

ABET Addendum: Fetal Cardiac MRI Phantom for Fetal Motion

1. Desired Needs

- A controlled phantom to simulate real fetal motion to validate motion correction (MoCo) algorithms.
- Engineer a phantom that mimics a T1/T2 relaxation of both the fetal torso and maternal womb

2. Constraints

- a. The phantom should be MRI compatible: all materials used must be non-ferromagnetic
- b. The risk of leakage (saltwater, melted PVA womb, gelatin) into MRI bore
- c. The utilization of low cost, reproducible materials allows low-income countries
- d. The accessibility of manufacturing techniques such as 3D printing program
- e. The phantom must produce MRI scans with minimum artifacts

3. Engineering Standards

- a. ASTM F2503 and ASTM F2052/F2213
- b. NEMA MS-1/MS-2 and Clinical fetal cardiac MRI imaging conventions
- c. ISO 10993 and Additive Manufacturing Best Practices (ASTM F42 guidance)
- d. MRI room operational safety protocols and Institutional MRI access and testing requirements (UCSD and Rady Children's Hospital)

4. Ethical, Environmental, or Societal Concerns

- a. Improper or inadequate validation may result in erroneous clinical confidence, postponing the detection of serious congenital heart disease (CHD)
- b. Plastic waste from 3D-printed components (PLA and TPU) necessitates proper recycling.
- c. High-field fetal MRI is expensive and internationally inaccessible

5. Active Teamwork and Leadership

- a. Varied perspectives integrated through weekly mentor meetings (MDs, PhDs) and conversations with physicians, MRI technicians, and research scientists to reconcile clinical requirements with engineering viability
- b. Each member led a specific subproject: I led Subproject #3: Motion System
- c. Gantt chart created for Winter-Spring quarter. Consistent design evaluations with mentors yielded essential critiques

6. Most Significant Motivating Factors

- a. The clinical necessity to enhance CHD diagnosis
- b. In the lack of sufficient budget, the group still managed to acquire necessary materials
- c. The team had an unwavering support for all the departments involved in the project

7. Innovative and/or Entrepreneurial Ideas

I was the sole person who designed on the motion system of the project which is the most important part of the project. I also played a significant role in creating the phantom: giving the right measurements, deciding which materials to use to mimic tissue, and purchasing the materials needed to create the phantom.