



**Carleton**  
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# **Electrical Impedance Tomography for Perfusion Imaging and Monitoring**

**Thesis Defence Presentation**

Symon Stowe

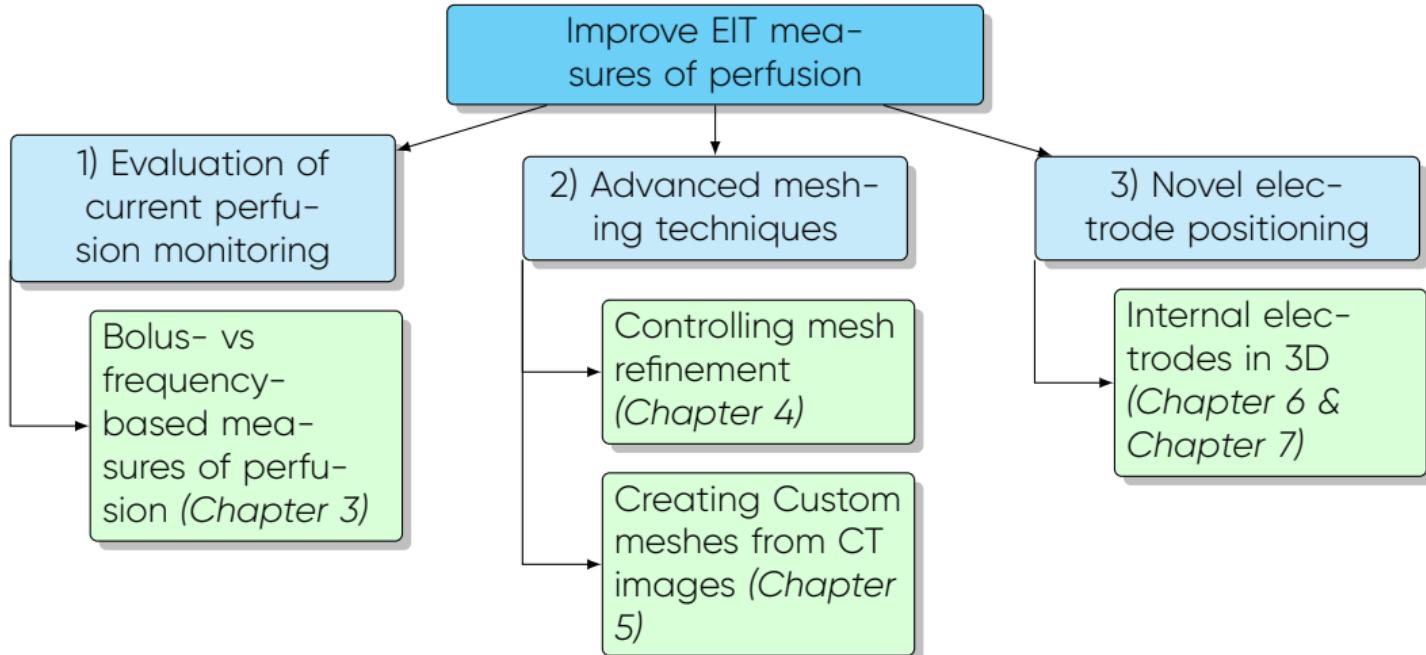
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# Overview

- ① Thesis Goals
- ② Contributions
- ③ Background
- ④ Methods and Results
- ⑤ Conclusions
- ⑥ Future Work

