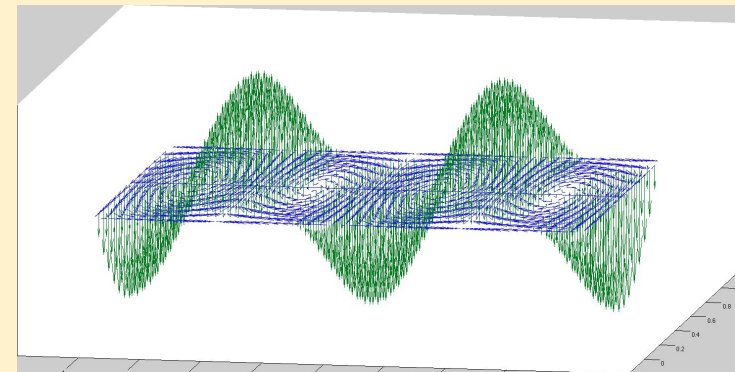




Bees and RF



Professor Martin and Dr. Howard
Joseph Florentine EE/Physics 2021
Bhargav Singaraju EE 2021
Justin Yu EBHS 2020

The Undergraduate Team

- Bhargav Singaraju

- EE 2021

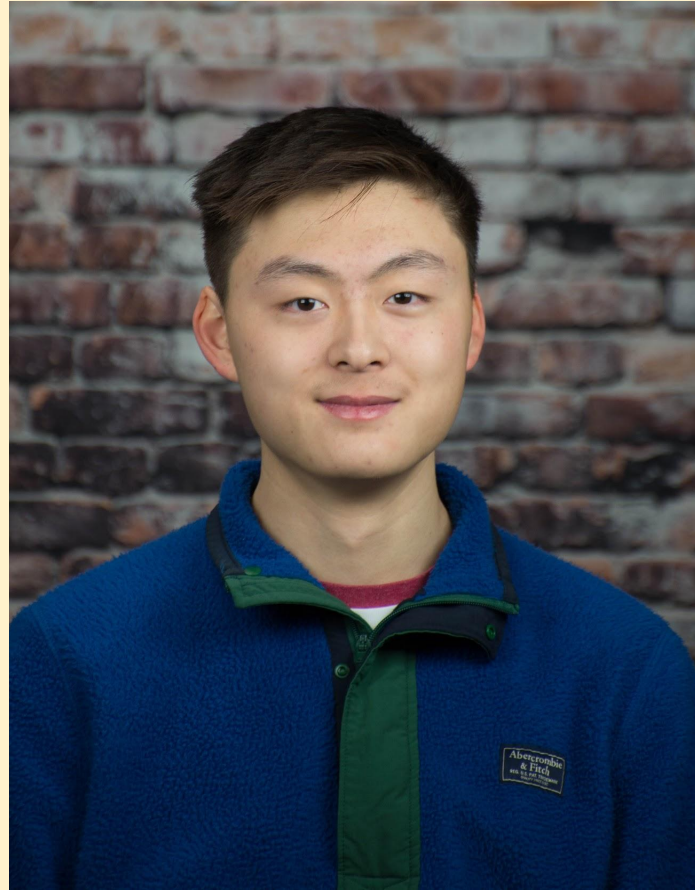


Joseph Florentine

EE/Physics 2021



The High Schooler



Justin Yu
EBHS 2020

Inspiration and Overview

- RF (Radio Frequency) is everywhere.
- In May 2014 *Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird* was published.
 - 1MHz RF interferes with birds finding magnetic north.
- Bees also navigate using the earth's magnetic field
 - RF consists of **Electromagnetic** waves

