Automation of a Solid State Cloud Chamber

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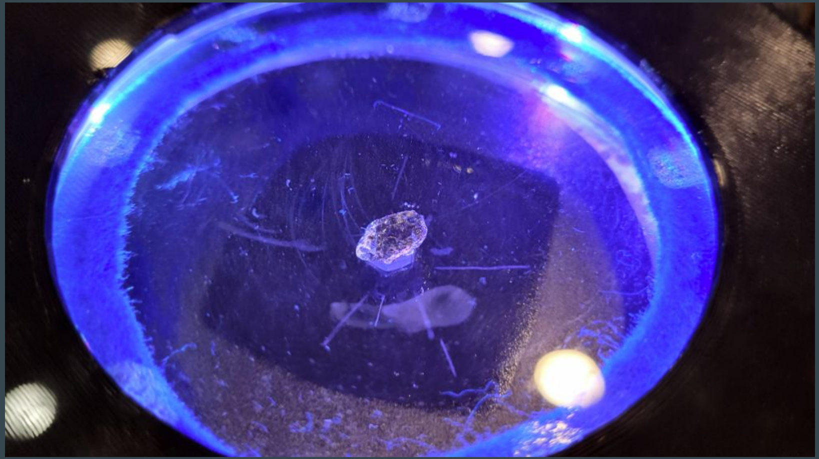
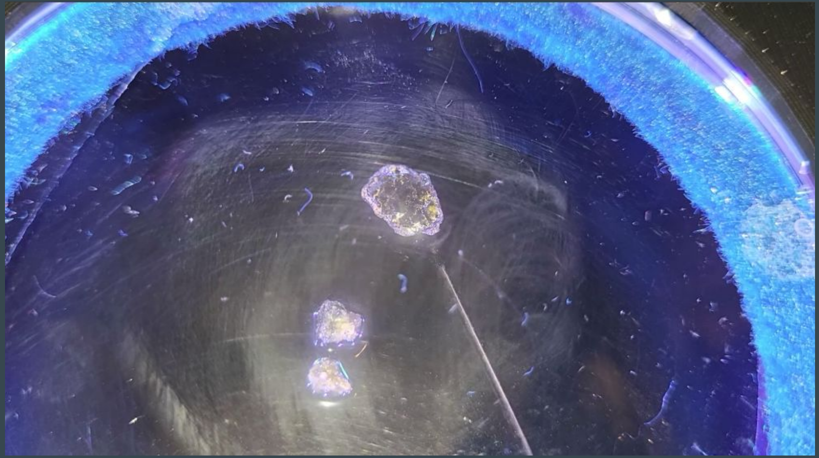
Overview

- Brief explanation of the design
- How it works
- Automation checklist (Thought process)
- Overview of the design of the code
- Demonstration
- Results





What is a Solid State Cloud Chamber?

