

# Photoacoustic System for Spinal Surgery

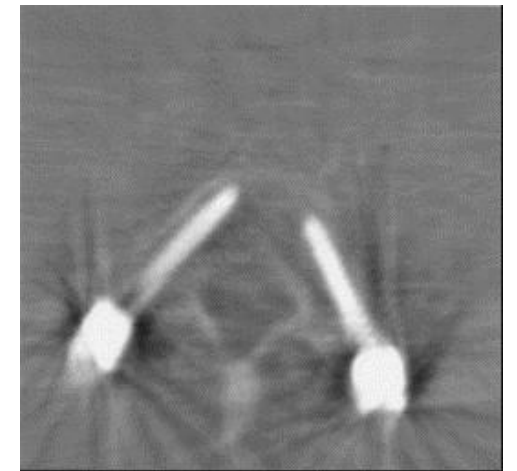
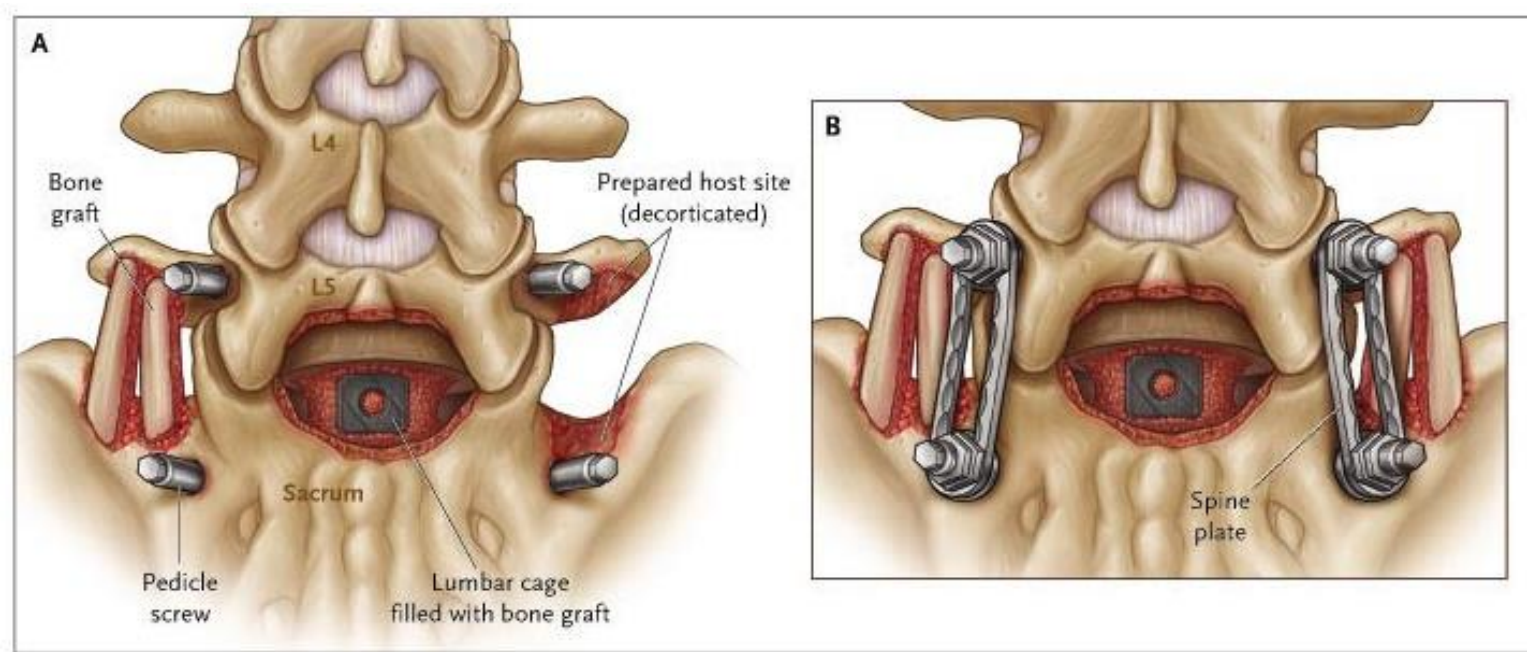
Group 3

