Tawfik Hussein

Boice/Reid Award
Ph.D. Student, Biomedical Engineering
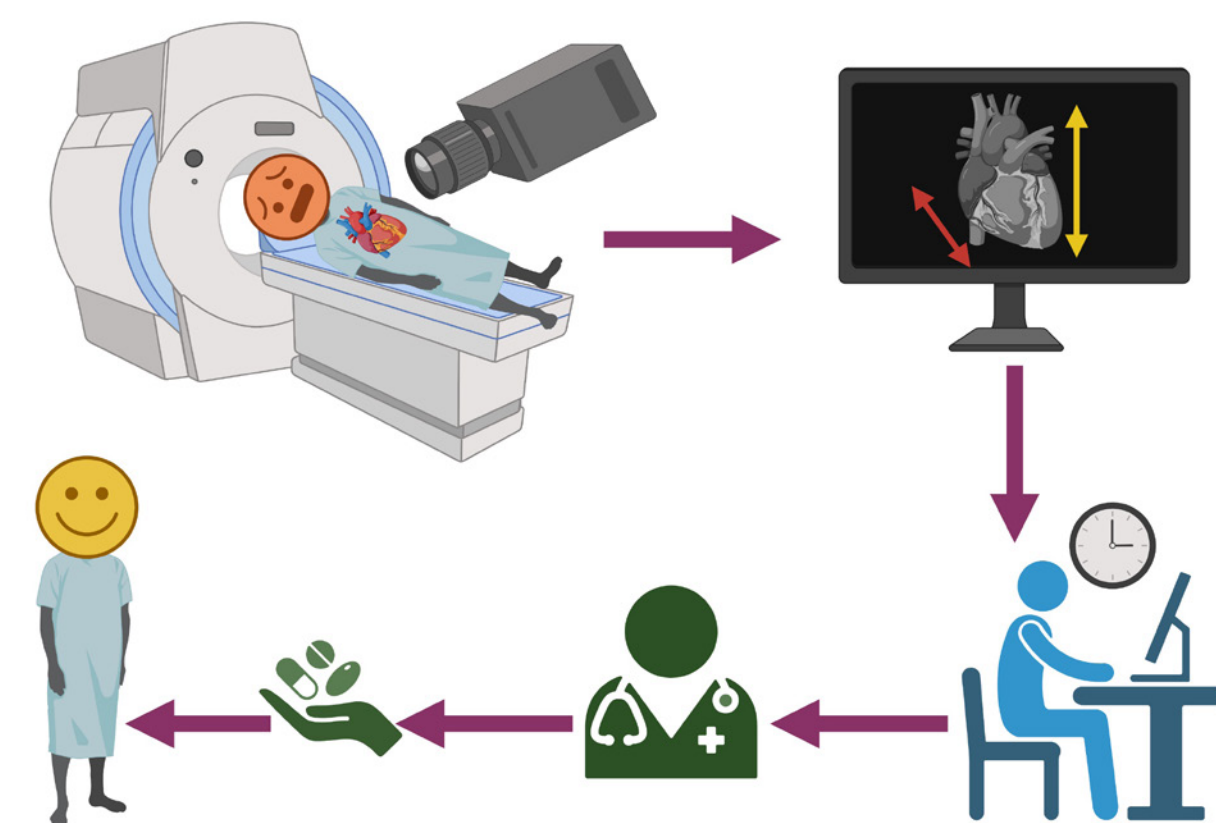*Third Year ARCS Scholar*

Georgia Tech

A Multiscale Computational Model of the Heart for Patient-specific Diagnosis of Heart Failure with Preserved Ejection Fraction (HFpEF)