Purpose - To visualize paths of ionizing radiation

"Solid State" - Utilizes solid state cooling strategies

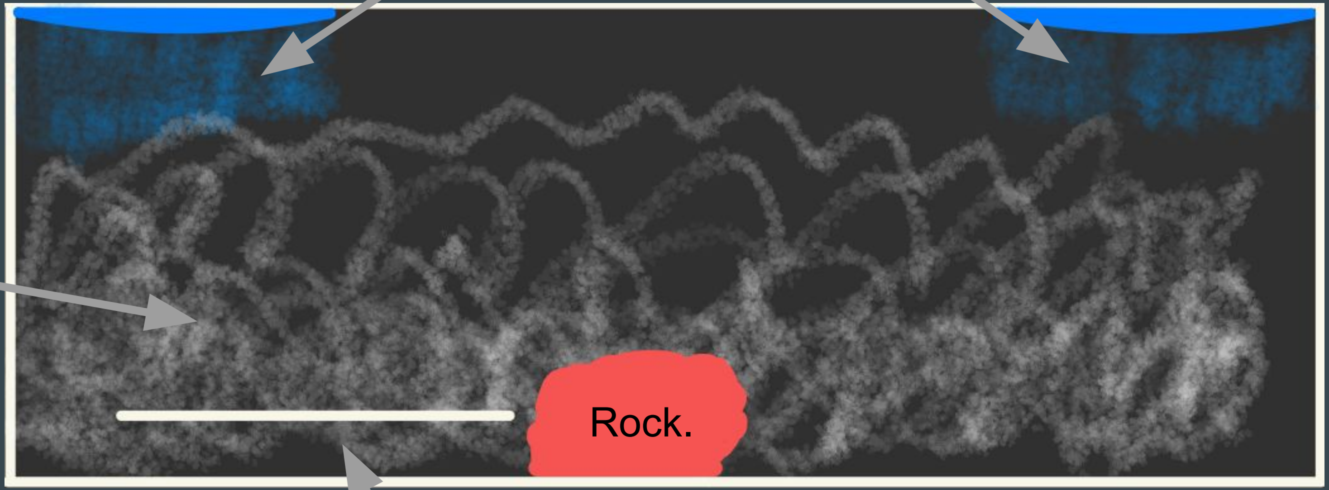
How? - Following the design from the physics students at Siena College, which was recreated here last year, our design utilises Peltier coolers.

Our Cloud Chamber:

How It Works

Alcohol evaporates at room temperature close to the top

Cools and falls to the bottom forming a supersaturated gas at the bottom of the chamber



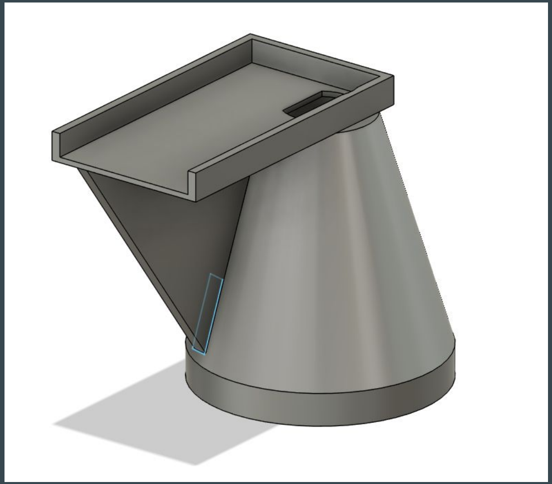
The subatomic particle ionizes some of these alcohol atoms, leaving an electric field, attracting more dipoles and creating a visible contrail

Design

500 W Power Supply

Phone Camera Mount

Fan



Design

Petri dish chamber

Felt for alcohol

Lights to view alcohol tracks

Washer and thermal paste for heat transfer

How to Automate:

White

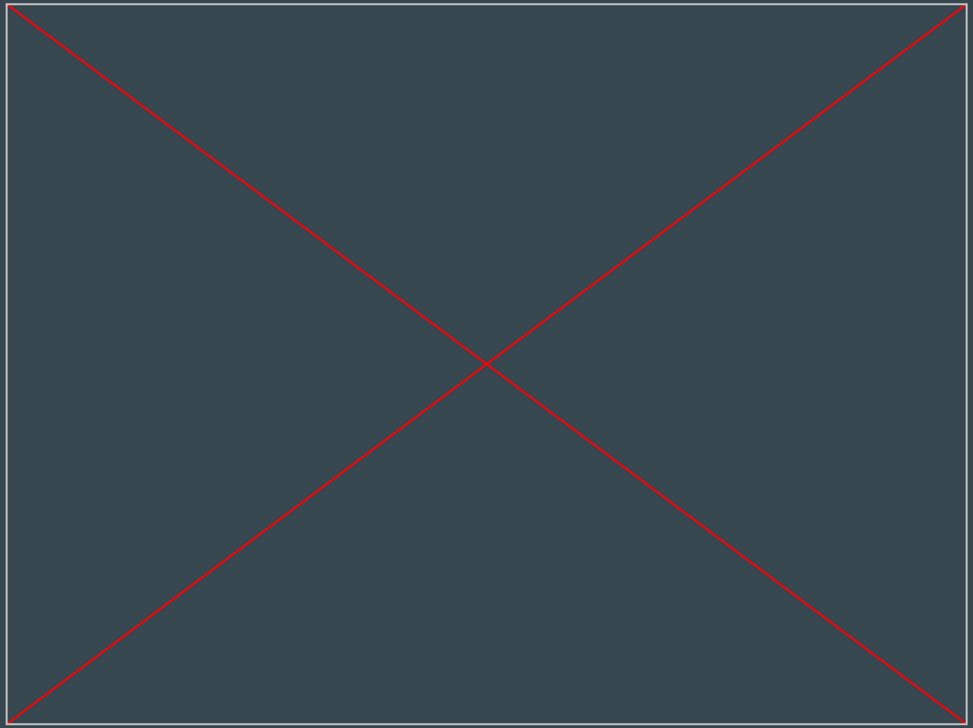
Low aspect ratio

They leave the screen after a couple frames

They shoot outwards from the rock

Alphas are short and wider

Betas are long and thinner



How do we get there?

Hunting and gathering

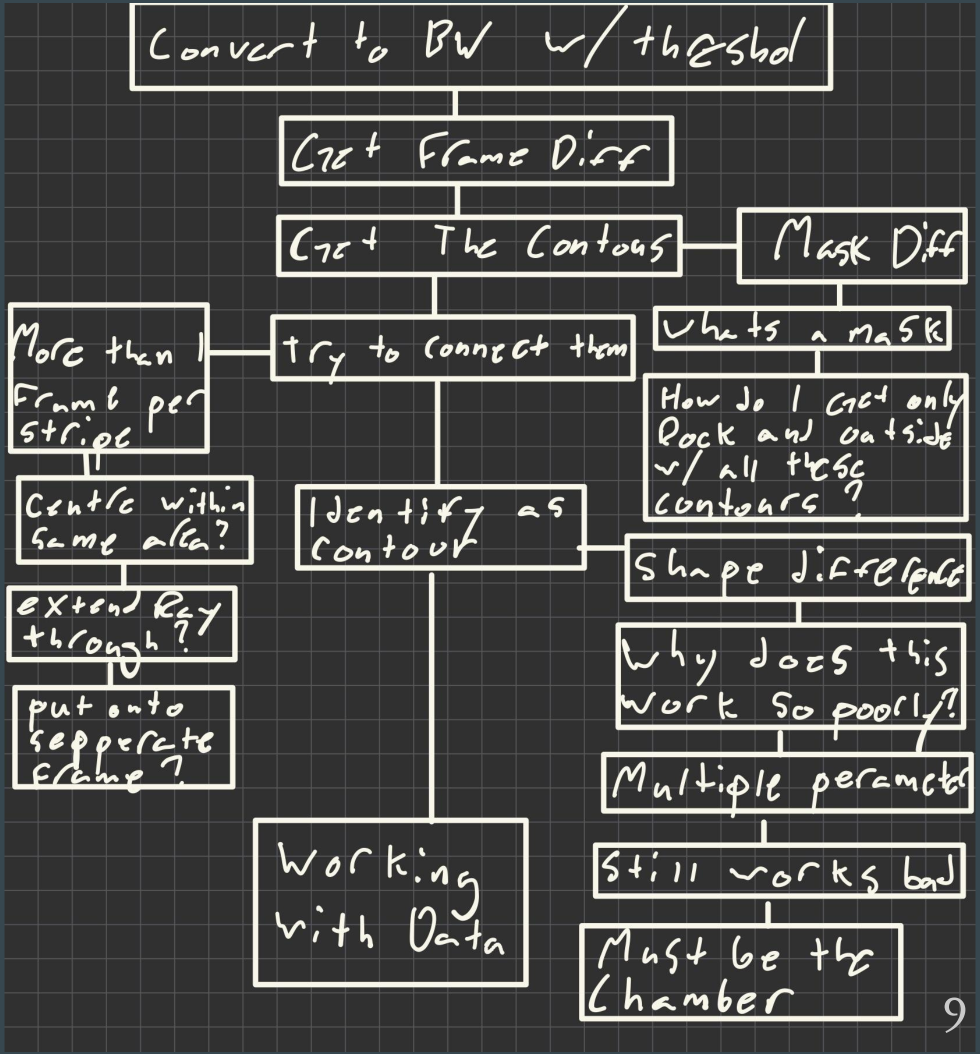
More documentation and strategies the better