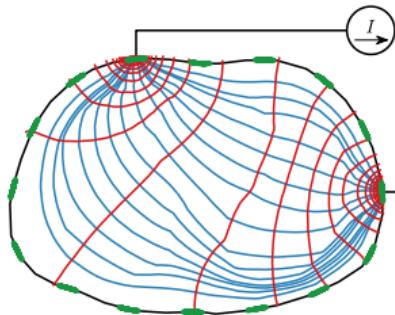
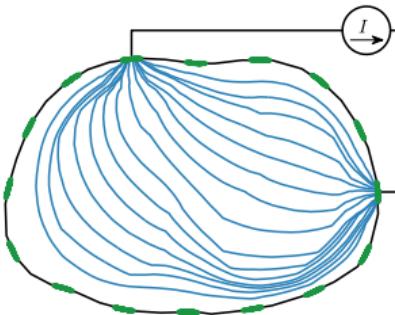
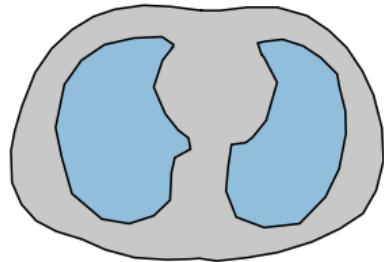
# Thesis Goals



# Contributions

- ① A mesh analysis technique to reduce error in sensitivity calculations on cylindrical meshes ([Chapter 4](#)).
- ② A tool to generate custom meshes of exterior and lung boundaries from CT images ([Chapter 5](#)).
- ③ An analysis of 3D electrode placements with internal electrodes on internal sensitivity ([Chapter 6](#)).
- ④ A method to reconstruct images using internal electrode measurements in the presence of movement ([Chapter 7](#)).

## Background: EIT



Electrodes on the body surface are used to inject current and measure the resulting voltages.

Thoracic EIT typically images impedance changes due to the movement of fluid in the chest.

# Background: Perfusion

What is perfusion?

## Background: EIT Measures of Perfusion

How is perfusion measured? Why EIT? Why does it need to be improved?

## Chapter 3: Introduction

There are **three common techniques** to measure perfusion with EIT.

- ① Ensemble averaging
- ② Frequency filtering
- ③ Bolus injection

# ARDS - Acute Respiratory Distress Syndrome

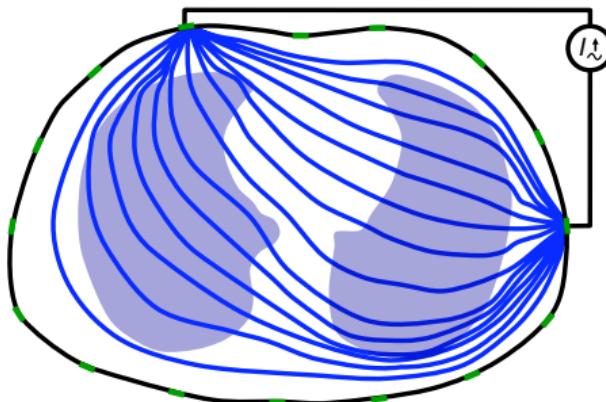
- Widespread inflammation in the lungs
- Reduces the lungs' ability to exchange oxygen and carbon dioxide
- Can be diagnosed with chest x-ray
- Treated with mechanical ventilation

# EIT - Electrical Impedance Tomography



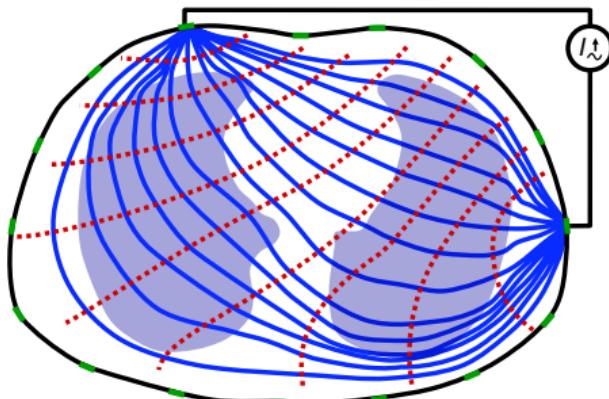
- used as a tool to monitor and guide mechanical ventilation
- non-invasive
- continuous
- low-cost
- safe