A new way to measure myocardial stiffness non-invasively in HFpEF patients to reveal new insights into how HFpEF changes the heart and predict its outcomes.
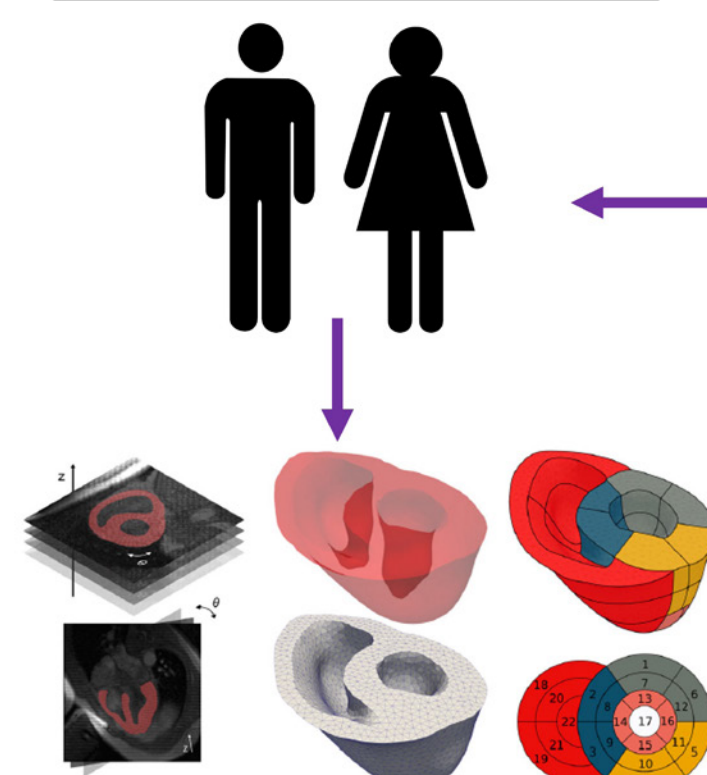
What is the clinical problem?

Normal — Problem →
1 The walls become stiff and thick
2 It's hard to relax and fill with blood
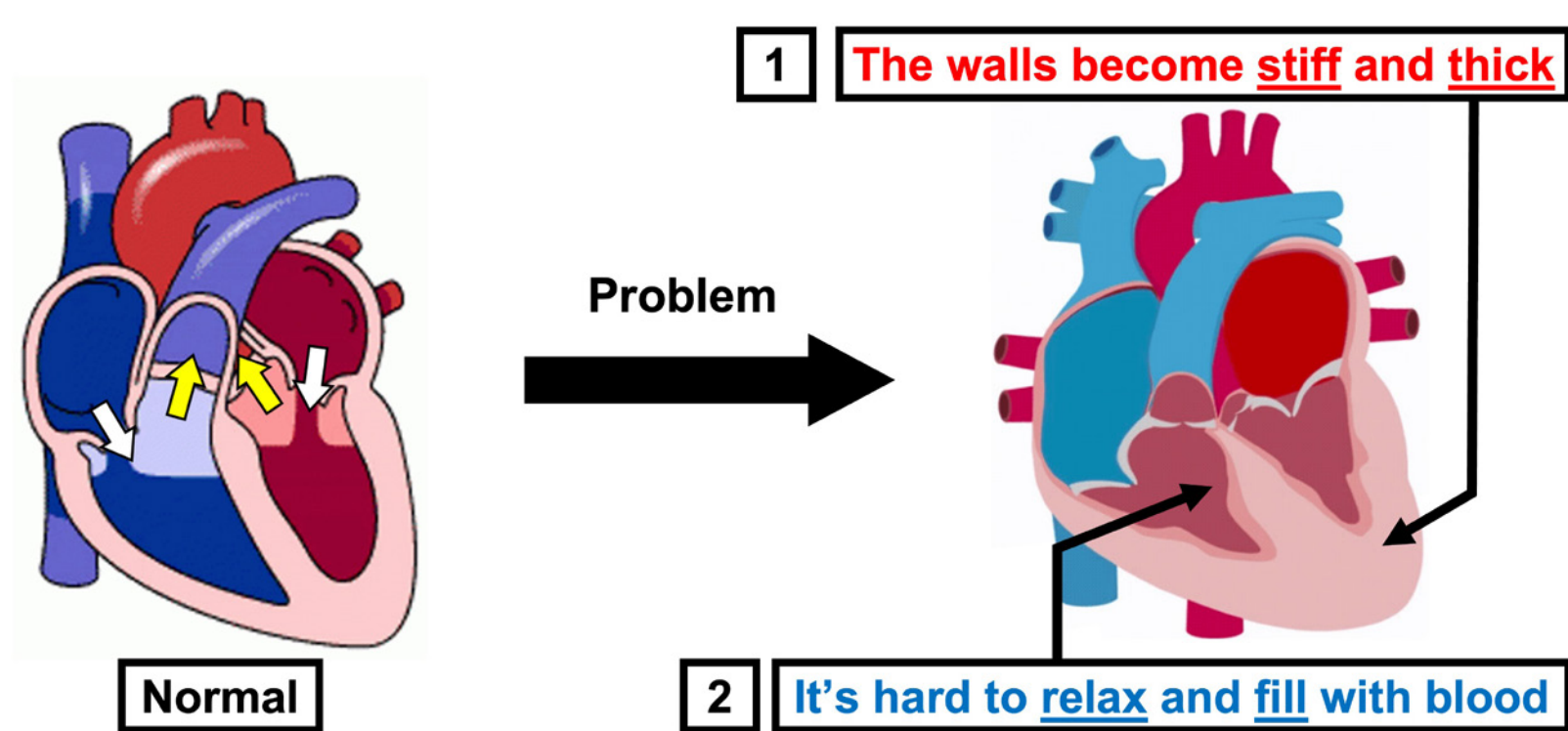
What is the big picture and ultimate goal?