Blackberrie Eddins

Mentor: M. A. Lediju Bell

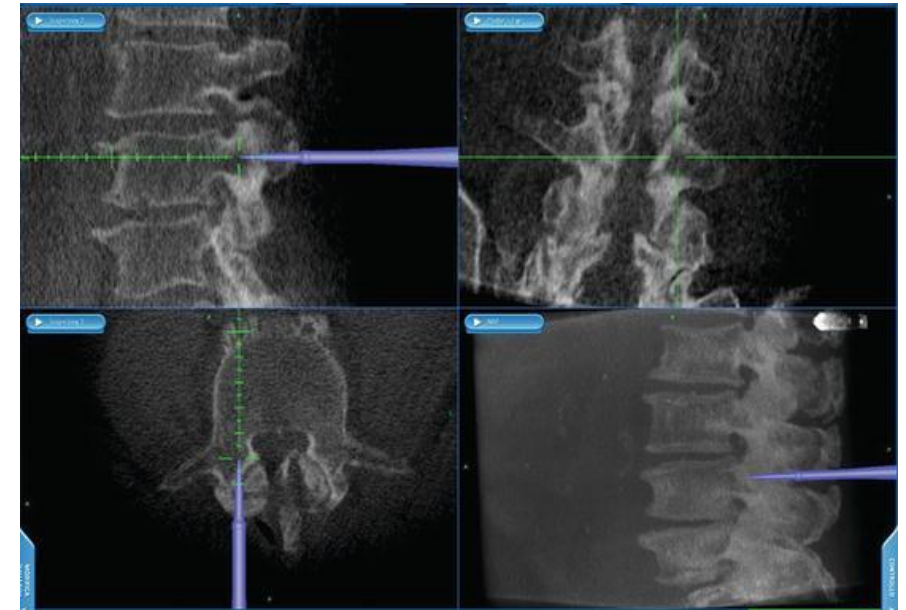
