Phys 150: Final Paper

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Initially, the objective was to take measurements at varying altitudes and angles to identify correlations between the data and these two variables. However, due to some last-minute issues, the trials I have taken are not coincidence and thus, this paper will discuss the set-up, data-collection, and analysis of a single detector. More specifically, the paper will discuss the results of collecting 1000 detections at 3 drastically different potentiometer (thresh hold) settings. The results show that with each counter clockwise 45 degree rotation on the potentiometer, the experiment time increases by a factor of 2, and the average frequency reduces by a rough factor of 1/2.

I. INTRODUCTION

For my measurements, I collected 1000 hits at 3 varying potentiometer settings on a single detector. Previously, I expected to sample about 100 hits per measurements because I was planning to take coincidence event data (or angular data with multiple detectors). Due to the fact that I am using only one detector, it is evident that the granularity of this experiment will decrease. As a result, the frequency of detections will be more erroneous and unreliable, so sampling 100 hits will be too short of an experiment time to derive sufficient data. Thus, by taking measurements for 1000 hits, I can hopefully reduce some of the error that comes from using only one detector.

These three trials were taken on March 12th and March 13th in the afternoon.

Trial 1 (the lowest thresh hold) was meant to be more of a test-run, where its purpose was to: (1) check that the board was outputting signals, (2) ascertain that the potentiometer affects detecton rate, and (3) gain some intuition of how to take future trials.

For Trials 2 and Trials 3, I twisted the potentiometer 45 degrees counter clockwise further per trial.

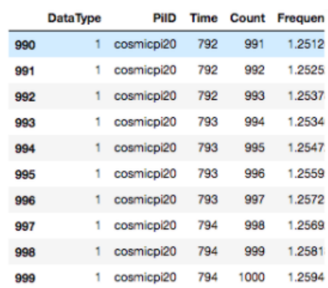
II. METHODS

The materials I used for conducting these trials include a cosmic Board, Raspberry Pi 3, keyboard, mouse, monitor/TV, Macbook Air, wires (for reading out signals from GPIO pins), and a battery pack.

A. Trial 1 (Dummy-Run)

Time Elapsed: 794 seconds, 13.233 mins
Average Frequency: 1.259

For this trial, I twisted the potentiometer on the discriminator pretty far to the right (clockwise), lowering the threshold by a significant amount. While running, the terminal printed hit-detection counts until the count reached 1000. Finally, I scp'd the output file back onto my computer and analyzed the data offline via Jupyter Notebook:



	DataType	PiID	Time	Count	Frequen
990	1	cosmicpi20	792	991	1.2512
991	1	cosmicpi20	792	992	1.2525
992	1	cosmicpi20	792	993	1.2537
993	1	cosmicpi20	793	994	1.2534
994	1	cosmicpi20	793	995	1.2547
995	1	cosmicpi20	793	996	1.2559
996	1	cosmicpi20	793	997	1.2572
997	1	cosmicpi20	794	998	1.2569
998	1	cosmicpi20	794	999	1.2581
999	1	cosmicpi20	794	1000	1.2594

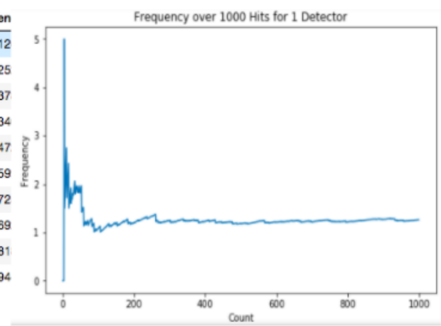


FIG1: Trial 1 Plots

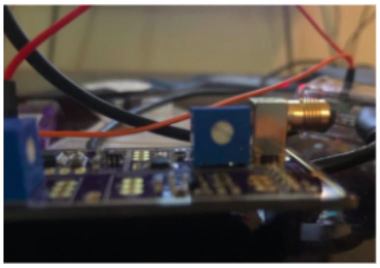
From a previous experiment (100 coincidence events between two detectors), I found that the average frequency and time elapsed was 0.0806, and 1228 seconds (This data was taken about a month ago). For this dummy trial, I found that the average frequency was significantly higher (1.259 hz) and took notably less time to finish collecting data.

