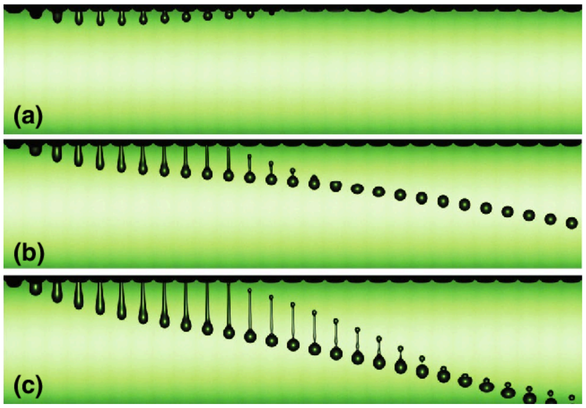
Procedure

In order to test the size of nozzle needed to create drops with a .7-.8mm diameter (for them to work well as walking droplets), many factors needed to be controlled. This proved to be a challenge as the delta h was not something that could be easily measured, so it was not kept consistent when changing the nozzles. When switching the nozzles, the old nozzle had to be removed, the new nozzle attached, and a test to ensure that it didn't leak before drop diameter could be tested. This is so that the pressure inside the fluid chamber is stable and we don't create air inside the fluid chamber that then would get compressed by the piezoelectric buzzer instead of pushing the oil out drop by drop.

First tests (0.6mm nozzle)

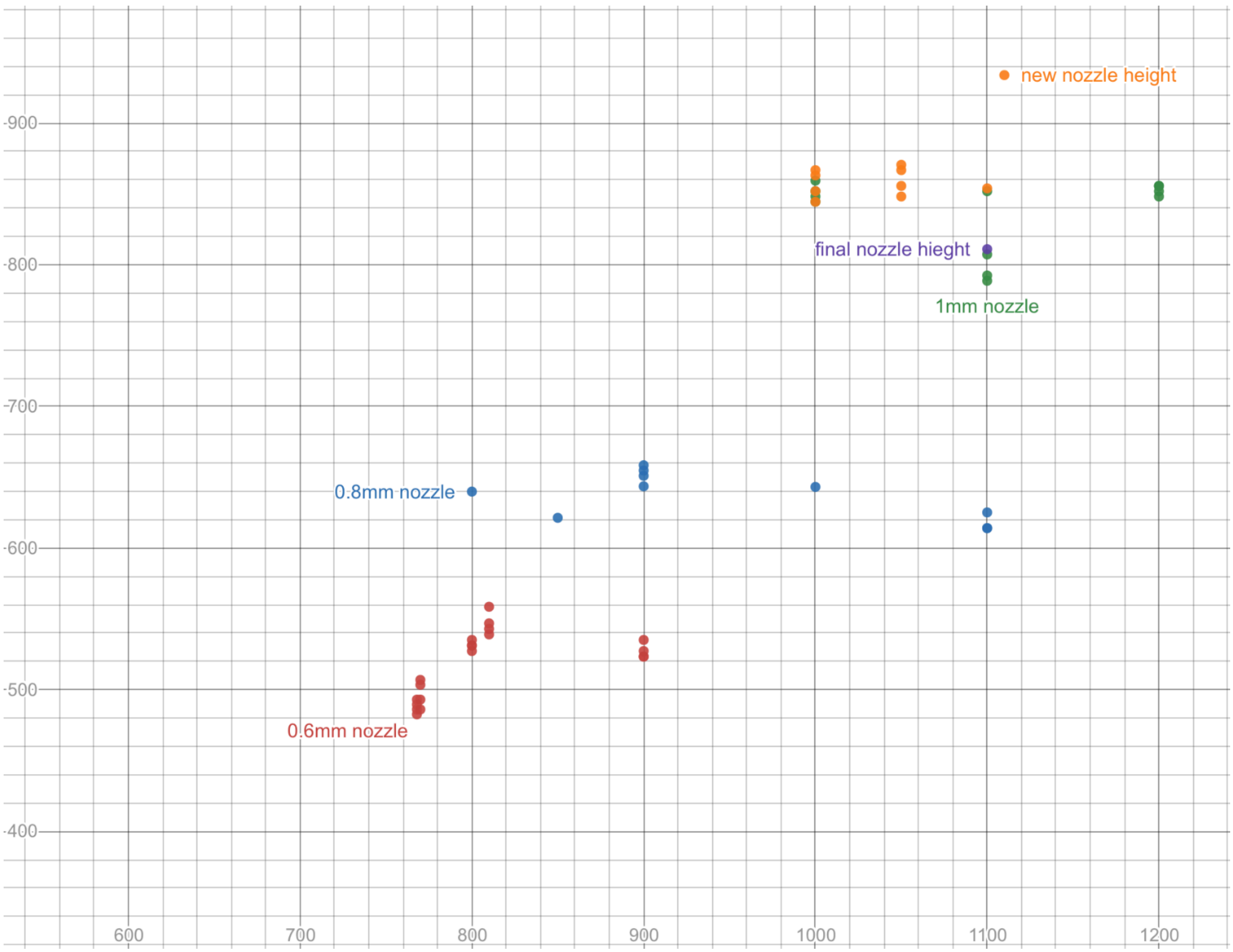
First, a 0.6mm 3d printer nozzle was tested, resulting in drops that were much lower than the desired diameter (0.48-0.559). In order to ensure the nozzle only released one drop (sometimes it would spit out a second tiny drop) (C) and make sure it is releasing the drop completely as opposed to releasing the drop only to have the drop get re-sucked back into the nozzle (A), different time intervals for the piezoelectric buzzer were used in addition to different velocities. As seen in the figure that was created at MIT.