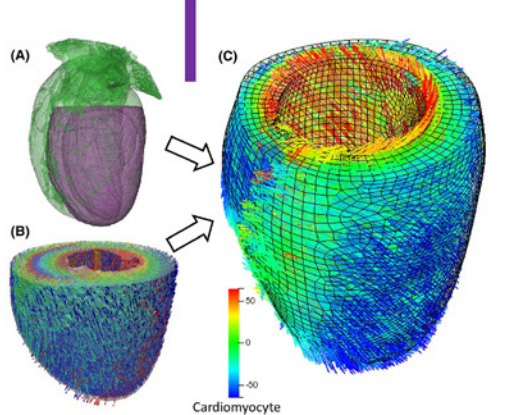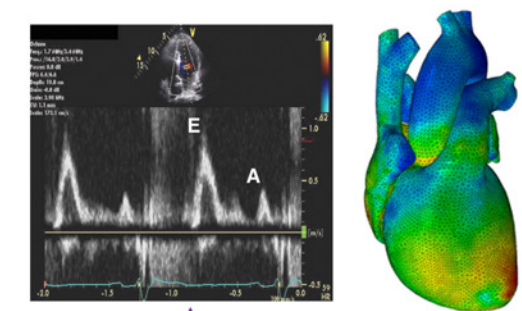### Recruit HFpEF Patients