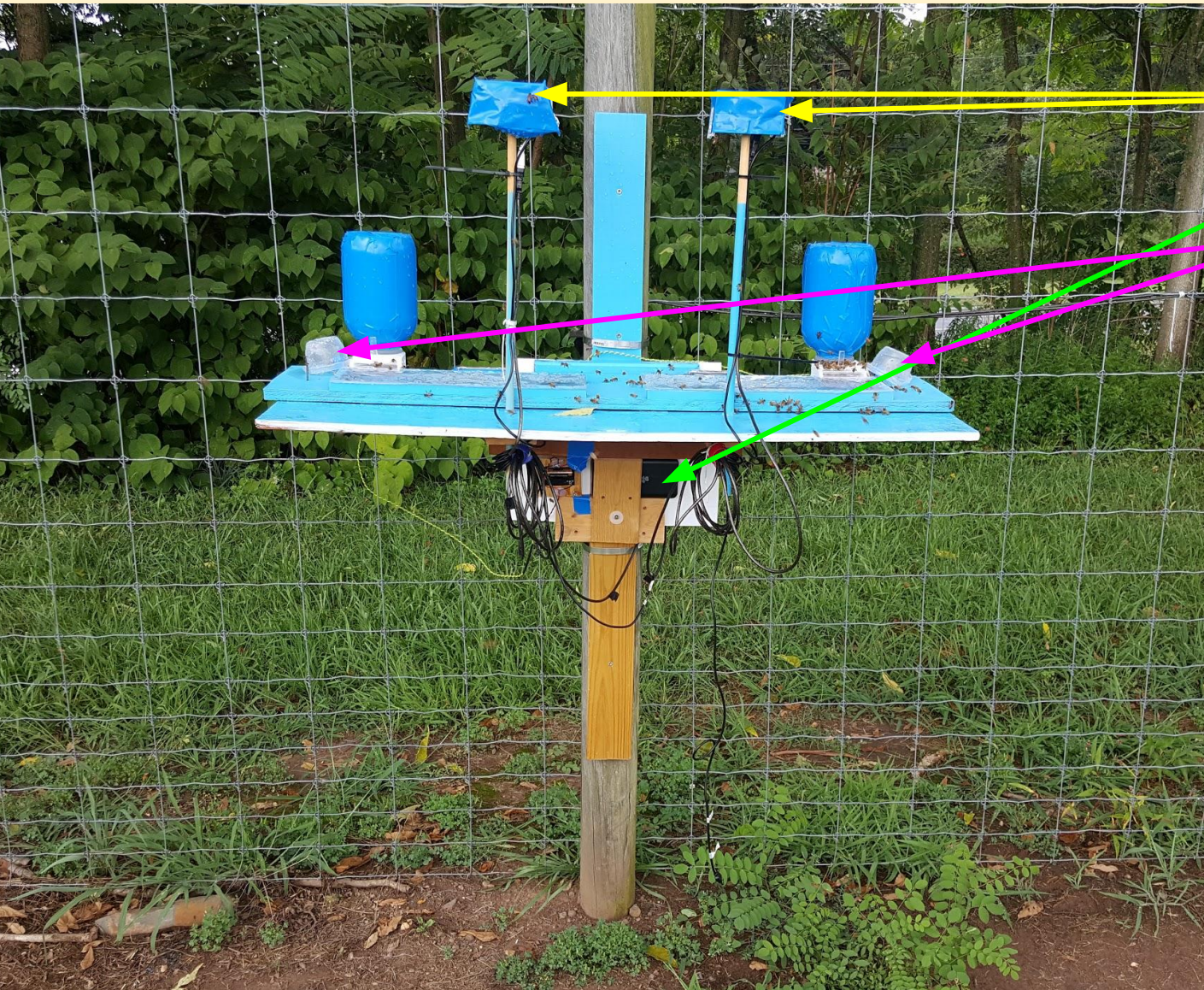


Project Overview

- Design and conduct a study to create specific RF/DC magnetic fields in the proximity to 4 feeders while observing bee presence/interaction at the feeders.
 - All equipment must be weatherproofed to survive field conditions, and overcome resulting challenges:
 - Power limitations
 - Limited access (mandates automation of some degree)
 - Budget constraints
 - Bees



