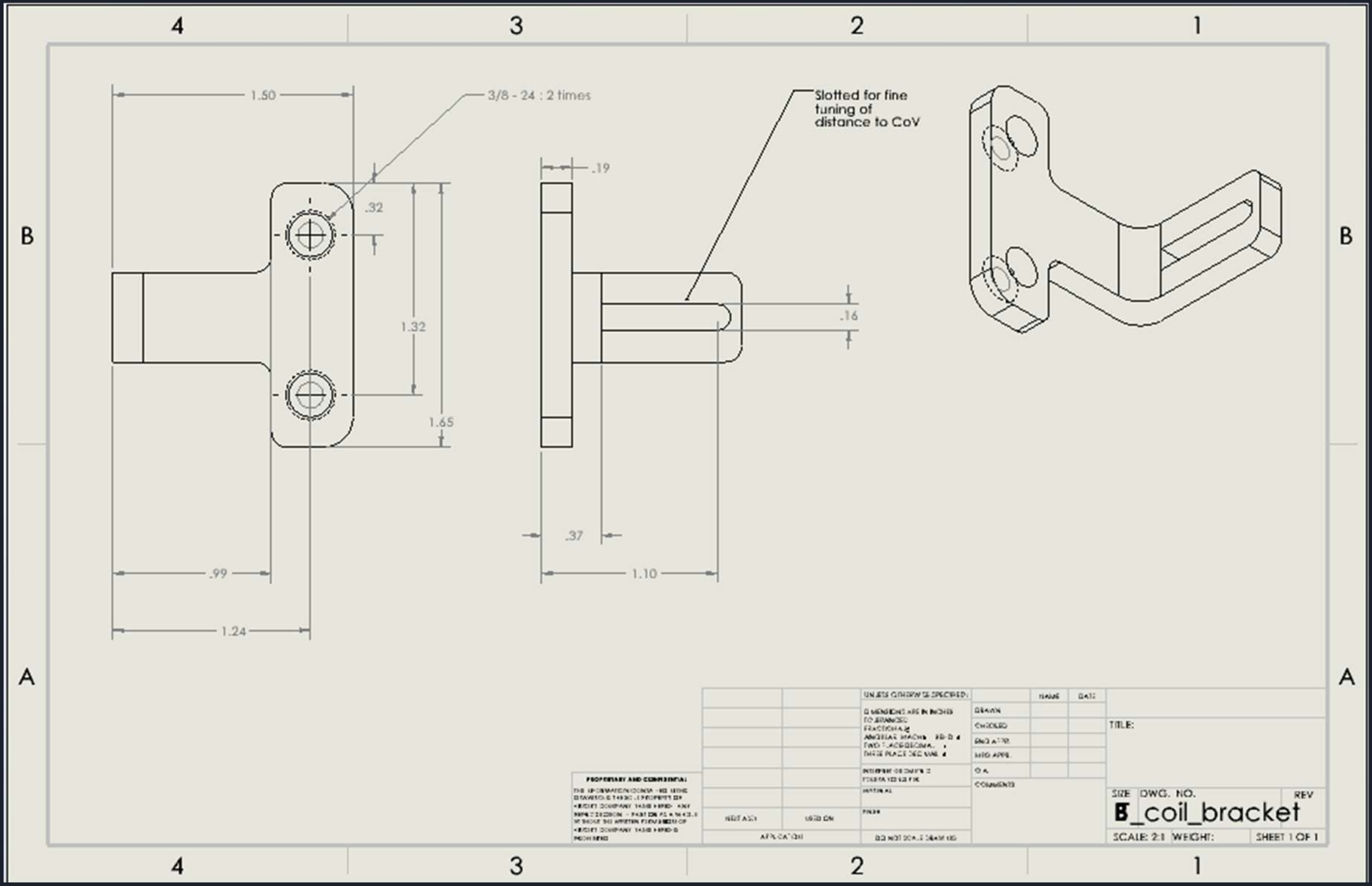
4
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2
1
B
A
1.50
3/8 - 24 : 2 times
.32
1.32
1.65
.99
1.24
.19
Slotted for fine tuning of distance to CoV
.16
.37
1.10
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS
TITLE:
PROPRIETARY AND CONFIDENTIAL
NEXT ASSY
USED ON
APPLICATION
MATERIAL
FINISH
DO NOT SCALE DRAWING
SIZE
DWG. NO.
REV
B_coil_bracket
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1