Aim 1: 3D Motion
Aim 2: Compute 3D Stiffness
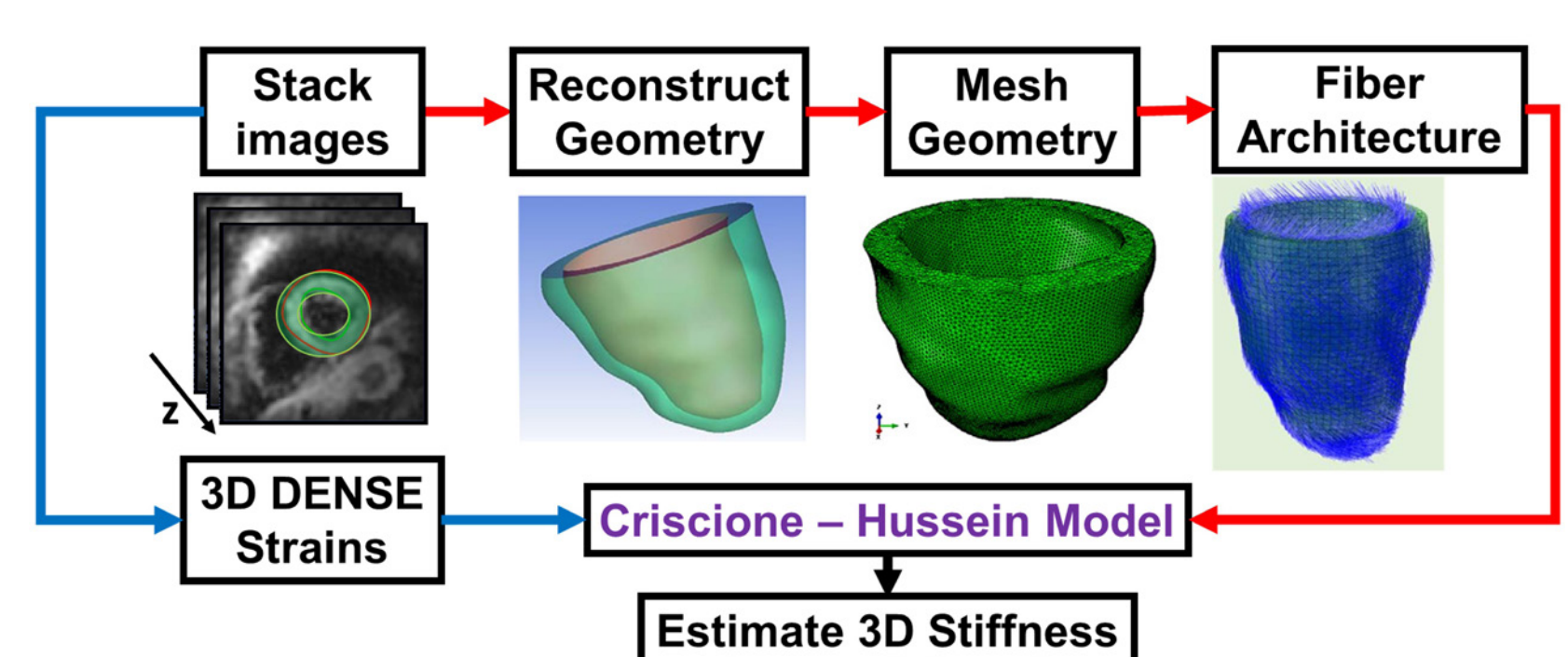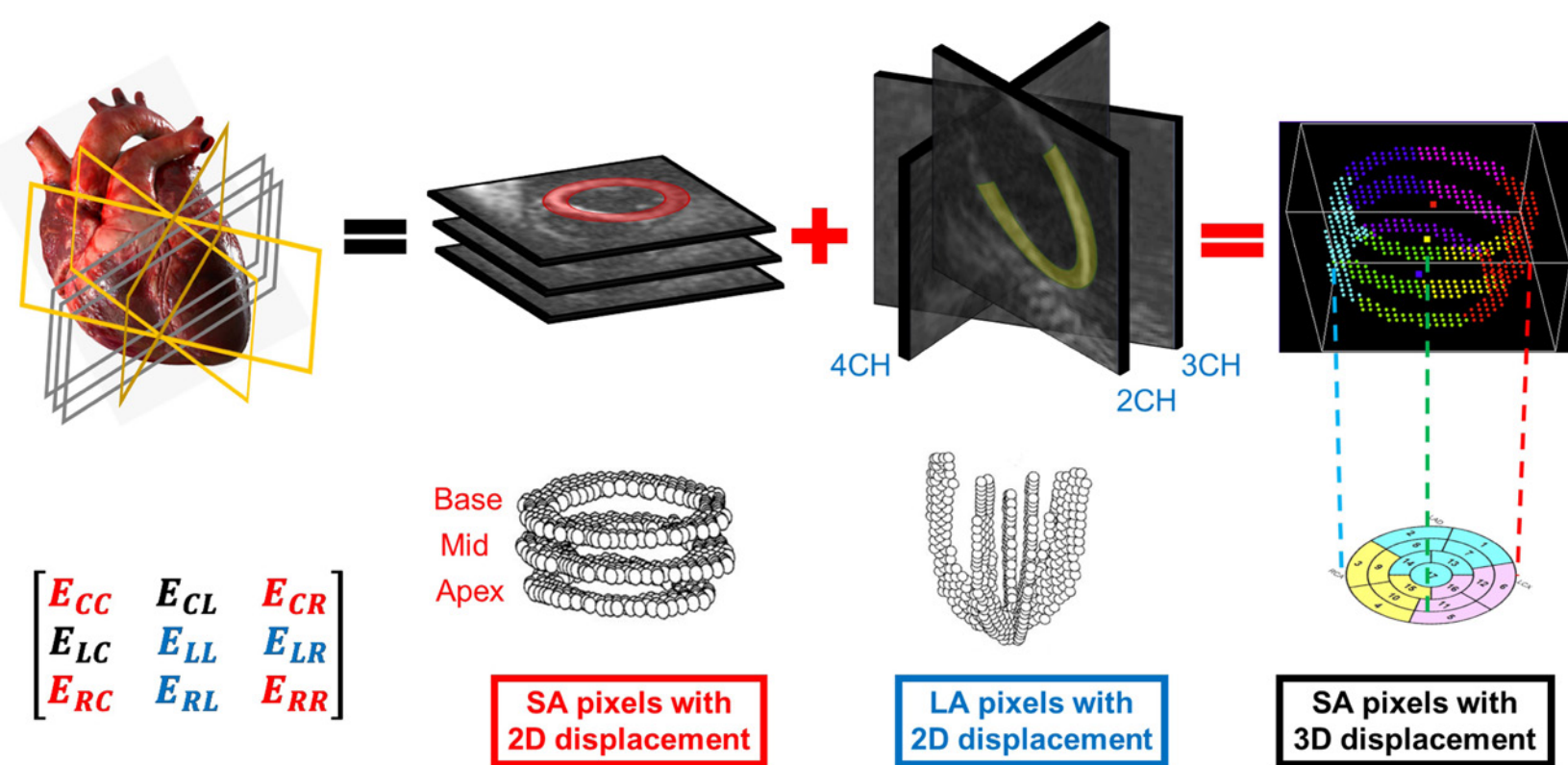Aim 3: Compare with Echo

How does the 2D motion of the heart look like?