Understanding of the concepts

Creating my software “pile”

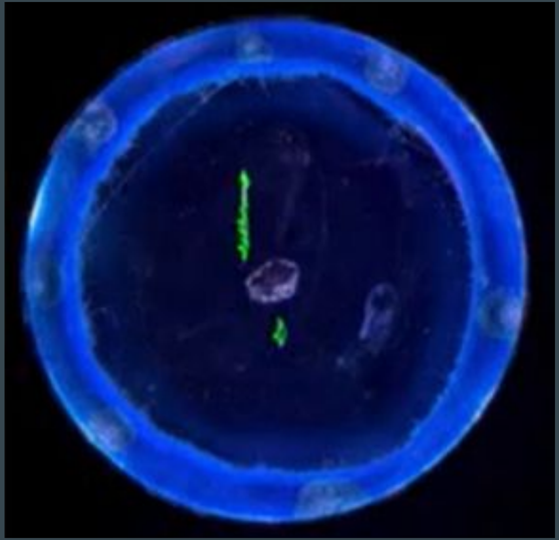
Mold it into what you want it to do

Adjust for accuracy



Overview of the Code

- Read frame
- Compare it to the first frame
- Threshold the image to convert to black and white
- Mask this image with the mask function that we get from the threshold of the first frame
- Get all the contours in this masked threshold image above an area of 200 pixels^2

