Agitation and Temperature Control of Sample Wells in Bio-Layer Interferometry

Members: Heath Muskat (MSE), Kelsey Lawson (MSE), Adriana Mejia (MSE), Inkiad Ahmed (MSE), Sherwin Eftekharian (BME)

Engineering Mentor: Michael Dubrovsky, Co-Founder and CCO, SiPhox Inc.

SiPhox COVID-19 Device

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SiPhox is developing a highly scalable COVID-19 test

A single CMOS chip factory can produce enough chips to test all 7.8 Billion people monthly.

[1]

Member Responsibilities

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Heath Muskat
Team Leader

Responsibilities:
Programming and Electronics

Adriana Mejia

Responsibilities:
Research

Kelsey Lawson

Responsibilities:
3D Modeling

Inkiad Ahmed

Responsibilities:
Prototyping

Sherwin Eftekharian

Responsibilities:
Testing

Introduction & Motivation

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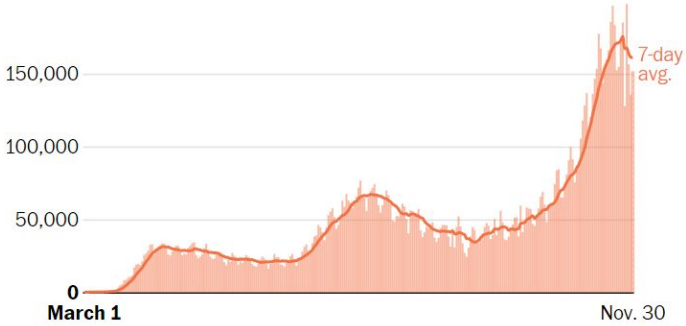
- Over 13M COVID-19 cases and 265K deaths in U.S.[3]
- Current Diagnostic Test Methods[4]
  - Polymerase Chain Reaction (PCR) Test : detects genetic material of the virus, RNA
    - Sensitive and accurate
    - Usually not usable at point-of-care (POC)
    - Can take a few hours to a few days to return results
  - Antigen Test: detects specific proteins
    - Inexpensive, POC, fast turnaround time (15-60 min)
    - Less sensitive and accurate
- Testing prevents spread of infection and helps with treatment[5]



Daily Trends in Number of COVID-19 Cases in the United States [2]

Approach

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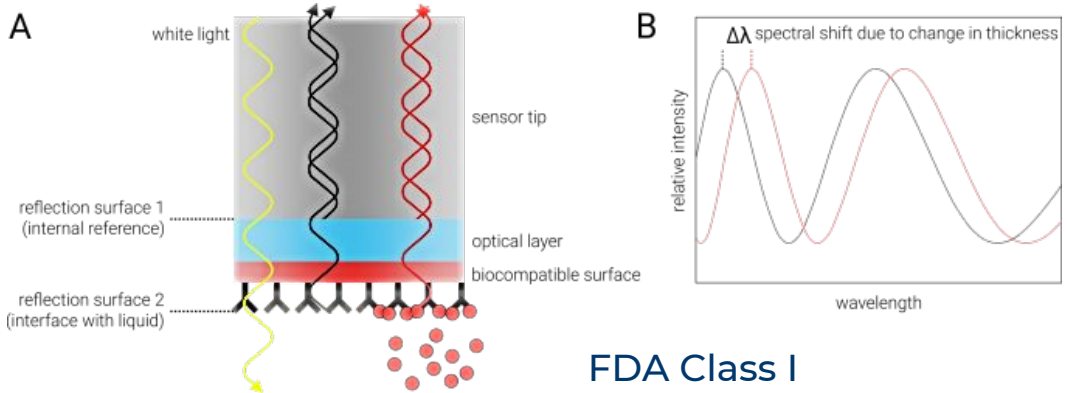
Solution: Bio-Layer Interferometry (BLI)