While I was watching the terminal as the script ran, I noticed unusual behavior. There would be anywhere from 4-8 seconds of inactivity, followed by a barrage (usually 4-6 counts) of signals being detected all within the same time stamp. While I expect the data to be discrete, I presume that the results for trial 1 are not ideal, because the frequency was too high due to noisy signals (need to adjust potentiometer to filter out unwanted data). For my next trials, I will be increasing the threshold via the potentiometer to reduce noise.

B. Trial 2 (Increased Threshold)

Time Elapsed: 1975 seconds, 32.917 mins
Average Frequency: 0.506

Prior to starting my script, adjusted the potentiometer like so (counter-clockwise).



This trial appeared to be more successful in discriminating noise from actual signals. We can see this from the significant decrease in frequency (1.259 to 0.506), and increase in experiment time (13 minutes to 32 minutes).

	DataType	PiID	Time	Count	Frequency
990	1	cosmicpi20	1973	991	0.502281
991	1	cosmicpi20	1973	992	0.502788
992	1	cosmicpi20	1973	993	0.503294
993	1	cosmicpi20	1973	994	0.503801
994	1	cosmicpi20	1973	995	0.504308
995	1	cosmicpi20	1974	996	0.504559
996	1	cosmicpi20	1975	997	0.504810
997	1	cosmicpi20	1975	998	0.505316
998	1	cosmicpi20	1975	999	0.505823
999	1	cosmicpi20	1975	1000	0.506329

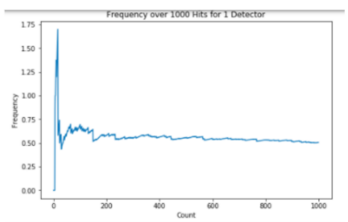
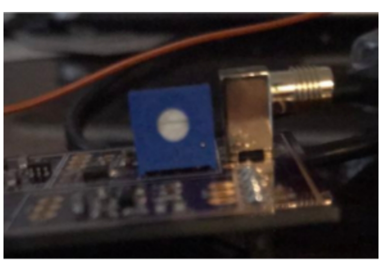


FIG2: Trial 2 Plots

C. Trial 3 (Highest Threshold)

Time Elapsed: 3069 seconds, 51.15 minutes
Average Frequency: 0.326

Prior to starting my script, adjusted the potentiometer like so (counter-clockwise).



When plotting FIG3, I noticed a difference between the average frequencies for this 3rd trial, and the previous trials. For the first two trials, the frequency spiked sharply in the first dozen detections, then decayed below this peak and leveled out to its average frequency. For this trial, I observed a smaller initial spike, a smaller decay, then a gradual increase to the point where the rate of detection evens out.

	DataType	PiID	Time	Count	Frequency
990	1	cosmicpi20	3033	991	0.326739
991	1	cosmicpi20	3033	992	0.327069
992	1	cosmicpi20	3061	993	0.324404
993	1	cosmicpi20	3061	994	0.324730
994	1	cosmicpi20	3061	995	0.325057
995	1	cosmicpi20	3061	996	0.325384
996	1	cosmicpi20	3061	997	0.325711
997	1	cosmicpi20	3061	998	0.326037
998	1	cosmicpi20	3069	999	0.325513
999	1	cosmicpi20	3069	1000	0.325839

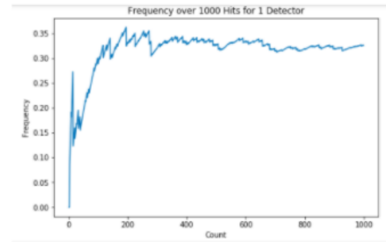


FIG3: Trial 3 Plots

III. RESULTS

For these 3 trials, I rotated the potentiometer 45 degrees (counter clockwise) to increase the threshold at which signals pass through. With each rotation, the experiment time increased by a factor of 2, and the average frequency reduced by a factor of .