More tests (1mm and 0.8mm nozzles)

After finding new nozzles, the new tests began. First, the 1mm nozzle where it was quickly discovered that the drops were larger than the goal (0.788-0.856). Next was the 0.8mm nozzles, but these drops proved to be too small. Then, going back to the 1mm nozzle, more tests were administered in order to see how small the droplets could be. The problem with the inability to measure the delta h proved problematic in the beginning as it was much larger than expected and had to be adjusted.

I have included a graph with most of the data I collected. This shows the difference between the different nozzles, and a few with the different delta h.



In conclusion, the 1mm nozzle should be close enough to the target droplet diameter as the range should allow the .8mm to work just as well. Although making a .9mm nozzle would give us that range we are looking for, we shouldn't need to even though there is no overlap and it has been difficult to make any drops with the .7-.8 size. Oddly enough, I seemed to get very different results in terms of the sized droplets I was able to get in addition to the pulse width necessary to create only a single droplet.

Additionally, this data should allow droplets with a certain diameter to be created more easily, although the delta h might need to be adjusted.

Ramp

Unfortunately, the ramp was unsuccessful in the beginning due to the layered surface from the 3d printer and the length of the ramp. This resulted in the drops not being able to be dropped far enough from the support that the droplet generator is on. When a clear piece of plastic was added, resulting in a bigger and non textured surface, the drops were able to go much further, but problems with the circuits and arduino put a pause on any tests to find the maximum distance the drops could travel.

Unfortunately a piece of the circuit broke and we had to order a new part.

Additionally there were more delays as it proved challenging to print a 3d printed box that was the right size and the 3d printer broke in the process. This required another part to be ordered.

Fluid dynamics

- Rebuilding droplet generator so it doesn't leak:
    - 3d printing lid for reservoir
    - Using carbide cutter to make generator out of solid plastic
    - Use a cutter in the shed for the holes (tap, etc.)
    - Make circuits more permanent on a circuit board
    - Create 3d printed box for circuits and button
    - Create arduino code in order to release only one drop
        - Figure out the circuits necessary
        - Start with leds and learning how to use the program
- Testing different nozzles for desired droplet diameter
- Worked on accelerometer
    - Created arduino code to find sine wave and display on LCD
        - Included circuits until LCD shield was used instead
    - Create box
    - Soldier circuits
- Helped create new leveling system for bath
    - Helped with assembly and disassembly of whole system
- Tested ramp
    - Machined bath in order for ramp to be more similar to MIT's ramp
- Tried briefly to form crystals w/ bouncy drops
    - Maden triangle, square, hexagon

1 Title

2 Project overview

- When silicone oil is vibrated at the right amplitude and frequency, a drop of that same oil will bounce endlessly on the surface of the oil forever. This is a bouncy droplet
- If the droplet is acted on by other sources, it could move around on the surface of the oil, creating a walking droplet
-
    - Pictures of other droplet generator
    - Other droplets, etc

3 Project overview

- People interested in self-organizing systems (crystals) for manufacturing maybe
    - Maybe show real world example (embryo)

- Droplet entry research on its own
- Don't know much about splashing phenomenon and what happens
    - Ocean oil spill how would splashing effect
    - Size distribution
    - (droplet generator)

4 Project 1 droplet generator

- Previously, the droplet generator had been 3d printed which resulted in many issues as the material was not airtight and would often leak.
- My first task was to remake the generator using a solid piece of plastic so that it wouldn't leak
- Also needed to test a few things which I will talk about later
    - Pictures:
        - Droplet generator
        - Maybe on shape logo and picture of carbide cutter

5 Project 2 accelerometer

- Accelerometer used to measure the amplitude of the bath
    - Picture of the box with LCD and stuff
    -

6 project 3 various tests Things I did

- I needed to test the nozzle size on the droplet generator so that we could get drops with a similar diameter to other researchers
    - For comparisons

- The ramp also needed to be tested so that bouncy drops were actually formed instead of falling at a velocity such that they would instantly combine with the rest of the oil
    - Pictures:
        - Results
        - Screenshot of cine

7 project 4 create liquid crystals
- There were many attempts to create liquid crystals, but then the summer came to an end and we were unable to create large crystals
- We were able to successfully create triangles, squares, and a hexagon
    - Pictures:
        - Bouncy droplets
        - Screenshot of cine for ramp demo

8 Future
- If this project would have continued, I would have done more work trying to create crystals with the bouncy drops
- (more testing with the ramp to see if they lose or gain oil) (Fix problem with generator creating two drops-why)
- Why not creating crystals
-
-

SKILLS:

(mini) projects:

- Ways drop interact- via wave interactions-different than billiard balls, not continuously (quantum mechanics) - positions described by wave functions - this provides analog that’s microscopic (allows to figure out how to come up with mathematical stuff)
-
- Figure out if the vibration is sinusoidal