- Shift in interference pattern of white light measures thickness of biological layer on biosensor tip
- Advantages[3]
  - High throughput
  - Accurate and highly sensitive
  - Fully automated
  - Excellent candidate for POC testing



FDA Class I

Approach

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Our Focus: Agitation and Temperature Control Components

Our team will:

- Design a prototype that is easily alterable to test various parameters including thermal conduction, fluid agitation, and temperature accuracy.
- Use multiple thermocouples to measure the temperature at various points on the block - determine sufficient time for liquid in vials to reach optimum temperature - use a feedback loop to control the heating elements output
- Analyze the time it takes for dye to sufficiently mix in the vials for agitation parameter
- Determine how accurately we can measure and maintain the temperature.

Design

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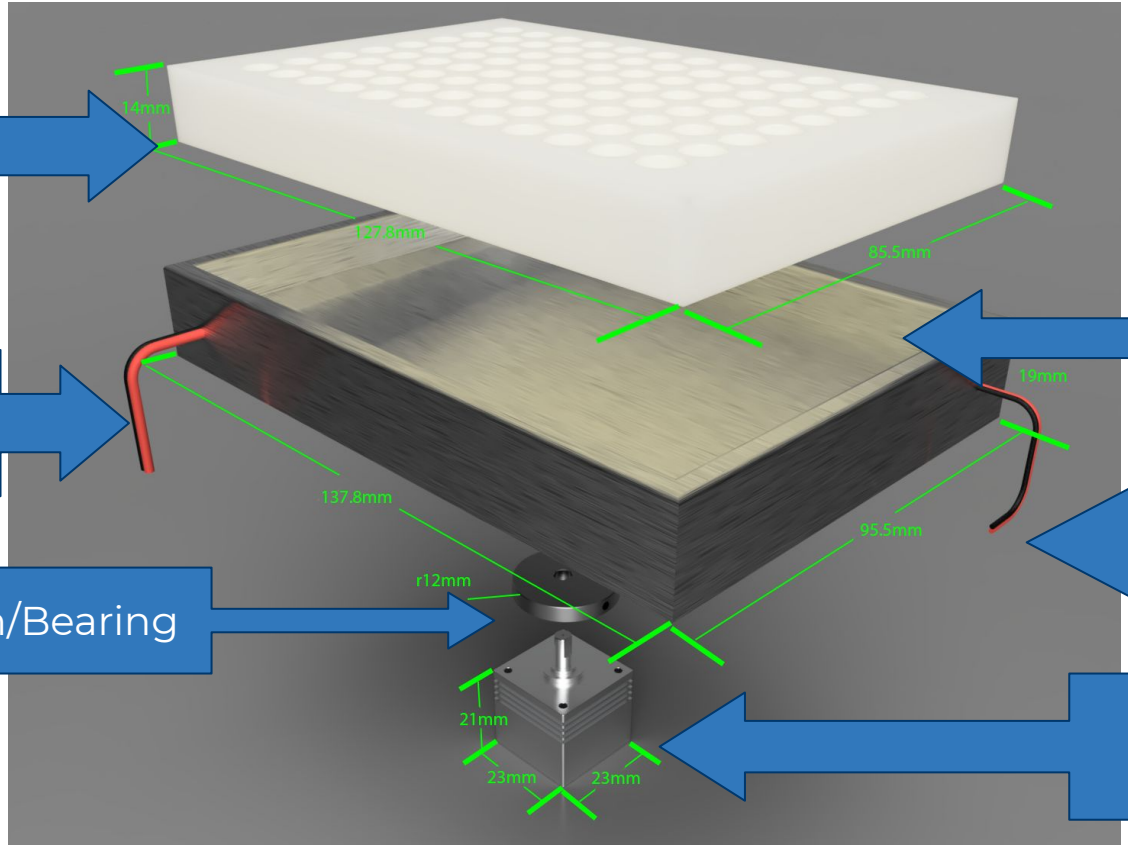
Aluminum 96-well cartridge