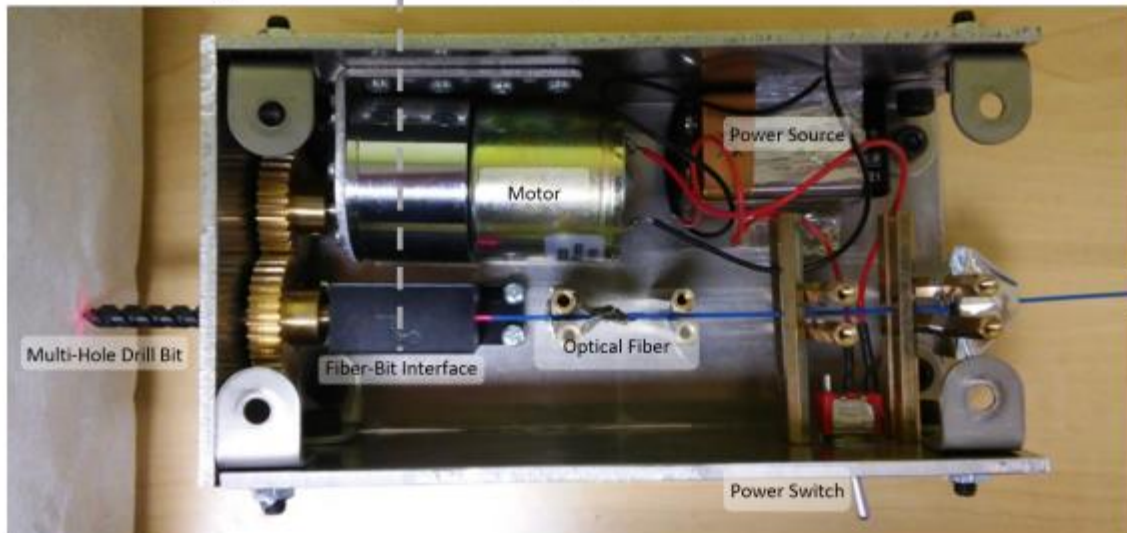
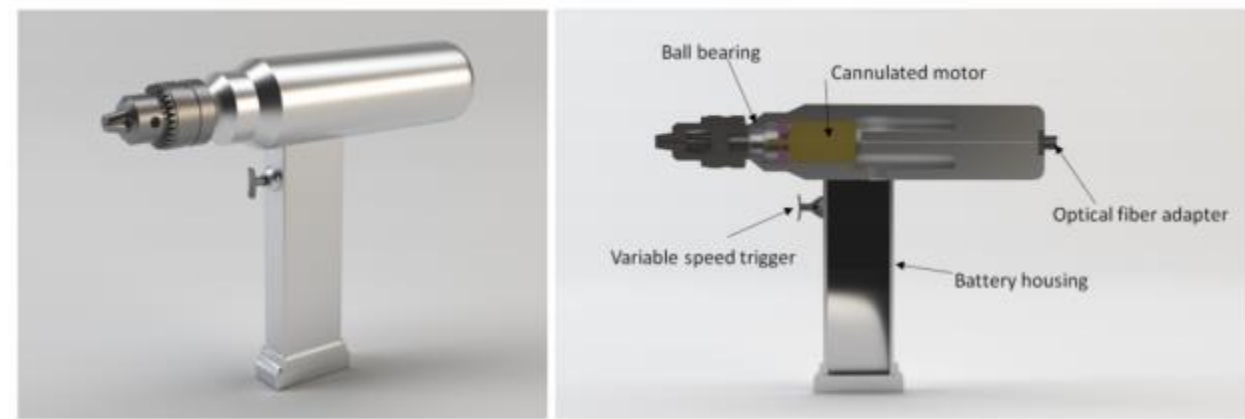
# Introduction