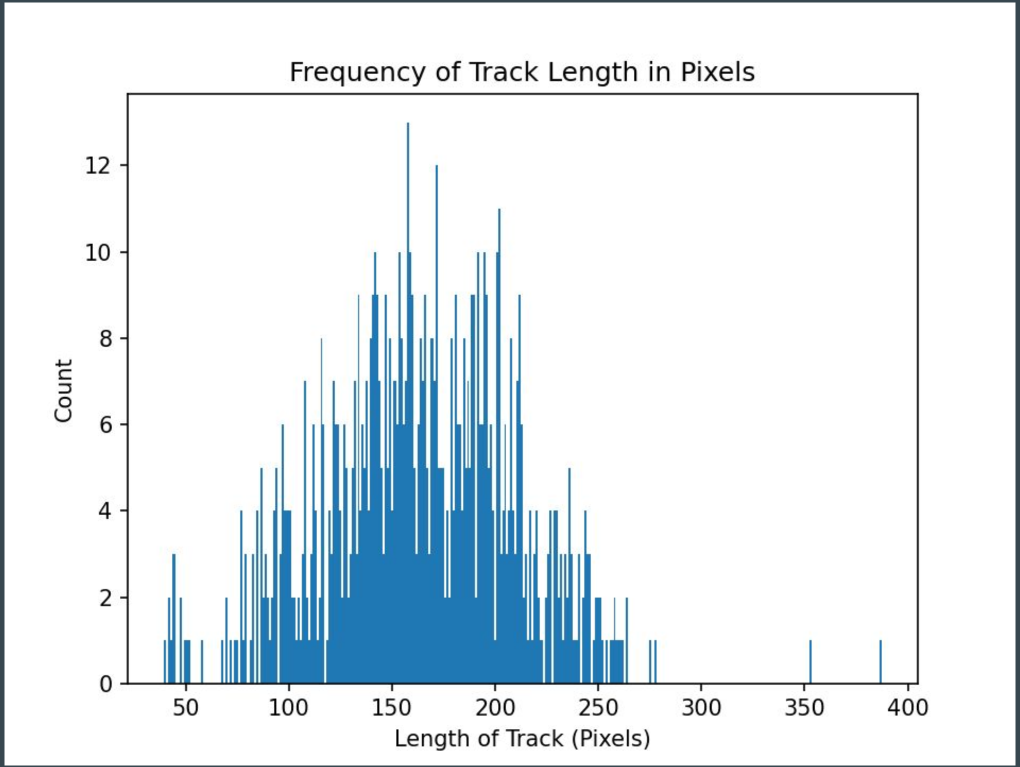


Overview of the Code

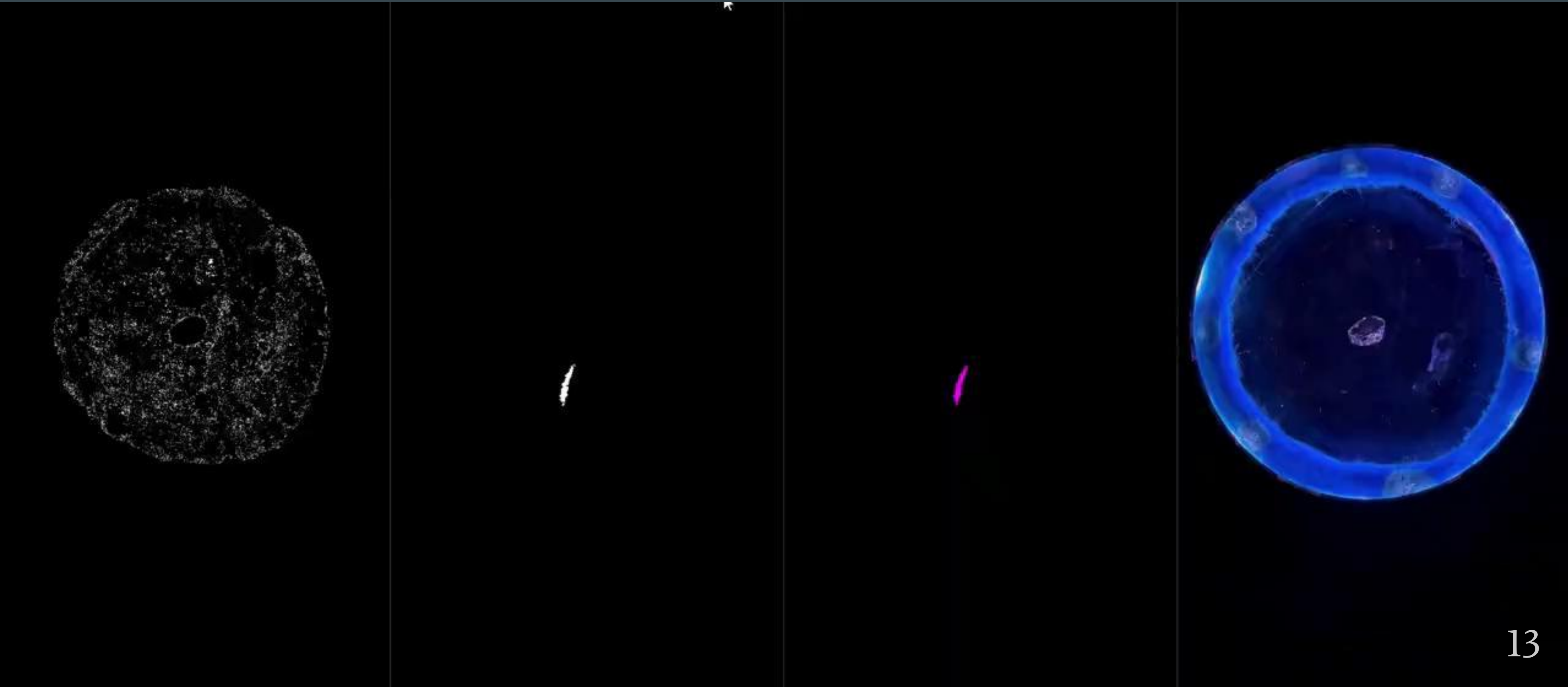
- Put all these contours onto a new frame
- Read all the contours on this frame and see if they are similar to any found on it in the past
- Classify these into growing, or finished contours
- Add these to lists so that they can be checked in the next frame
- If they are done add to the final list