Electrical Heating Element

Eccentric cam/Bearing



Aluminum Base

Multiple thermocouples to monitor temperature

Stepper motor

Design

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		Name	Quantity	Price Per Unit	Total Price Per Total Units
		Total:			$1,407.88
CNC	to drive plate up and down	z axis stepper (d2)	1	$40.00	$40.00
	to mate with pulley from shaft	z stepper pulley (d2)	1	$5.00	$5.00
	to drive plate back and forth	y-axis stepper	1	$23.99	$23.99
	to drive plate left and right	x-axis stepper	1	$23.99	$23.99
	to operate the stepper motors	stepper controller	4	$10.00	$40.00
	to make structural facing/ input support	2x24x1/8" al	4	$21.08	$84.32
	to make structural framing	1x1x48x1/8" angle al	1	$35.69	$35.69
	to support the pulleys to drive axis movem	rod (d1)	4	$15.00	$60.00
		acme threaded rods	4	$27.00	$108.00
		acme nuts	4	$10.00	$40.00
	to support the rods	bearing (d1)	12	$10.00	$120.00
		x/y stepper pulleys (d1)	12	$5.00	$60.00
	keeping gears in sync	belts	6	$10.00	$60.00
	cnc controll and calculations	Computer	2	$60.00	$120.00
	touch screen for user input	Interface	2	$99.99	$199.98
	creating flow across the sensors	agitation motors	4	$10.00	$40.00
	for homing the head	switches/sensors	3	$5.00	$15.00
	conducting the light	optical fiber	1	$10.00	$10.00
	measuring plate temperature	thermocouples	4	$10.00	9.99
		fuse	1	$5.99	$5.99
		fuse holder	1	$6.99	$6.99
		heated bed	1	$39.99	$39.99
		heated bed controller	1	$15.99	$15.99
		hinge			
		handle			$0.00
3D Printing		filament	4	$22.99	$91.96
	bearing adaptors, tubs supports,	Operation /hour	80	$1.00	$80.00
MISC	grease/lubricants	light oil	2	$10.00	$20.00

Design Criteria

- Allowable temperature fluctuations
- Agitation motion to be no more than the difference of the ID of a vial and the diameter of the measuring probe
- Computer to allow for single interface to operate all parameters

Acceptance Criteria

- Our group can successfully analyze the time it takes for dye to sufficiently mix in the vials for agitation parameter
- The plate can accurately measure and maintain the optimum temperature.