# EIT - A brief overview



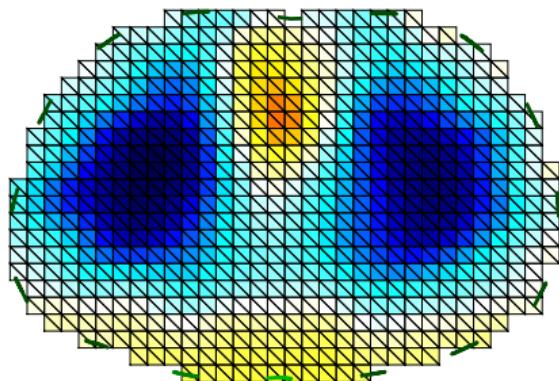
- current (blue) is injected between electrodes
- voltage is measured at the body surface
- voltages are reconstructed into images

# EIT - A brief overview



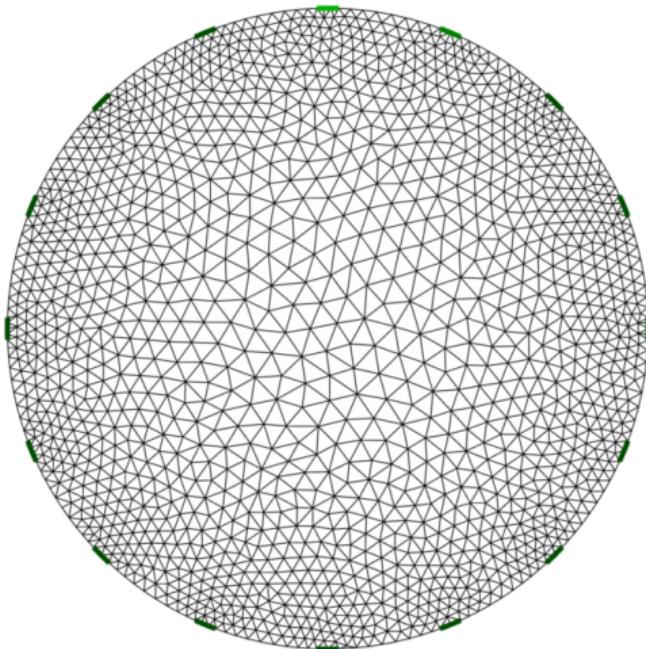
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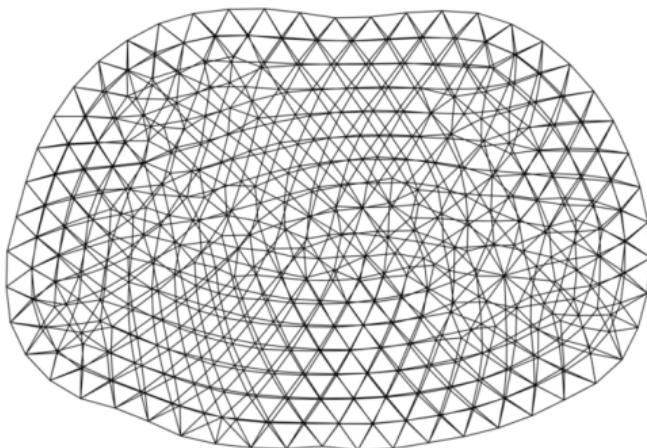
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# Finitie Element Models (FEMs) in EIT



