

# Use of Voltage Sensitive Dyes with Photo acoustic Brain Imaging

## *Project Checkpoint*

Timothy Mullen & Darian Hadjiabadi

Mentors: Dr Emad Boctor, Dr Arman  
Rahmim, Dr Behnoosh Tavakoli

# Overview

- Project Summary
- Current Progress
- Updated Timeline and Deliverables
- Summary

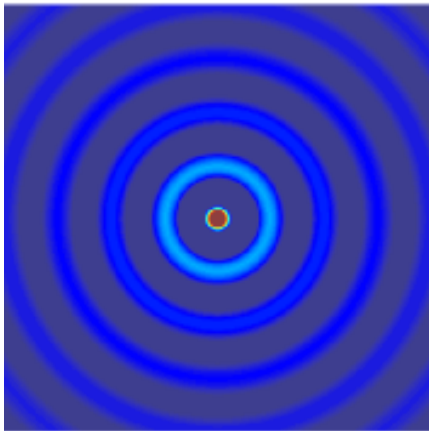
# Project Summary

- Current brain imaging modalities do not provide satisfactory image of brain signal time-path
  - Steep trade off between temporal and spatial resolution in PET and fMRI
- Dyes that react to pH or voltage change have the potential to break through the gap
  - pH and voltage changes occur when neurons fire

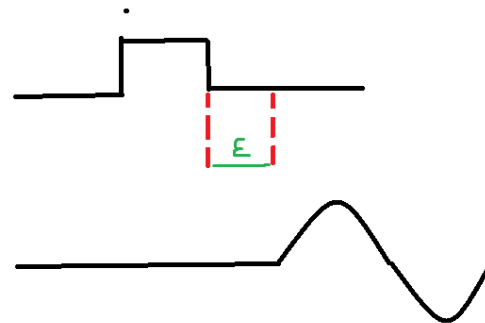
# The photoacoustic wave

- Formation of a sound wave after a material absorbs light energy
- Wave characteristics are highly dependent on the absorption of the material

$$\nabla^2 p(\vec{r}, t) - \frac{1}{v^2} \frac{d^2 p(\vec{r}, t)}{dt^2} = \frac{-\beta}{C_p} \frac{d}{dt} H(\vec{r}, t)$$



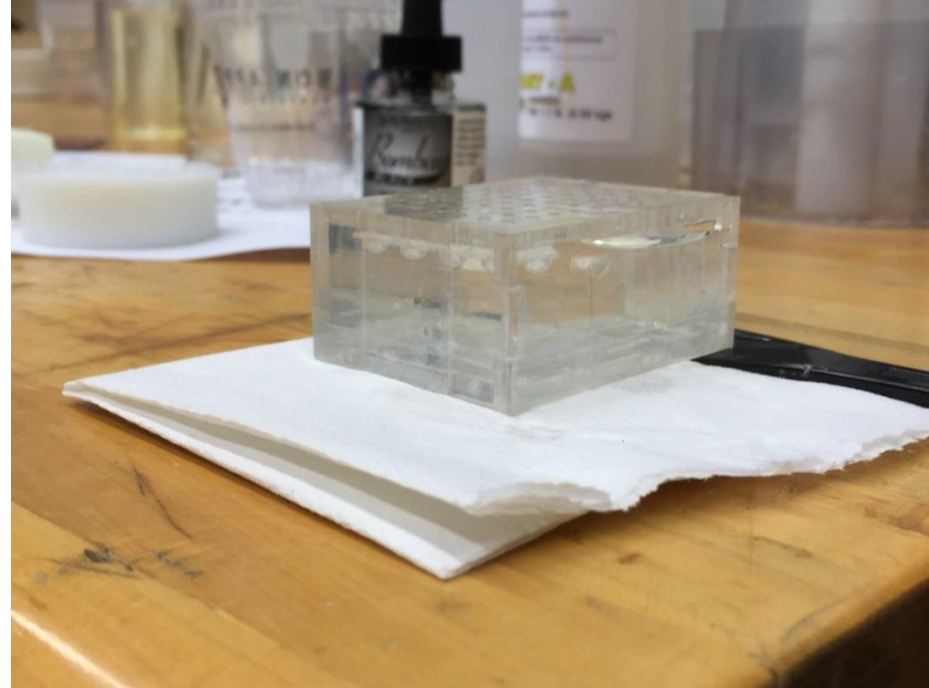
- We essentially end up with a point source emitter