Andrew

Spectrometer Updates

- Initial issues
  - missing libraries
  - fixing file pathing
  - detecting hardware

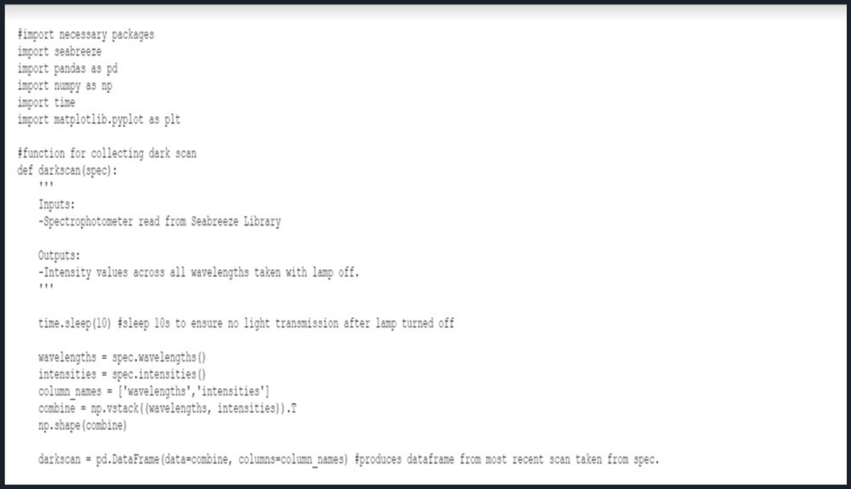
- Software successfully installed and tested

