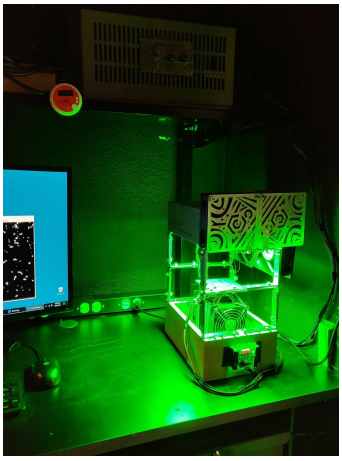
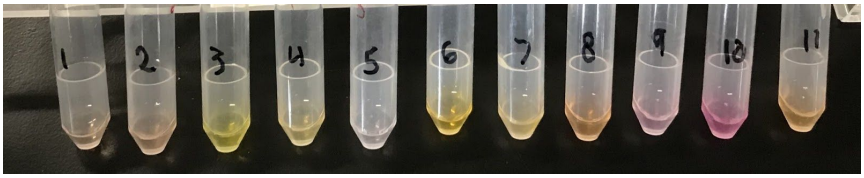
The Shaner lab typically releases its projects in large batches, so I don't have an individual paper on my research. My proteins and software will be included in the next big paper.

In 2017, I built a custom green light source 10x brighter than looking directly at the sun, with a cooling plate to prevent the sample from overheating. Under a fluorescence microscope, fluorescent proteins (FPs) are exposed to highly concentrated light that will eventually denature the protein. The solar simulator I built allowed us to select for FPs that could withstand intense light for long periods of time. I also learned a lot about biology and lab work, and helped my PI with various FP projects.



My photobleaching project

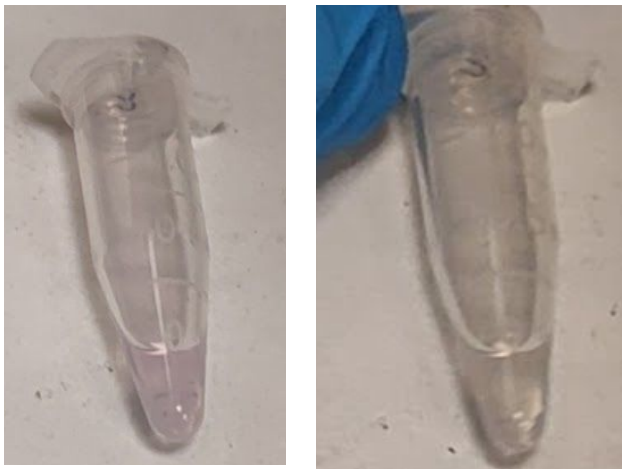
In 2018, I finalized my solar simulator, and took on interesting software projects. I wrote prototype software to automate counting cells with clumps of FPs (a sign that the FP is interacting with itself, an undesirable trait) -- a process that used to take hours of manual labor. I also wrote software that allowed us to screen for photoswitching FPs in large batches. I also took on my own chromoprotein investigation project, on a beautiful array of chromoproteins isolated from the Portugese Man O' War. I performed mutagenesis on all of them, to see if I could get any of them to fluoresce, and instead discovered one protein whose absorbance spectra changed in the presence of metals.



The Portugese Man O' War Proteins

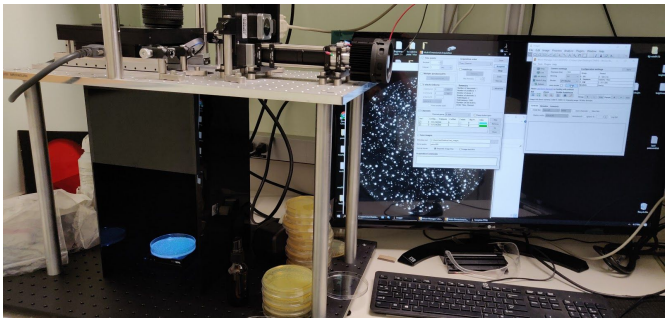
Last summer, I performed a round of directed evolution to improve a bioluminescent protein (not released yet), two rounds of directed evolution a potentially photoswitchable protein (with little success), and an intense protein investigation and design on a photoactivatable mRuby3 variant.

One of our collaborators was having a really hard time sequencing the mRuby3 variant, so I designed oligos and sequenced it from the inside out and outside in, and combined the results. I then ordered a synthetic gene based on what I thought was the most likely sequence, and sure enough it was photoactivatable. After a round of directed evolution, the protein was almost colorless normally, but when turned on using 450nm (blue) light it became a faint red (absorbing 550nm light, emitting 650nm). I look



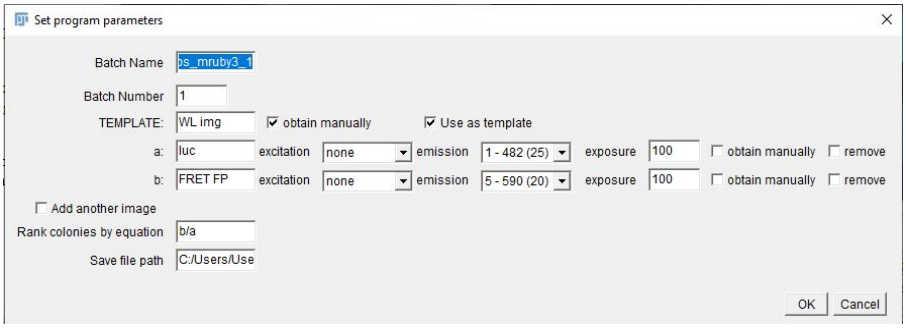
The protein before and after 450nm light

forward to improving this protein (and hopefully shortening its maturation time, right now it's around 2 weeks) next summer.



I also wrote software for the low light camera our lab recently acquired, that allows us to quickly quantitatively screen for brightness (that previously was done by eye), and to screen for other traits that were previously impossible. The software detects the boundaries of all of the colonies based on the input images, and then ranks the colonies based on a user-defined equation. For example, the program can compare the before and after states of photoswitching proteins and select the colonies that changed the most, or select for bioluminescent proteins that use up the substrate quickly.

Once the colonies have been ranked, the results are displayed on an iPad mini, so that the user can easily pick the right colonies by putting the plate on top of it.



I ended up having to use three different programming languages, one scripting language to control the filter wheels and camera, the imageJ macro language to do the vision processing, and java to make the GUIs.