Future Goals

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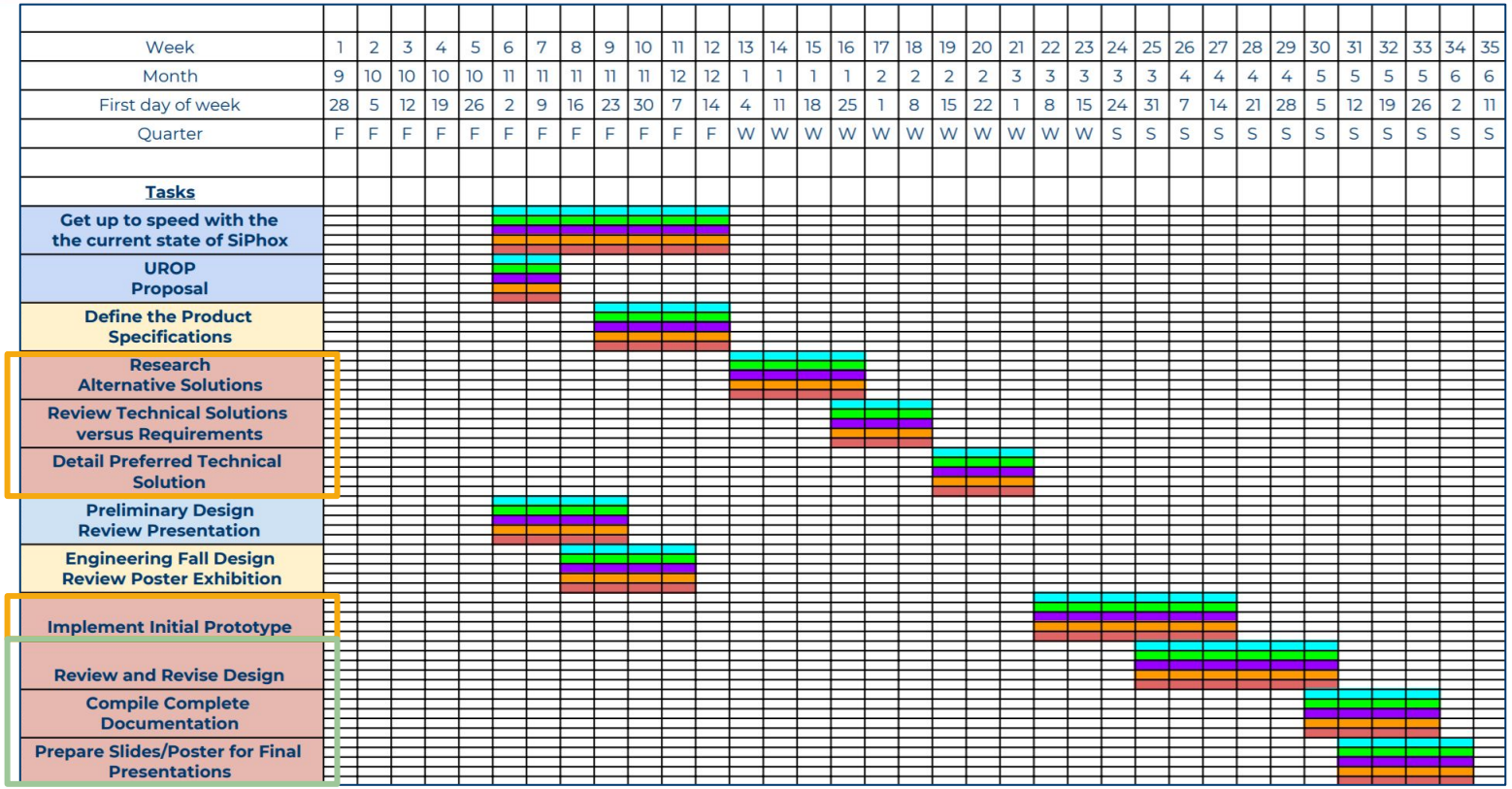

Tasks Key
Not Started
In Progress
Completed

Responsibilities Key:
Heath Muskat
Kelsey Lawson
Adriana Mejia
Inkiad Ahmed
Sherwin Pasha Eftekharian

References

[1] “OneLab,” *SiPhox*. https://siphox.com/onelab (accessed Dec. 01, 2020).

[2] “U.S. coronavirus cases: Tracking deaths, confirmed cases by state,” *Washington Post*. https://www.washingtonpost.com/graphics/2020/national/coronavirus-us-cases-deaths/ (accessed Nov. 30, 2020).

[2] CDC, “COVID-19 Cases, Deaths, and Trends in the US | CDC COVID Data Tracker,” *Centers for Disease Control and Prevention*, Mar. 28, 2020. https://covid.cdc.gov/covid-data-tracker (accessed Nov. 29, 2020).

[4] “How Nanophotonic Label-Free Biosensors Can Contribute to Rapid and Massive Diagnostics of Respiratory Virus Infections: COVID-19 Case | ACS Sensors.” https://pubs.acs.org/doi/full/10.1021/acssensors.0c01180 (accessed Nov. 29, 2020).

[5] “Why COVID-19 testing is the key to getting back to normal,” *National Institute on Aging*. http://www.nia.nih.gov/news/why-covid-19-testing-key-getting-back-normal (accessed Nov. 30, 2020).