Experiment Setup

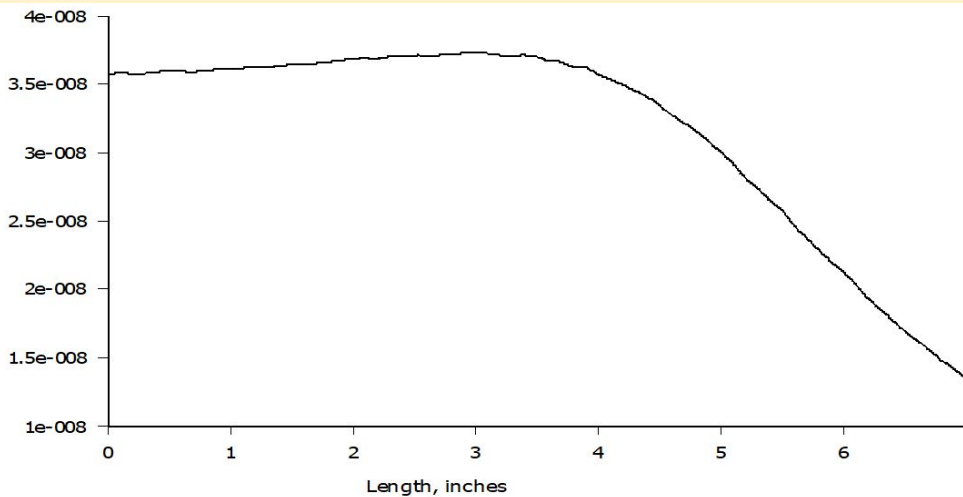
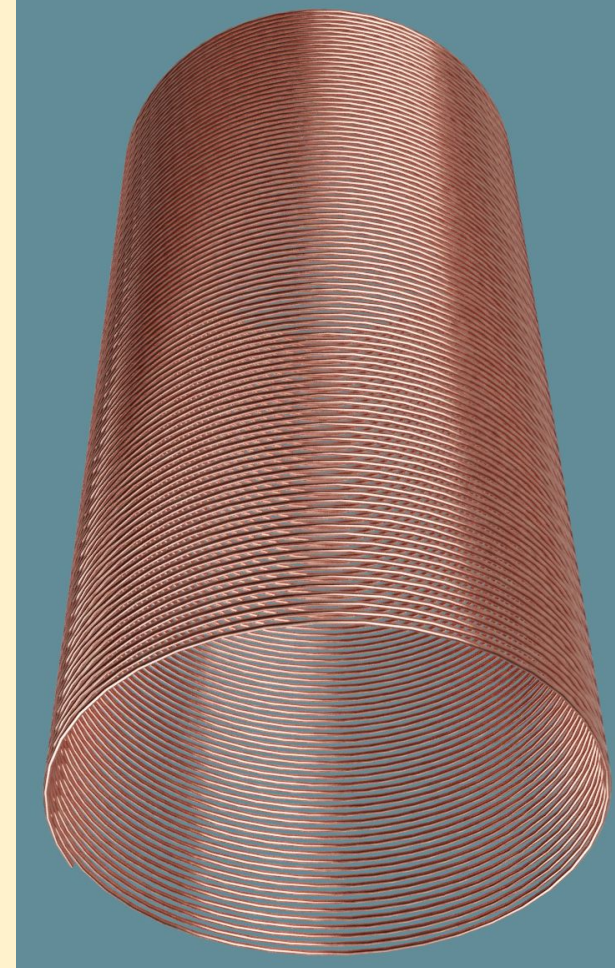


Feeder Specifications:

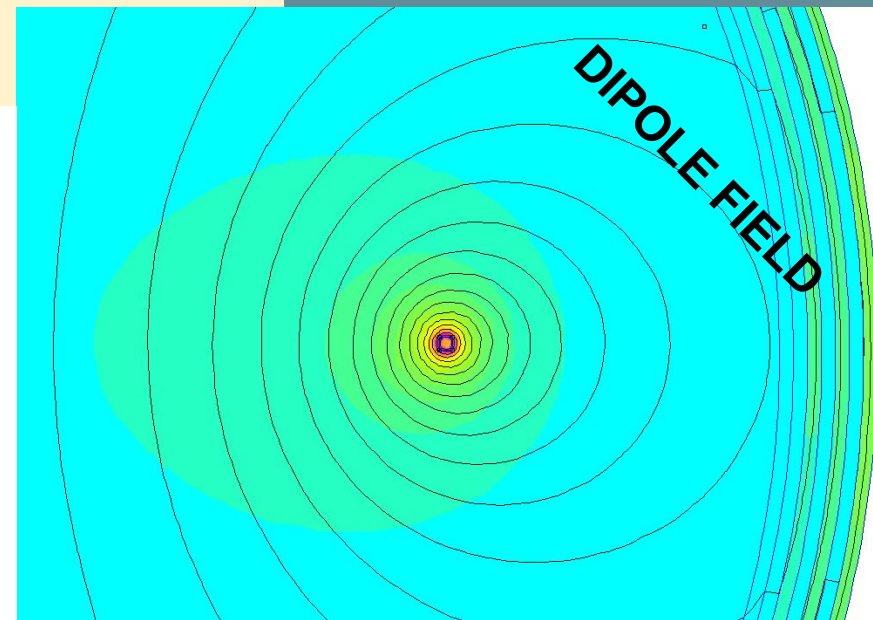
- Raspberry Pi Zero (2)
 - Raspberry Pi Cam V2
- 20Ah 5V battery bank
- 400Hz Buzzers
- Active USB extensions
 - 128GB SD cards
- 2 Liter sugar water jars