Overview of the Code

- If they are complete check the distance from the centre of the stone
- Remove all these completed ones from the frame and the list
- Loop through this until video ends
- Calculate the activity level
- Show a histogram of the distances



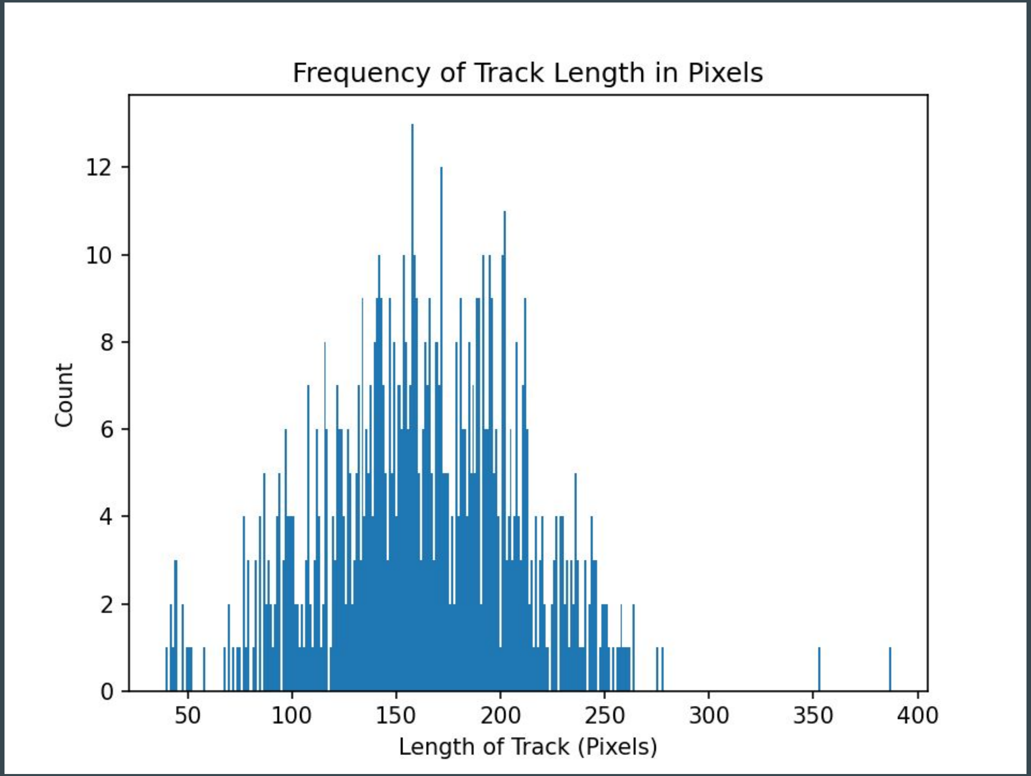
Demonstrations



Results!

What do we get out of the image?