- 150,000 spinal fusions performed each year
- Patients and orthopedic surgeons exposed to radiation during procedure
- How can this be solved?



# Goals

- Proof of Concept
- Drill Tracking
- Image Processing



# Overall Technical Approach

## Experiments

- Show drill tips inside water and obtain matched US and PA images to get a baseline
- Use a phantom with blood filled tubes, take images with and without bone

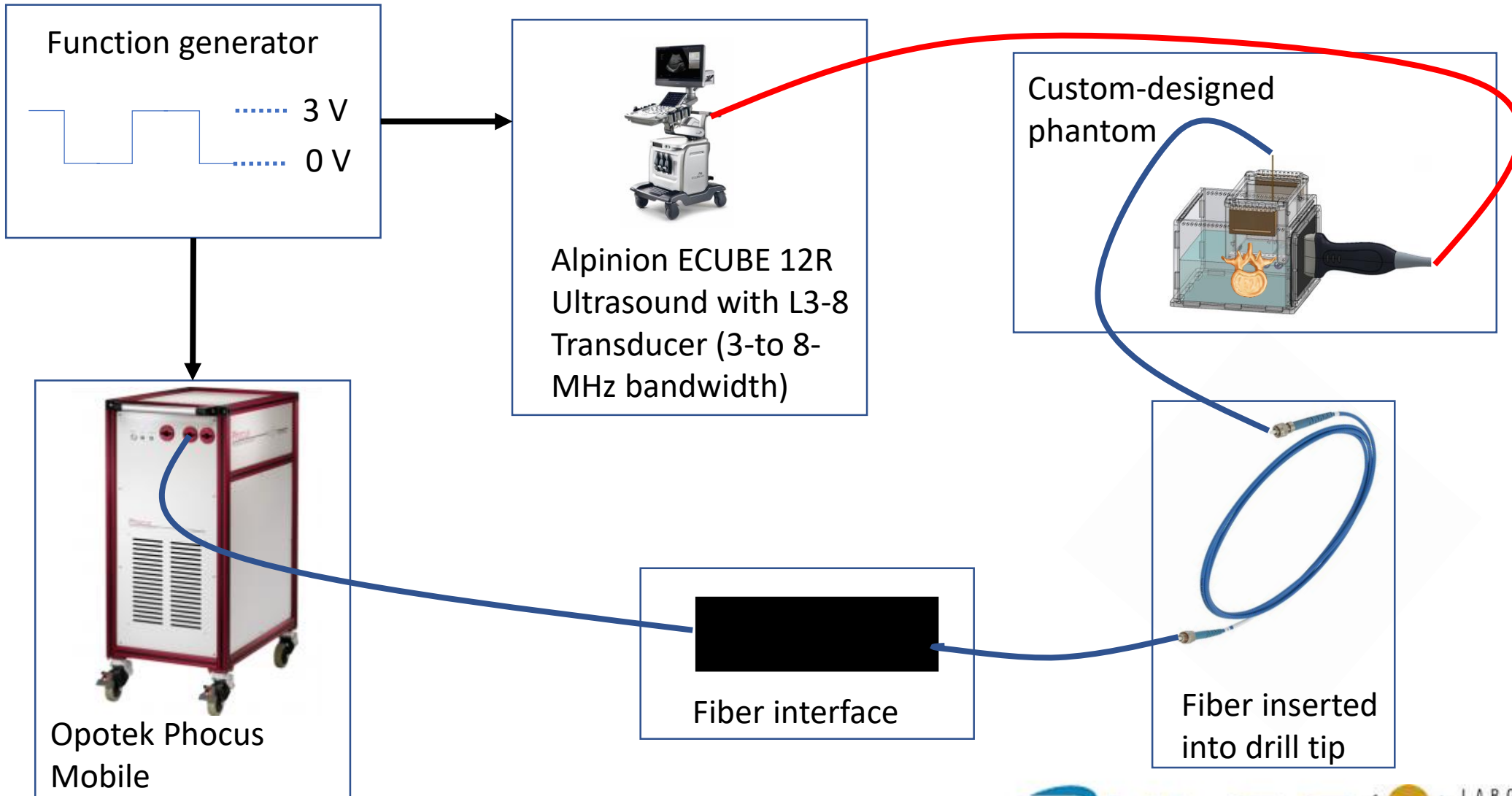
## Tracking

- Make movie of PA images of drill bit tip moving inside vertebra
- Extract PA position data
- Overlay coordinates on CT image