Antenna Design:

- Coil is driven off MSP430 with a mosfet
- Initial idea: Solenoid
 - Bees enter clear tube to access feeder
 - Coil is wound around tube
- Final version: Two Dipoles (DC&RF)
 - Under platform (no visibility issues)
 - Reduced power draw
 - Easier to assemble

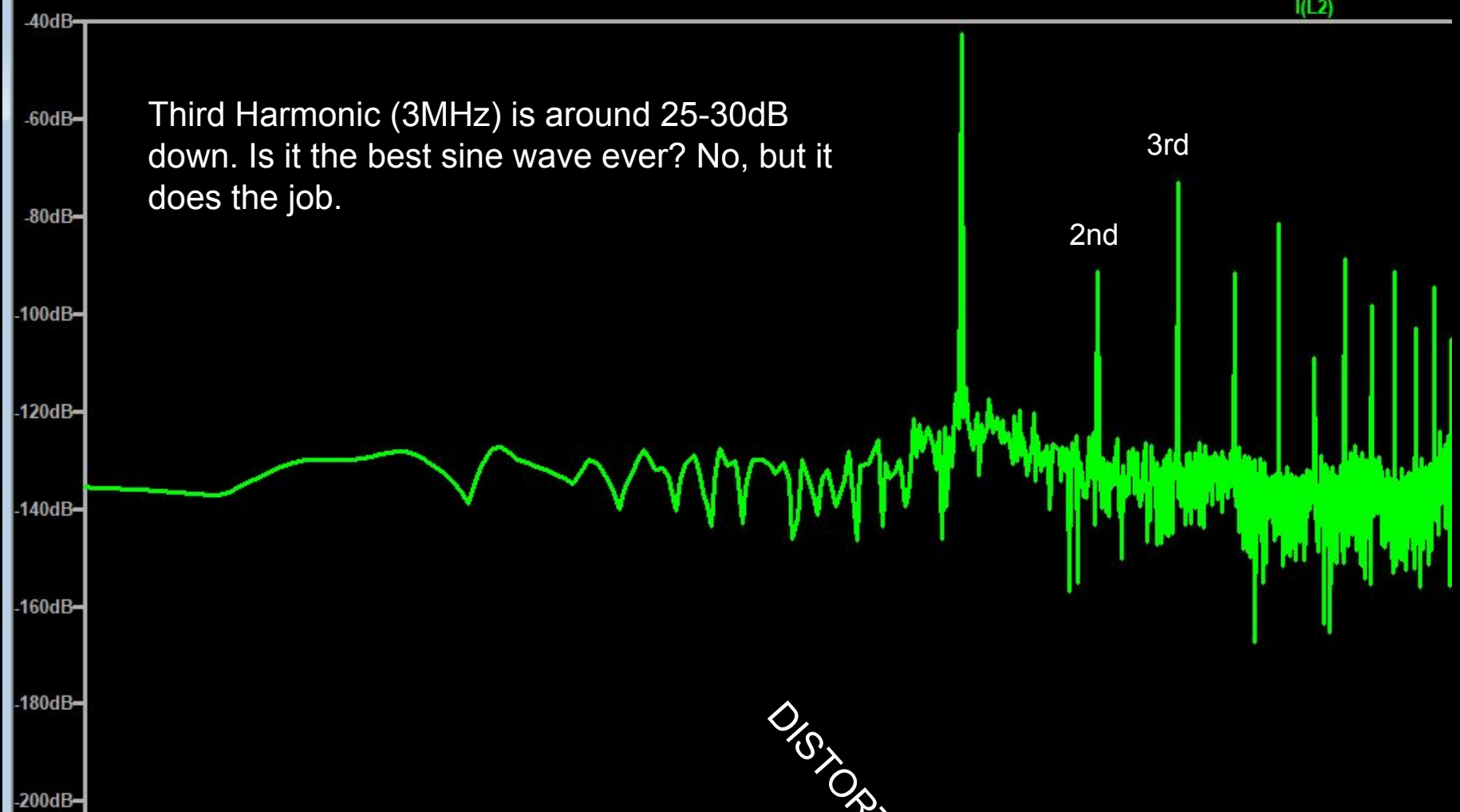


|B|, Tesla

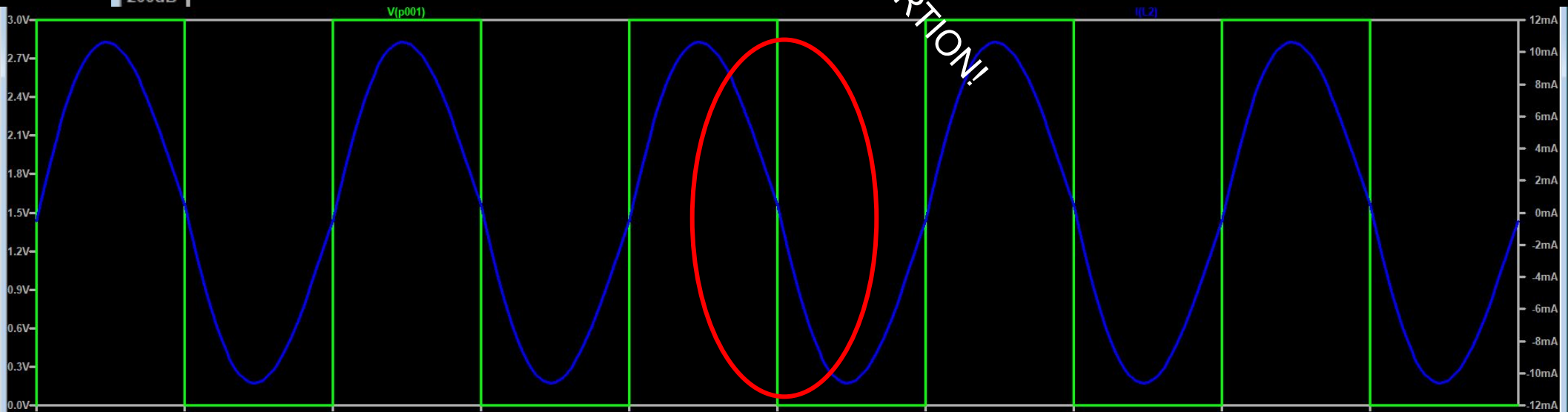


I(L2)

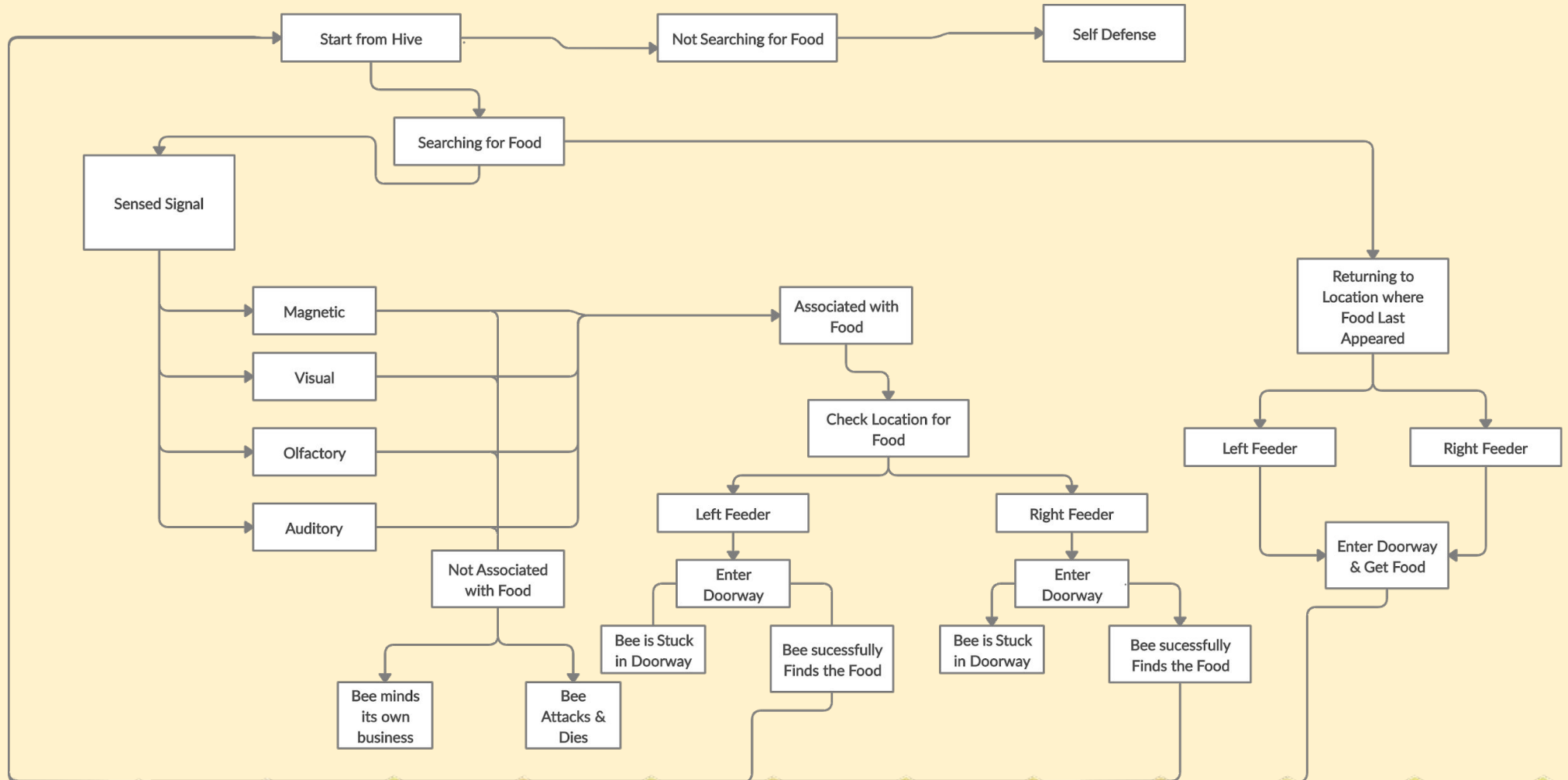
Third Harmonic (3MHz) is around 25-30dB down. Is it the best sine wave ever? No, but it does the job.