- Aspect ratio
- The time it was on the screen
- How far it traveled
- When it appeared
- How many in the video
- Frames of the video
- Activity level



Calculating Activity Level

$$\int_0^{0.54}\int_0^{2\pi} sin(\theta)\, d\theta\, d\phi$$

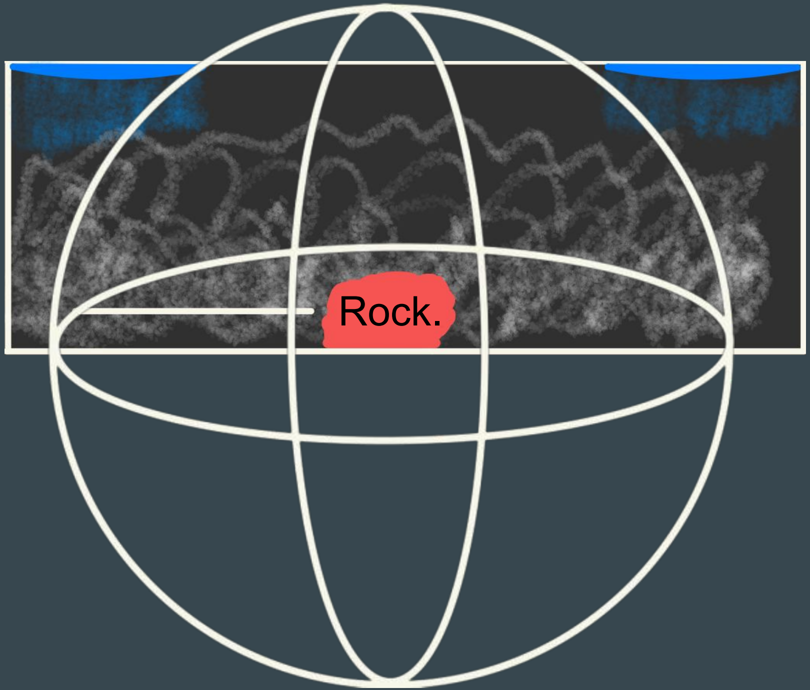
$$= \int_0^{2\pi} d\phi \int_0^{0.54} sin(\theta)\, d\theta$$