Ocean Optic Flame S

Tim Ly

Spectrometer Code

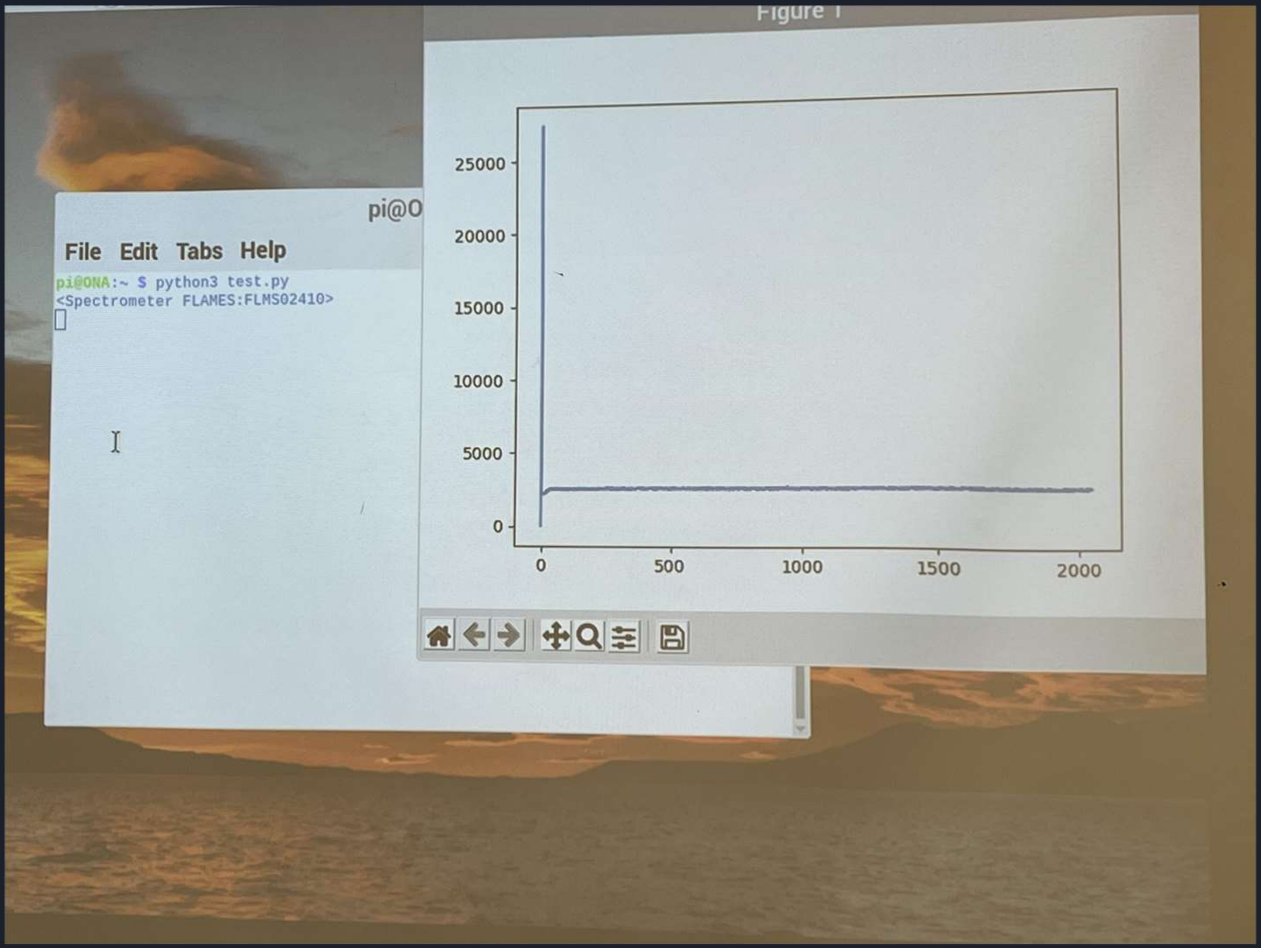
- Main functions Provided by Marine @MLML
- Our job:
    - split
    - integrate
    - test with lab values



```
#import necessary packages
import seabreeze
import pandas as pd
import numpy as np
import time
import matplotlib.pyplot as plt

#function for collecting dark scan
def darkscan(spec):
    '''
    Inputs:
    -Spectrophotometer read from Seabreeze Library

    Outputs:
    -Intensity values across all wavelengths taken with lamp off.
    '''

    time.sleep(10) #sleep 10s to ensure no light transmission after lamp turned off

    wavelengths = spec.wavelengths()
    intensities = spec.intensities()
    column_names = ['wavelengths','intensities']
    combine = np.vstack((wavelengths, intensities)).T
    np.shape(combine)

    darkscan = pd.DataFrame(data=combine, columns=column_names) #produces dataframe from most recent scan taken from spec.
```