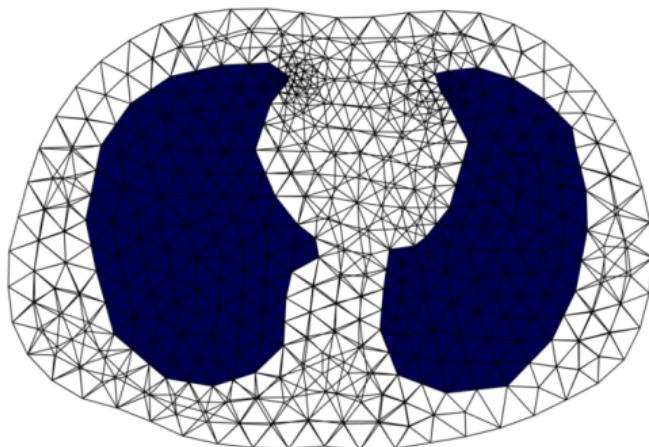
- finite element model is required to reconstruct voltages into images
- The more accurate the FEM the better the reconstruction
- More prior information regarding the body conductivity is better

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# Motivation

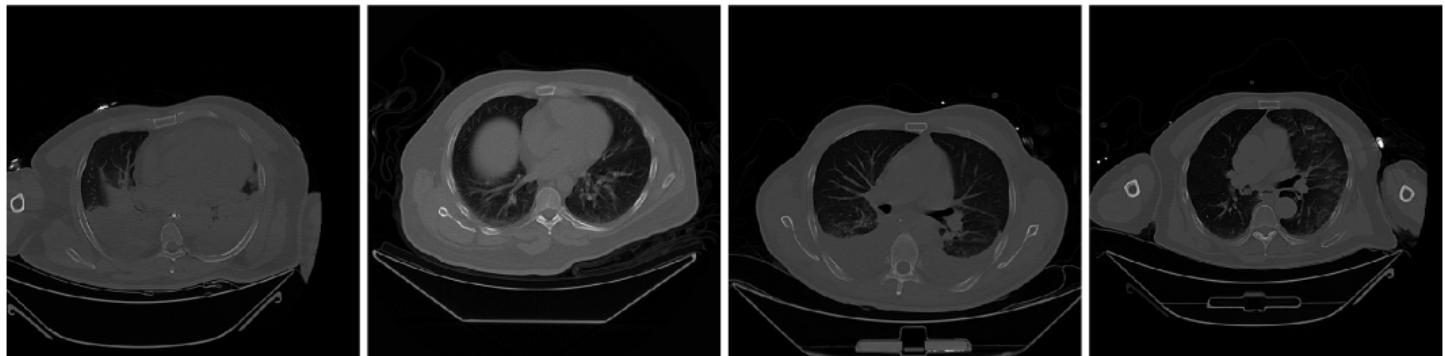
- Often a generic model is used for reconstructions
- True electrode locations and internal geometry is unknown
- With ARDS patients we have information from diagnostic CT images
- More prior information

Can we use this to improve EIT image reconstruction and monitoring of patients?