$$= (2\pi - 0) \times ((-cos(0.54)) - (-cos(0)))$$

$$= 2\pi \times 0.14$$

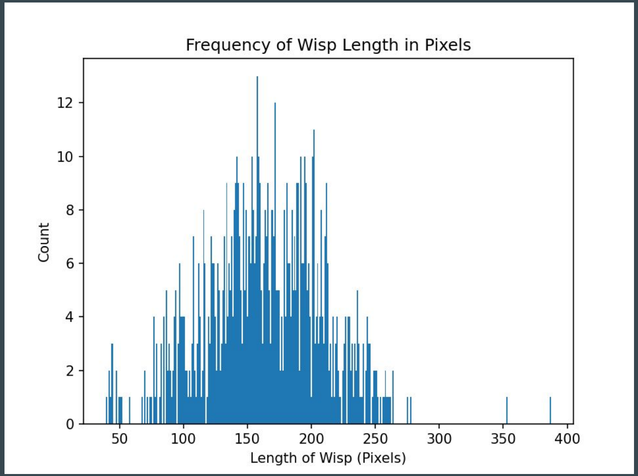
$$= 0.9036$$

$$\frac{tracks}{mass \times time} \div \frac{steradians}{4\pi}$$



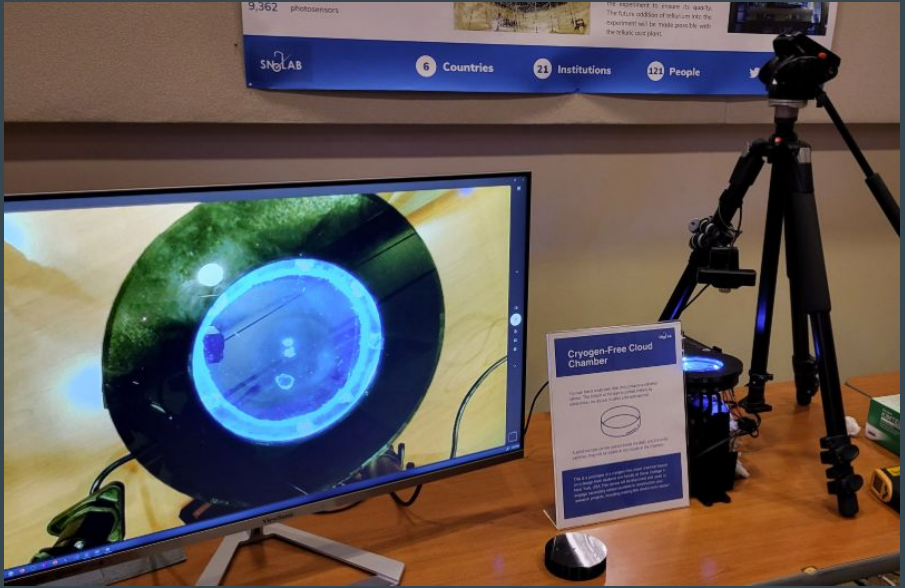
Summary

- I started from a prototype solid state cloud chamber built last summer
- I learned to understand particle radiation and visualization
- I designed software to analyze the chamber automatically
- I 3D printed a camera mount to reduce light noise in the chamber
- I was able to extract track length
- Next steps are to finish activity level and energy estimates, and to analyze beta particles

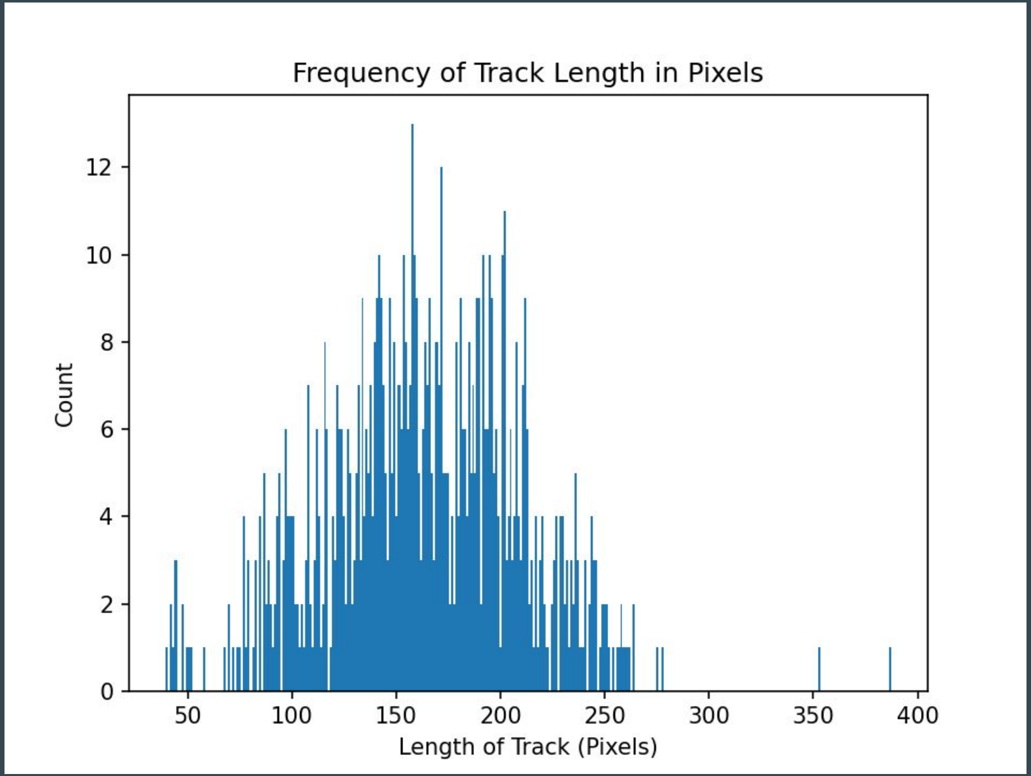


Special Thanks:

- Pierre Gorel for lending his rock
- Steve Brunelle for printing the camera mount and bringing it back to surface
- Josée Bertrand Houle for printing my printable ruler
- Remington Hill for teaching me integrals
- Emma Larcher for helping me with my training technical difficulties



Graph Found via Software



Alpha Spectrum (U-238)