Code provided by Marine from MLML

Tim Ly



```
pi@ONA:~ $ python3 test.py
<Spectrometer FLAMES:FLMS02410>
```

Next Steps for data collection

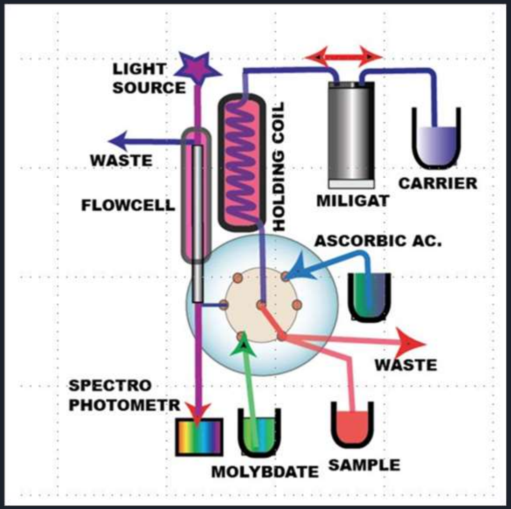
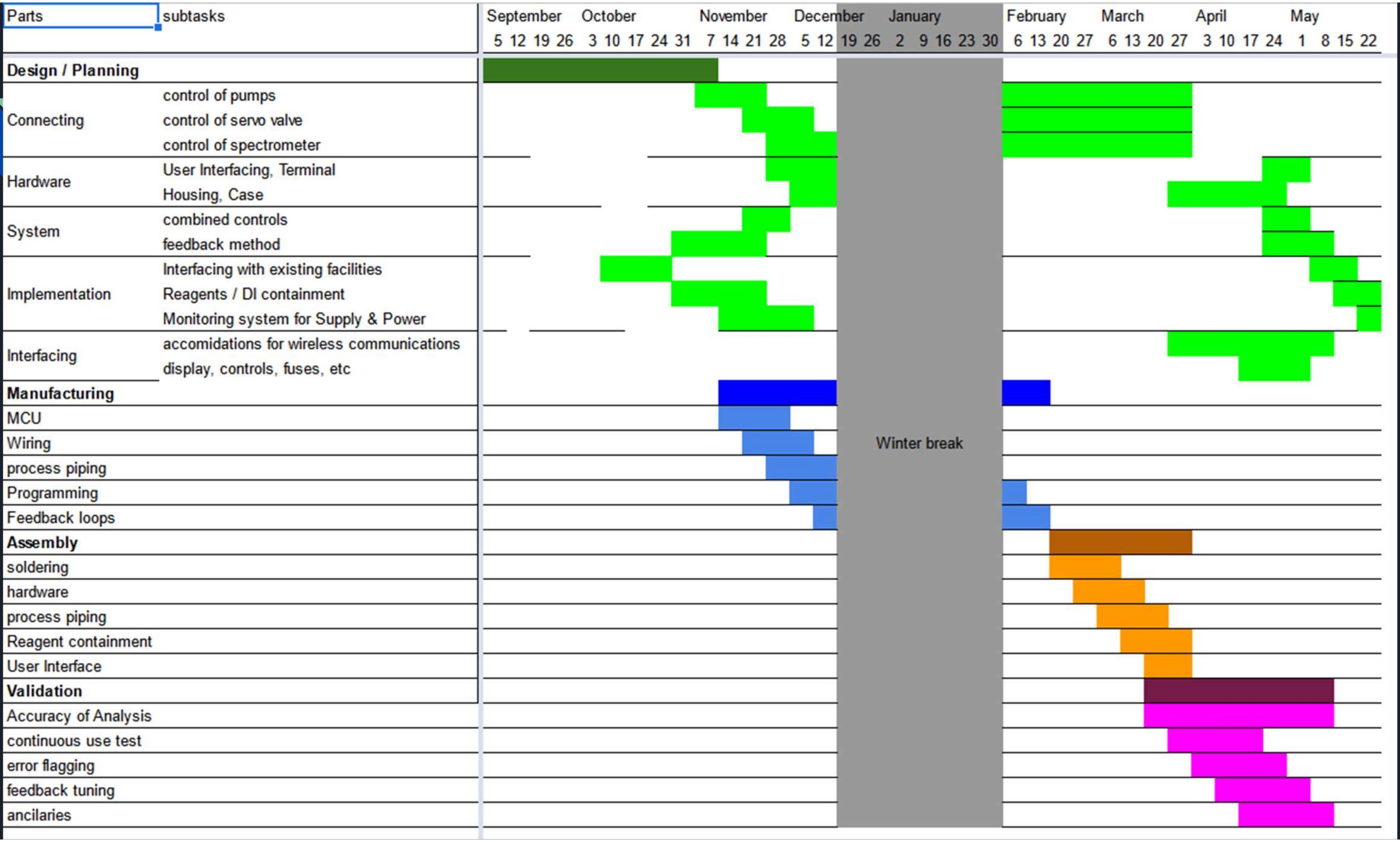


diagram of system flow

- Install the rest of the components
  - light source, flow cell, tubing

- Run tests using deionized water and blue dye
  - Compare numbers with values ran from lab deployed system
  - Adjust our system as needed

Tim Ly



Parts	subtasks
Design / Planning	
Connecting	control of pumps
	control of servo valve
	control of spectrometer
Hardware	User Interfacing, Terminal
	Housing, Case
System	combined controls
	feedback method
Implementation	Interfacing with existing facilities
	Reagents / DI containment
	Monitoring system for Supply & Power
Interfacing	accomidations for wireless communications
	display, controls, fuses, etc
Manufacturing	
MCU	
Wiring	
process piping	
Programming	
Feedback loops	
Assembly	
soldering	
hardware	
process piping	
Reagent containment	
User Interface	
Validation	
Accuracy of Analysis	
continuous use test	
error flagging	
feedback tuning	
ancilaries	

SJSU