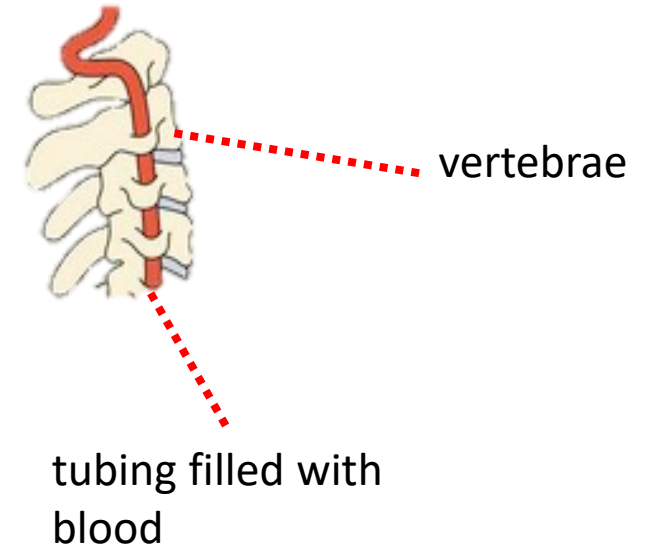
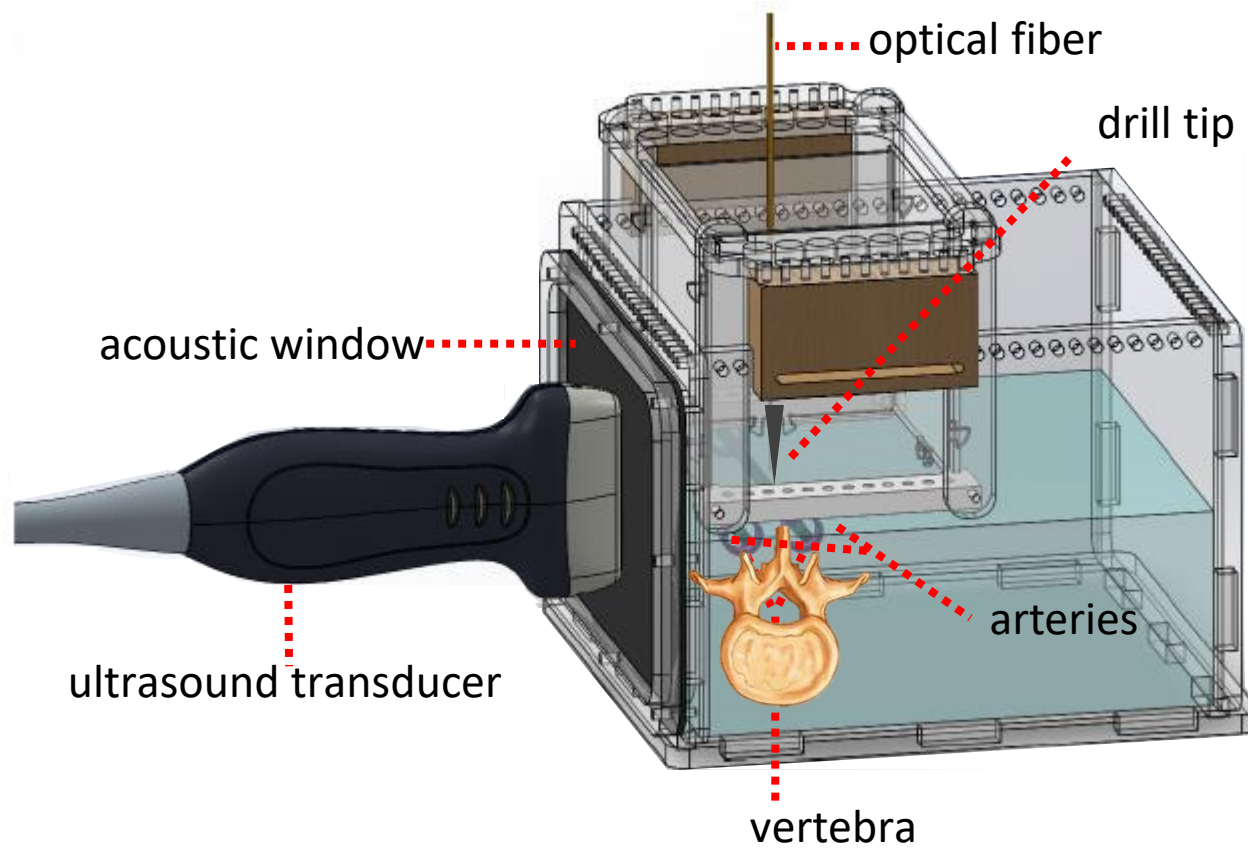
## Image Processing

- Apply SLSC imaging to enhance PA image display of signals inside the spine
- Explore enhancement of different signal types