Short-axis View — LV, RV — Magnitude — Phase — Displacement — Strains E_{CC} E_{RR}

Long-axis View — LV — Magnitude — Phase — Displacement — Strains E_{LL} E_{RR}
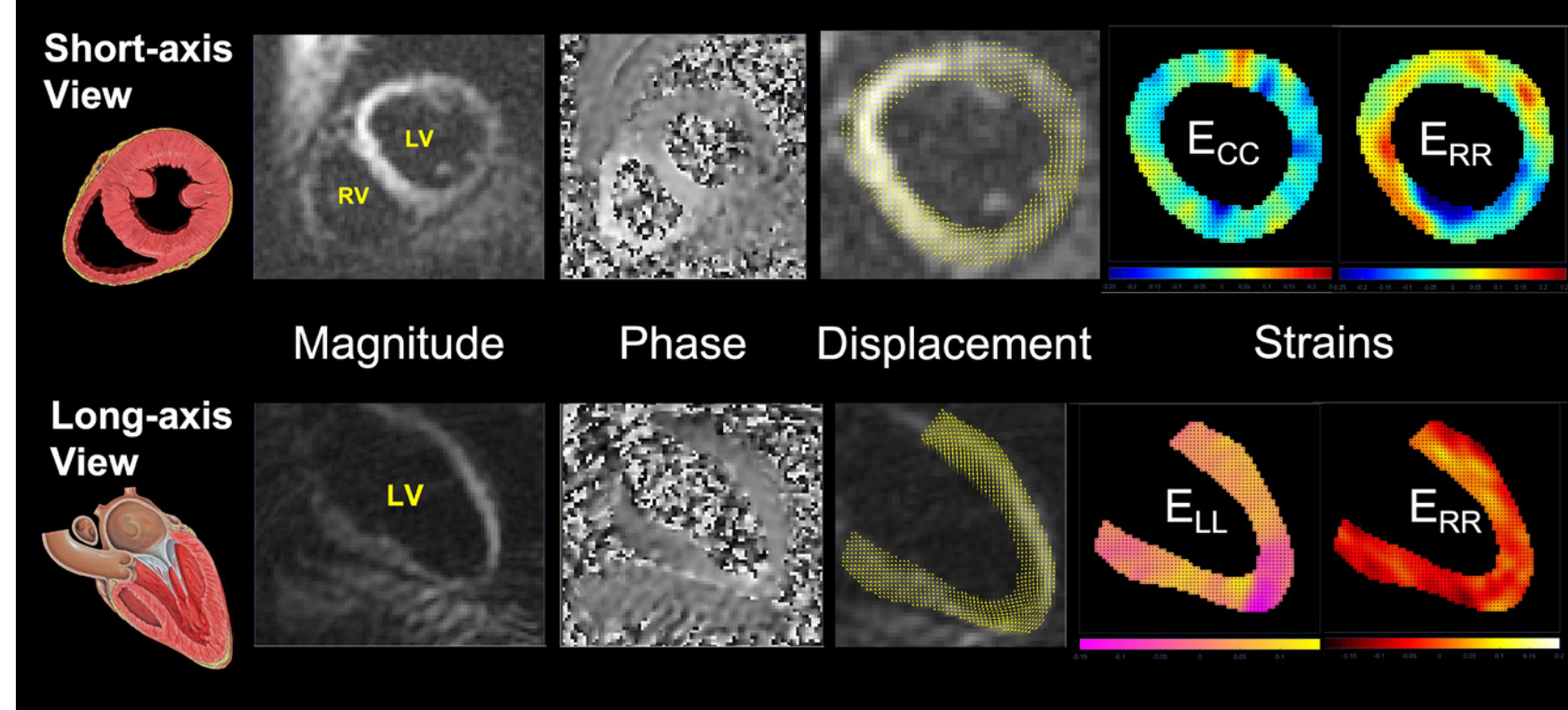
How do we get 3D motion from 2D images?

$$\begin{bmatrix} E_{CC} & E_{CL} & E_{CR} \\ E_{LC} & E_{LL} & E_{LR} \\ E_{RC} & E_{RL} & E_{RR} \end{bmatrix}$$

Base / Mid / Apex

SA pixels with 2D displacement
LA pixels with 2D displacement
SA pixels with 3D displacement

4CH / 3CH / 2CH

How do we get the heart's stiffness?

Stack images → Reconstruct Geometry → Mesh Geometry → Fiber Architecture

3D DENSE Strains → Criscione – Hussein Model

Estimate 3D Stiffness

Scholar Awards Celebration
November 13, 2024

ARCS
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