Trial #	Potentiometer Setting	Average Frequency	Exp Time
Trial 1	(|)	1.259 hz	13.23 min
Trial 2	(\ )	0.506 hz	32.92 min
Trial 3	(—)	0.326 hz	51.15 min

Summary Table for Trials 1-3

IV. DISCUSSION

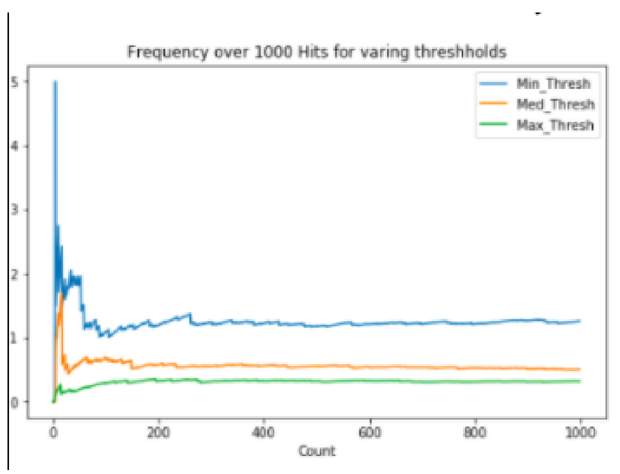


FIG4

This plot describes how the frequency changes throughout the three trials. As previously mentioned, the data from the last trial (in green) produced a different shape than the first two when I plotted it. After decaying from the first initial spike, the average frequency climbs and levels out higher than this first peak. This is unlike trials 1 and 2, and can be seen more clearly when looking at Trial 3's frequency plot (FIG3).

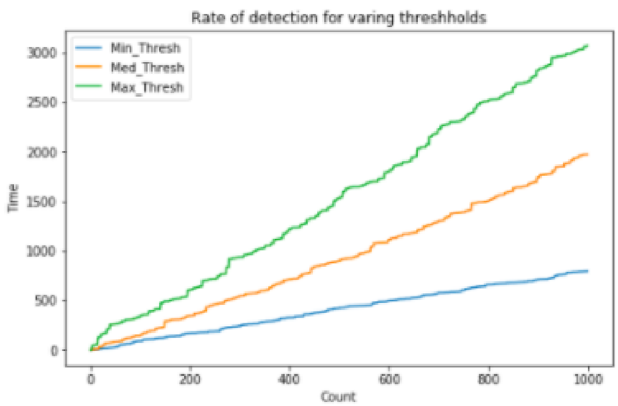


FIG5

This plot describes the number of detections vs experimental time. I will be using this plot to discuss the majority of my following analysis.

Here, trial 3's rate (in green) also seems to experience a slightly different growth than the other 2. For trial 1 and 2 where there is very little threshold, the growth rate appears to be mostly smooth or constant. For trial 3, however, the trend is more jagged and unstable.

From these results, it is observed that the data from a detector (such as in trial 3) that properly filters out noise, generates a graph with more interesting peaks and discrete instances of detection. For example, from 750-1000 seconds in FIG5, the Max Thresh line for trial 3 indicates that there is a sudden slow down in detections.

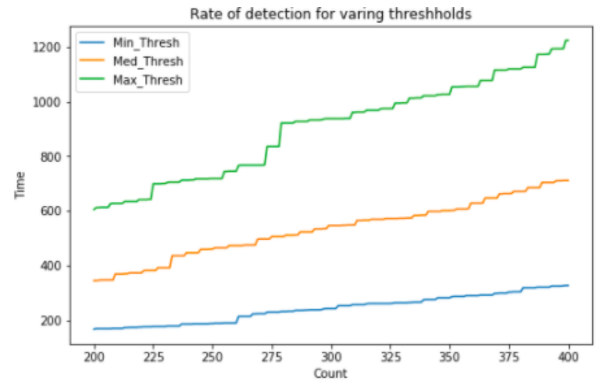


FIG6: A Closer Look at FIG5

Indeed, when looking at this figure, it is apparent that there are some step-wise jumps in detection for trial 3 (from counts 250-300).

Upon comparing trial 3's results to the others, I conclude that filtering out these unwanted signals produce more "interesting" data that can be analyzed. In order to explore this more, I will further increase the threshold to find the setting where taking 100 "hits" will take longer than 15 minutes / 900 seconds. This happens to be the time needed to collect 1000 hits for the minimum threshold experiment in my trial 1. While it is crude, I believe this to be a somewhat decent way to ensure that there is adequate data and experimental time for the analysis of just just one detector.

ACKNOWLEDGMENTS

I would like to acknowledge Hiroki for providing me with useful measurement ideas, and Rebecca for helping me with getting my detector up and running.