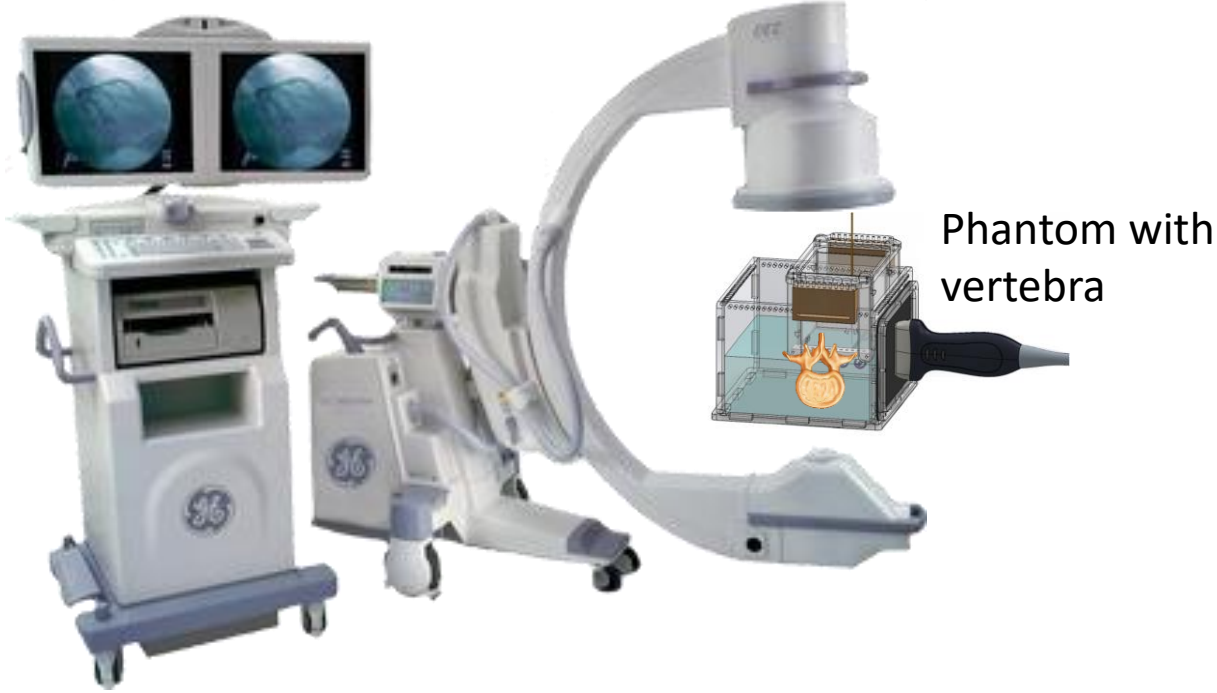
# Technical Approach: Experiments



# Technical Approach: Experiments



# Technical Approach: Tracking



C-arm

# Technical Approach: Image Processing

- Apply SLSC imaging to enhance photoacoustic image display of signals inside the spine
- Explore the enhancement of three signal types:
  - signal from drill tip
  - signal from blood
  - signal from bone



# Deliverables

- Minimum
  - See blood in PA image with fiber inserted into multiple drill tips.
- Expected
  - Tracking the drill tip as it is inserted into the spine (phantom).
- Maximum
  - Novel image processing methods to enhance PA images.

# Dependencies: Experiments

| Dependency                     | Solution                         | Progress    |
|--------------------------------|----------------------------------|-------------|
| Drill Prototype                | Search Lab, Drill existing piece | Solved      |
| Blood                          | IRB protocol                     | Ongoing     |
| IRB Protocol                   | Talk to Dr. Bell                 | Solved      |
| Lab Access                     | Talk to Dr. Bell                 | Ongoing     |
| Experiment holder for vertebra | Design/build one                 | Not started |