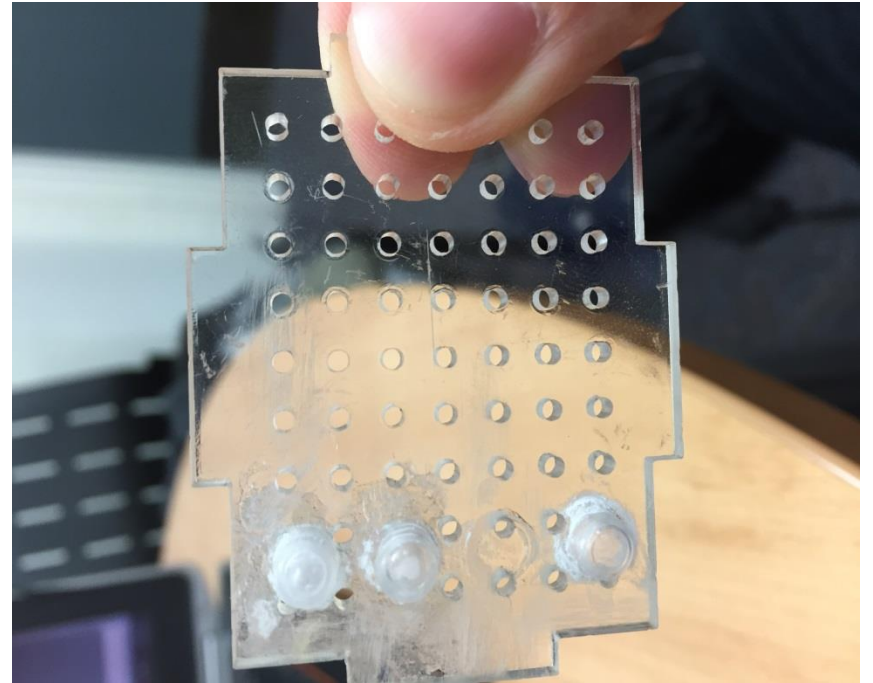
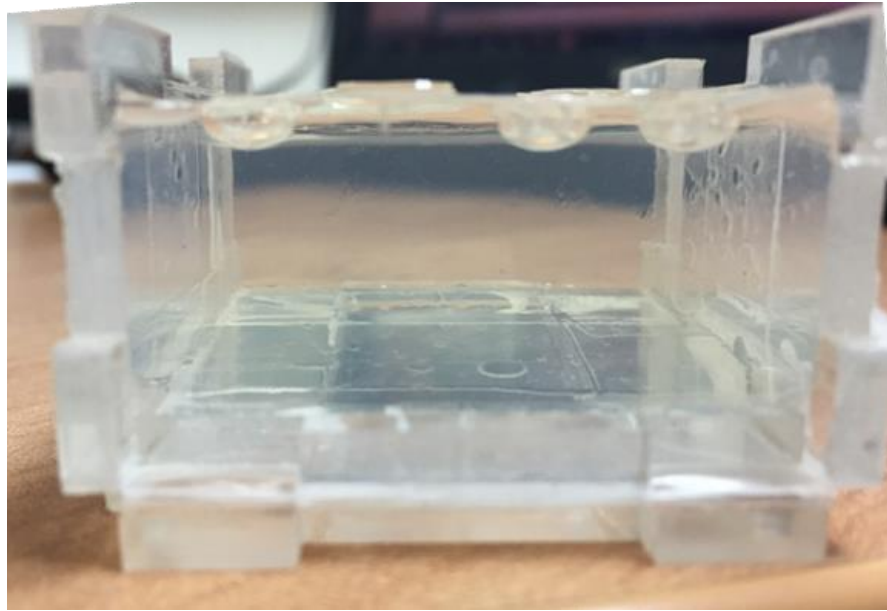
# Our goal

- Photoacoustic imaging is non-invasive and is a good candidate for observing changes in voltage or pH sensitive dyes for brain imaging
- In order to choose good candidate dyes, the photoacoustic response of various dyes must be known across voltage and wavelength
  - We aim to produce such characterizations