# Overview

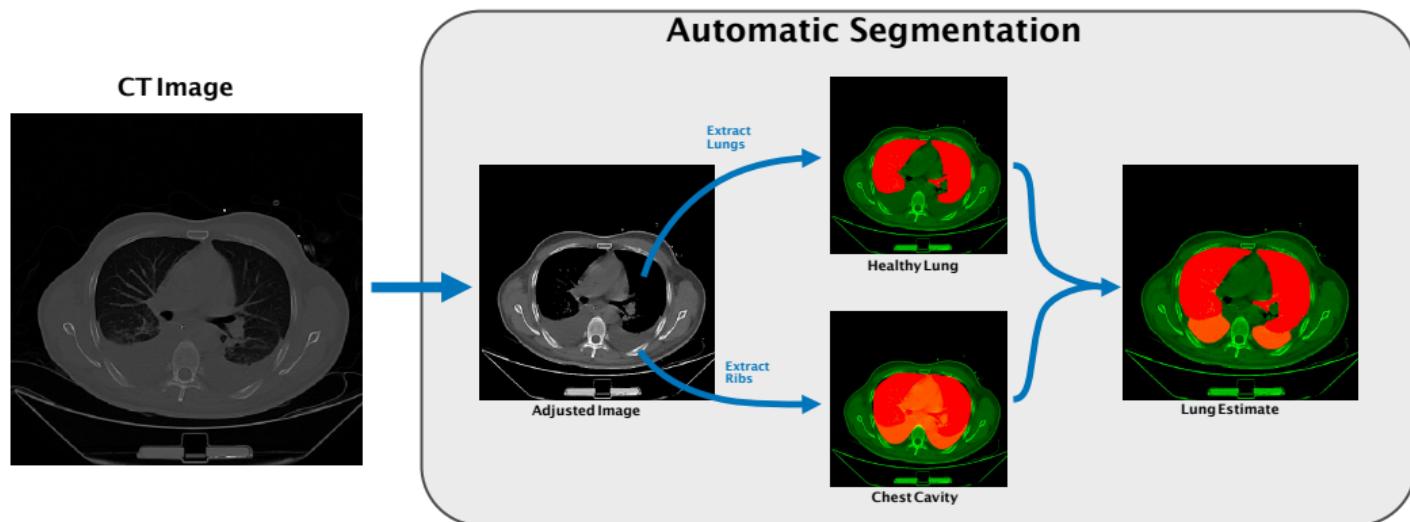
- ① Obtain CT images
- ② Automatically identify lung regions
- ③ Present in a GUI for correction by doctors or technicians
- ④ Generate a FEM based on the corrected segmentation
- ⑤ Reconstruct EIT data

# CT images

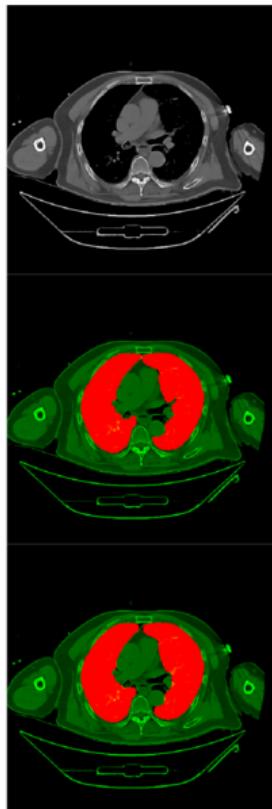
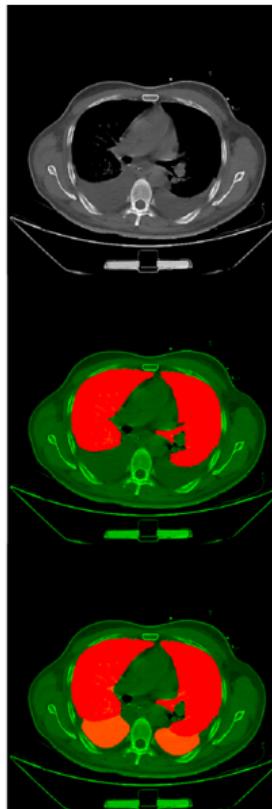
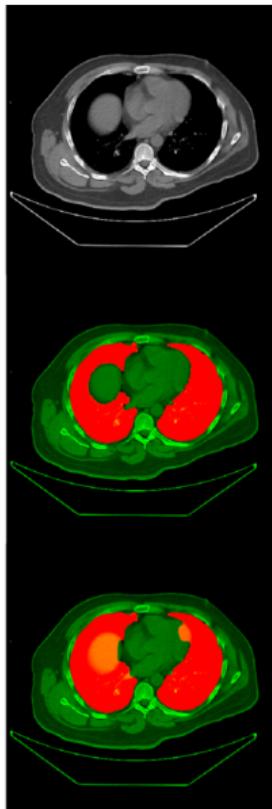
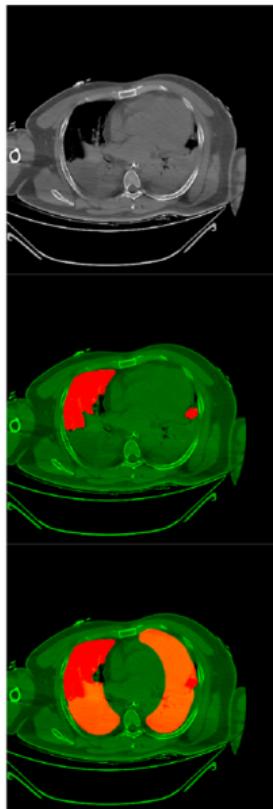