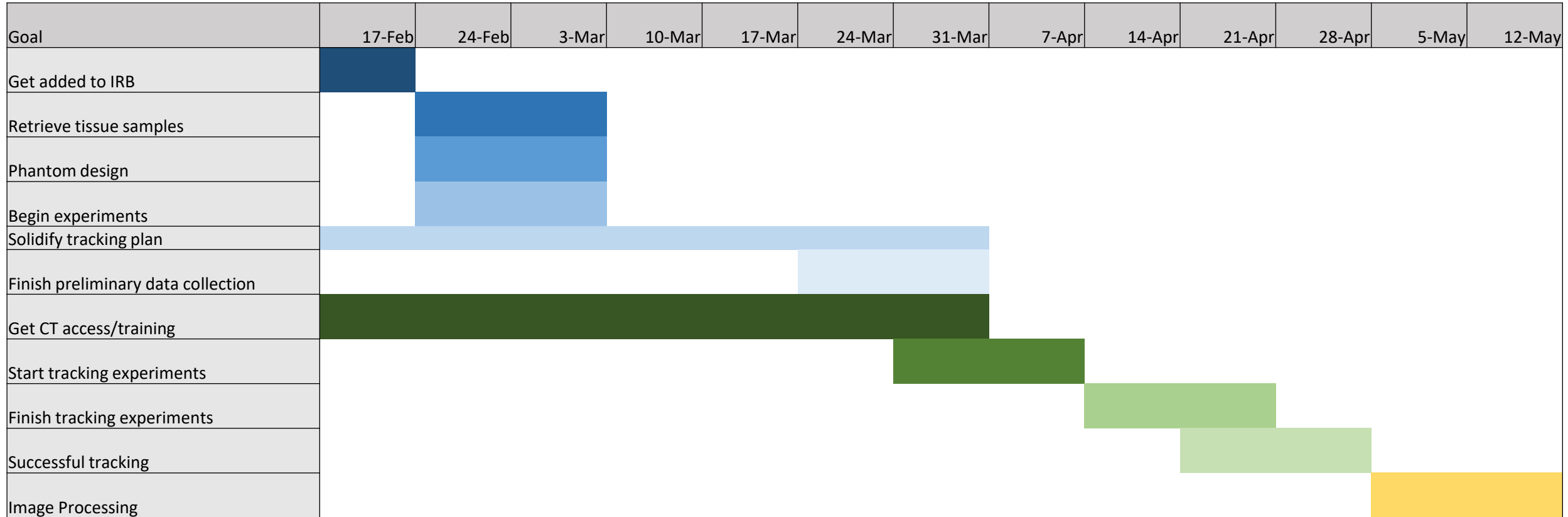
# Dependencies: Tracking

| Dependency                       | Solution                         | Progress    |
|----------------------------------|----------------------------------|-------------|
| Phantom with pre-drilled hole(s) | Design/build                     | Not started |
| CT Access/ training              | Talk to Dr. Bell, grad students  | Not started |
| CT Registration Algorithm        | Use Eduardo's, or other existing | Not started |

# Dependencies: Image Processing

| Dependency                | Solution              | Progress    |
|---------------------------|-----------------------|-------------|
| Knowledge of SLSC Imaging | Read papers, Dr. Bell | Not started |
| PA image data             | Experiments           | Not started |

# Project Schedule



# Key Dates

1. Feb 24: Phantom Design finished
2. March 3: begin experiments
3. March 31: finish preliminary data collection
4. April 7: begin tracking experiments
5. April 28: tracking achieved
6. May 12: finish ALL experiments and image processing
7. May 16: project presentation

# Management Plan

- Weekly meeting with Dr. Bell Friday's at 1:30 pm
- Lab Monday and Friday evenings
- Track progress in Excel

# Reading List

- Shubert J, Bell MAL, A novel drill design for photoacoustic guided surgeries 2018
- Reiter, A. and Bell, M. A. L., “A machine learning approach to identifying point source locations in photoacoustic data,” in [Photons Plus Ultrasound: Imaging and Sensing 2017], 10064, 100643J, International Society for Optics and Photonics (2017).
- Allman, D., Reiter, A., and Bell, M. A. L., “A machine learning method to identify and remove reflection artifacts in photoacoustic channel data,” in [Ultrasonics Symposium (IUS), 2017 IEEE International], 1–4, IEEE (2017).
- Shubert, J. and Bell, M. A. L., “Photoacoustic based visual servoing of needle tips to improve biopsy on obese patients,” in [2017 IEEE International Ultrasonics Symposium (IUS) ], IEEE (2017)



# Image References

- Written by Tony Schnuerer, PA; Reviewed by Stewart G. Eidelson, MD. (n.d.). Lumbar Spine Surgery. Retrieved February 12, 2018, from <https://www.spineuniverse.com/conditions/back-pain/low-back-pain/lumbar-spine-surgery-will-you-need-surgery-your-lower-back-pain>
- Themes, U. (2016, September 04). The cervical spine. Retrieved February 12, 2018, from <https://musculoskeletalkey.com/the-cervical-spine-4/>