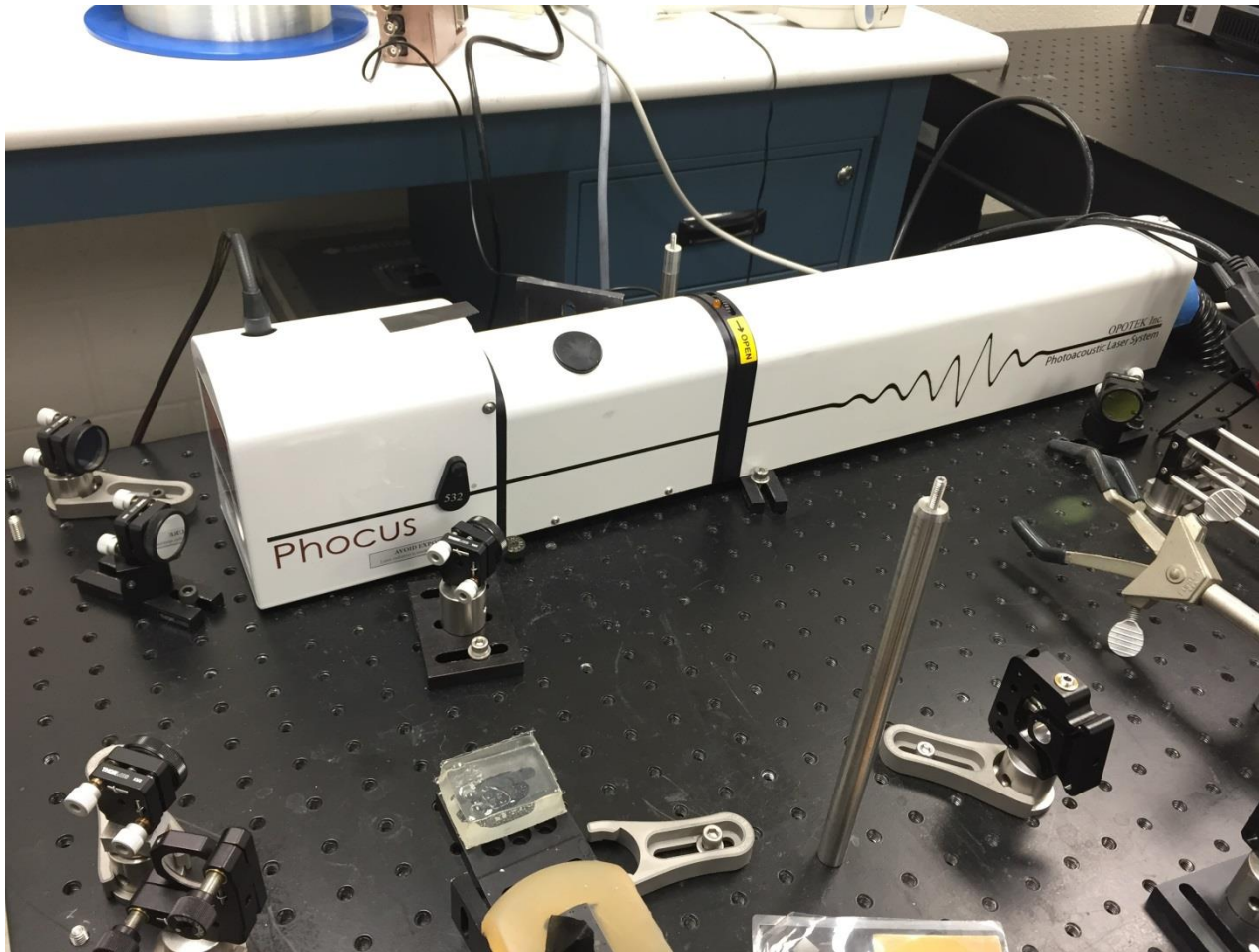
# Progress



# Progress (cont.)



# Progress (cont.)





# Progress (cont.)

- Completed building the mold
  - Contains wells which will house candidate dyes
- Test rig is ready
  - Dry run performed last week
  - Testing to begin today

# Dependencies – all satisfied

Dependency	Resolution
Access to mentors	Aim to schedule at least 1 meeting / 1.5 weeks
Access to laboratory. Sub-dependencies are necessary training and equipment	Training provided via Dr Boctor's masters student. Dr Boctor will allow us to use his lab, which contains all equipment needed, to perform experiments
Access to dyes	Order far enough in advance via commercial source or via an outside lab so that dyes are in possession when experimentation begins
Synthesized liposomes from JHMI	Established contact with Dr Thorek. Once our system is defined (solute and phospholipid choice, concentrations, etc), a batch of liposomes can be physically produced in < 1 hour
Photoacoustic test software	Dr. Boctor's lab has some software for automating the photoacoustic measurement process. During our first meeting with our contact in Dr. Boctor's lab, we will discuss how to tie into this software for our own testing procedures.

# Minimum Deliverables

- Minimum
  - Design document for analyzing photoacoustic output across voltage range seen in neurons
  - Construction of test apparatus and test battery procedures
  - Short paper summarizing existing fluorescent dyes and research regarding potential as photoacoustic VSD and pH dye candidates
- Set for completion

# Expected Deliverables

- Complete maps of photoacoustic output across multiple voltages and wavelengths for a dye

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- Graphs of photoacoustic output across baseline (0 V) voltage and wavelengths for a larger complement of dyes

# Maximum Deliverables

- Apply photoacoustic imaging technique with fluorescent dye with skull phantom in between laser source and dye.
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- Off the table
    - Complete map of photoacoustic output across multiple voltages and wavelengths for several dyes

# End Goal

- Hope is to have a relatively large amount of good data on baseline photoacoustic response of a variety of dyes
  - Usable
- Additionally, give an idea of what voltage map response looks like

# Milestones update

- *March 27* – Test apparatus complete, test procedures verified
- *April 3* – Characterization Data for at least one VSD acquired
  - Instead of characterization over multiple voltages, we will aim for baseline, aiming to complete
- *April 10* – Data from VSD analyzed
  - Deliverables have changed
- **New Milestone:** *April 17* – 5 dye baseline response graphs
- **New Milestone:** *May 1* – Have 12 dye baseline response graphs completed and 1 voltage characterization

# Timeline

- *April 10 – April 17*
  - *Baseline dye characterizations*
  - *Analyzing data from first characterizations*
- *April 17 – May 1*
  - Start planning for final presentation and paper
  - Work on voltage characterization and remaining baseline dyes
- *May 1 – May 8*
  - If necessary finish voltage map data analysis
  - Create final report and presentation