Example images taken from the 4th intercostal space for each subject

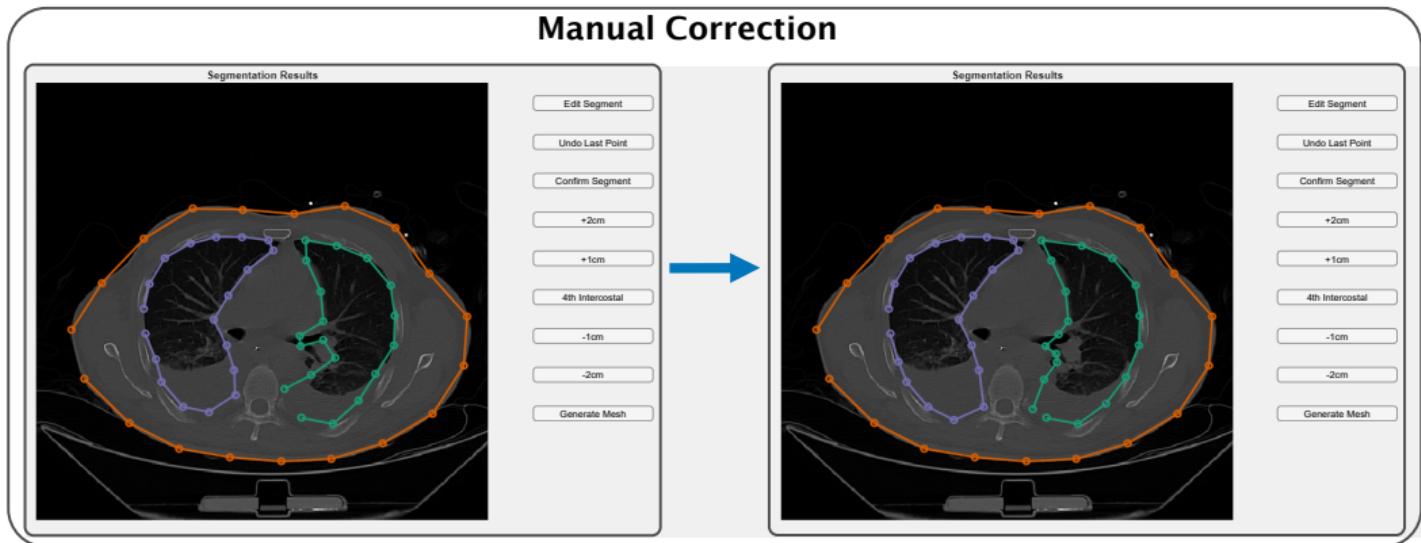
# Methods



# Segmentation Results

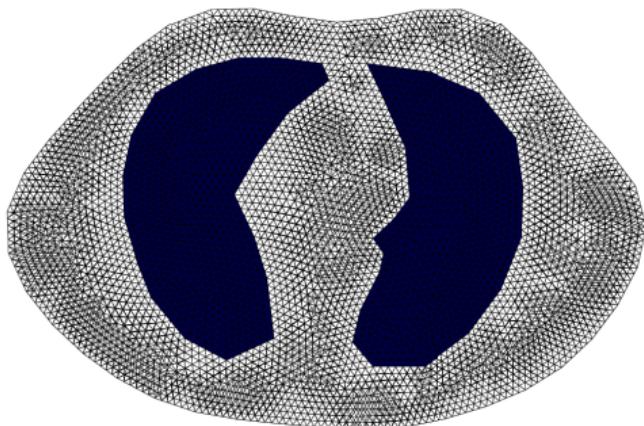
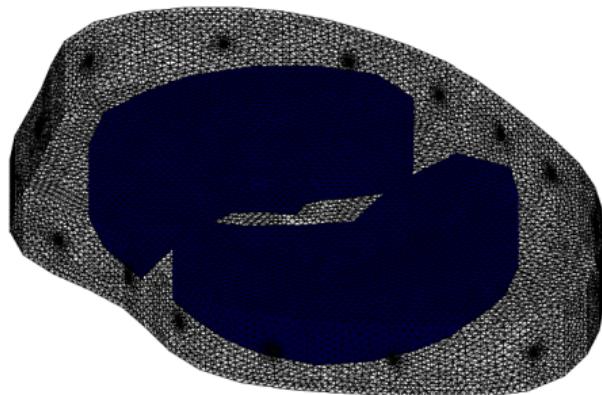


# Methods

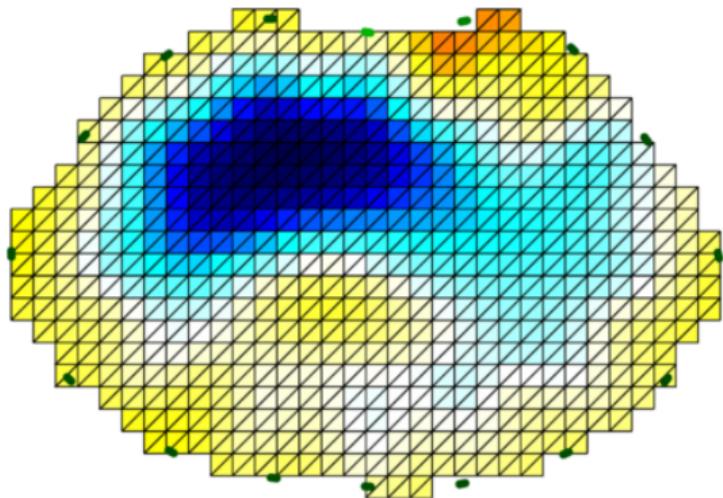
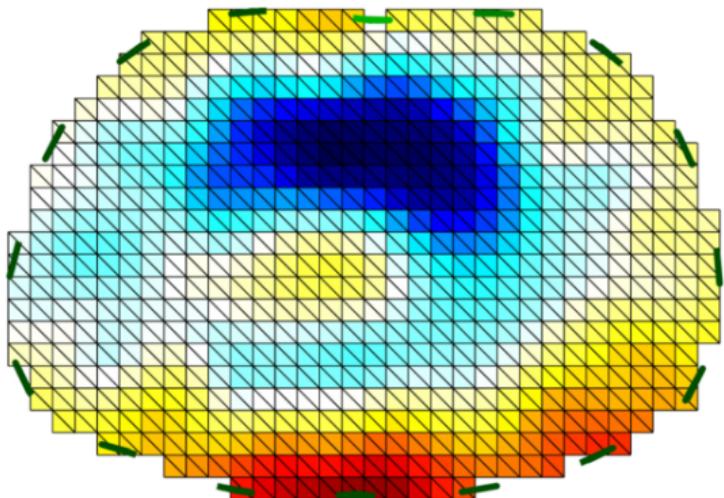


# Methods

## Mesh Generation



# Preliminary Results



An average breath imaged for two FEMs

# Current Work

## Improvement

- Apply the segmentation to larger numbers of patients
- Create a more user friendly editing program to accelerate segmentation and meshing
- Create a database of meshes that can be applied to additional subjects

Validate the use of custom meshes for ARDS monitoring

Do patient specific meshes:

- improve on generic meshes for ARDS monitoring?
- give increased accuracy in measures of lung collapse and fluid movement?
- Improve detection of collapse and overdistention



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