DISTORTION!

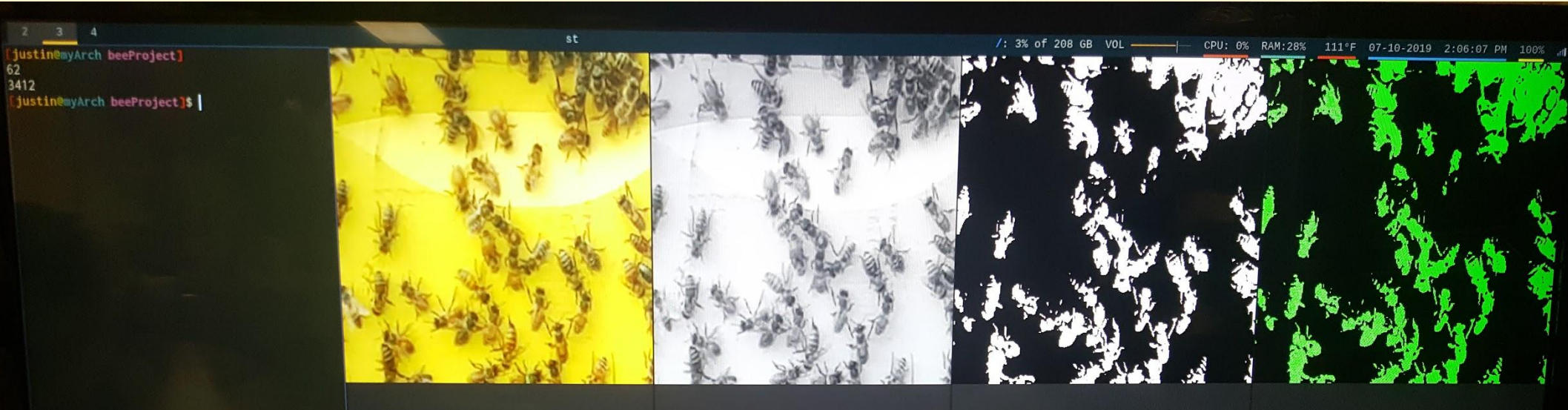


Bee Cognitive & Behavioral Model



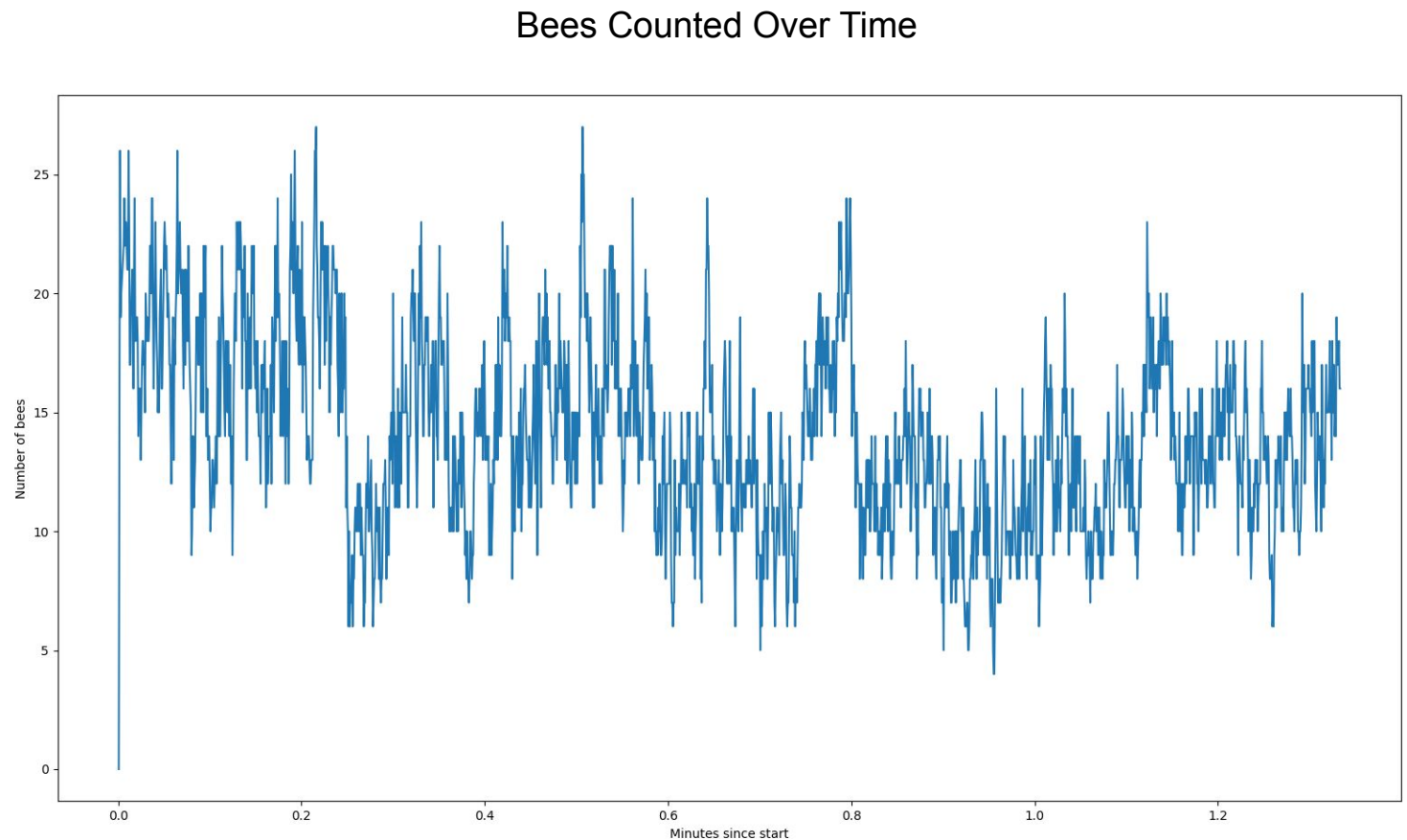
Bee Counting

- Python Image Processing Library (OpenCV)
- Grayscale, threshold, pixel counting (Clumps)
- Issue: Shadows



Bee Counting 2.0

- OpenCV
 - Static and Dynamic
- Ants
- Trees?



Footage of the Bees:

From Raspberry Pi:

<https://youtu.be/QTCOFtUdneQ>

BEEroll of Bees:

https://youtu.be/_YusUmGQ6Q4





Goals for the Rest of Year

- 400 Hz Training
- Track bees
 - Track paths → classify behavior
 - Density (RF)
- Control two feeders with brick pi3
 - EV3 lego motors
- Reinforcing for extra weather proofing
 - Thunderstorms
- Software efficiency



Thank You For Your Time

- Any Questions?
 - Please visit our poster!

