HIGH THROUGHPUT QUANTITATIVE EX VIVO MRI OF THE MOUSE BRAIN

UW BME Design

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Background and Motivation

- Dr. JP Yu's lab studies neurological disorders by taking MRI's of modified murine brains [2].
- Current loading and unloading method of single syringe insertion is inefficient and time consuming.
- Client wants a new standard streamlined method of loading.
- Current: 3 Rat, 6 Mice per scan. Costs $500 per scan.

Figure 1.1: Current methodology. Six mouse brains in syringes taped together, then sealed [1].

Figure 1.2: WIMR Small Animal MRI Machine

Design Specifications

Design must:

- Hold greater than 6 mice brains
- Maintain brains in consistent orientation during scanning despite constant vibrations, tilting should not exceed 3 degrees
- Have complimentary loading procedure
- Be able to fit within coil bore of 37.8 mm.
- No air bubbles in contact with the brain, no leaking
- Be reusable and reproducible
- Not damage brains
- Be MRI compatible: no metals or polar molecules[3]
- Contain watermark
- Brains must be suspended in fluorinert (an inert non-polar fluid)
- Brains must be removable

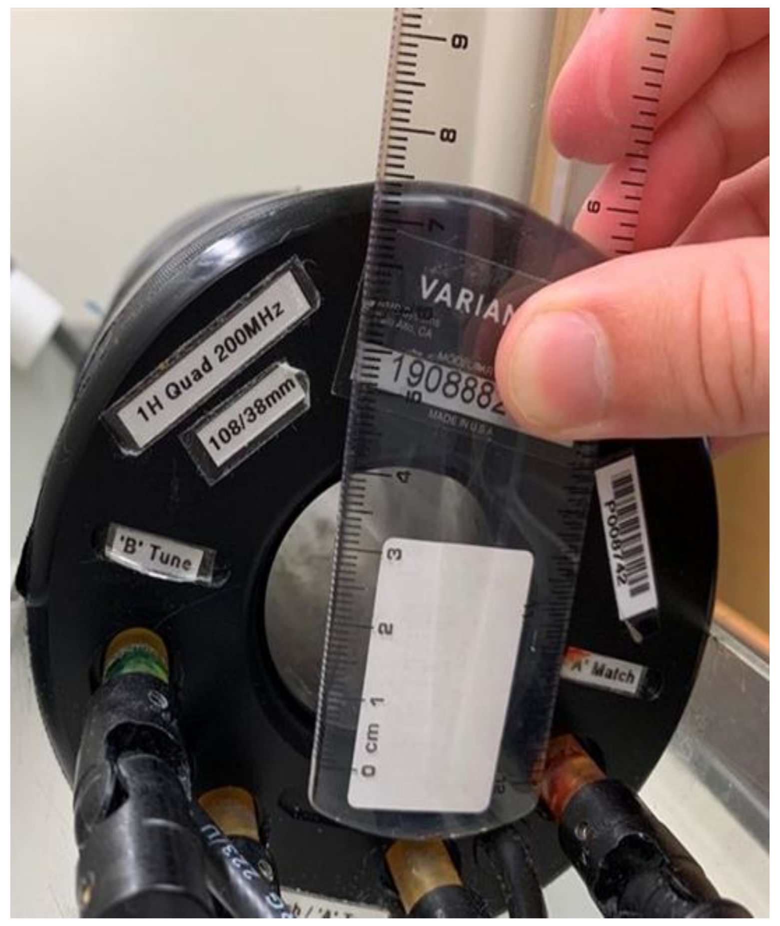
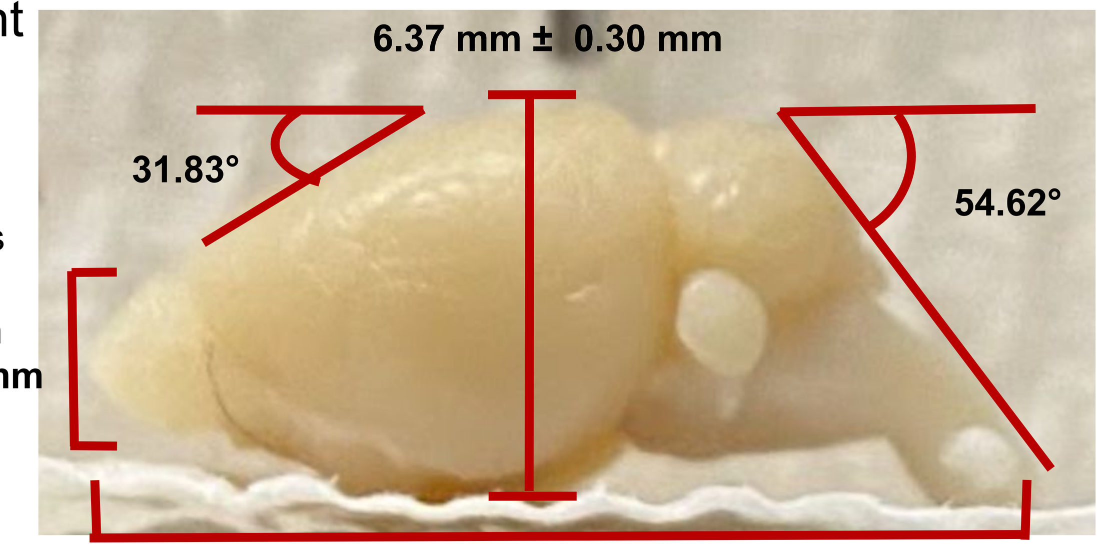


Figure 2.1: Coil inserted into MRI with 37.6mm diameter bore

Measurements

- Measurements of **20 mouse brains** were taken using a digital caliper
- Angles were evaluated using ImageJ
- Most significant are height and width dictating hole size.



4.39 mm ± 0.16 mm

14.97 mm ± 1.18 mm

Max width not shown on diagram: 9.04 mm ± 0.54 mm

Figure 3: Diagram of measurements taken for 20 mouse brains.

Design process

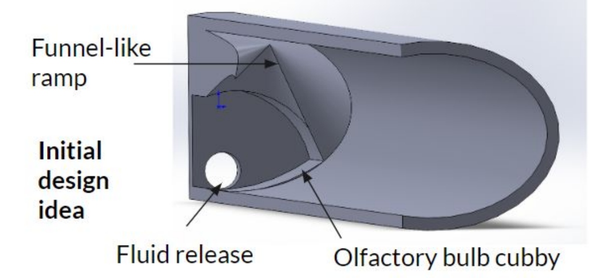


Figure 4.1: Initial design idea

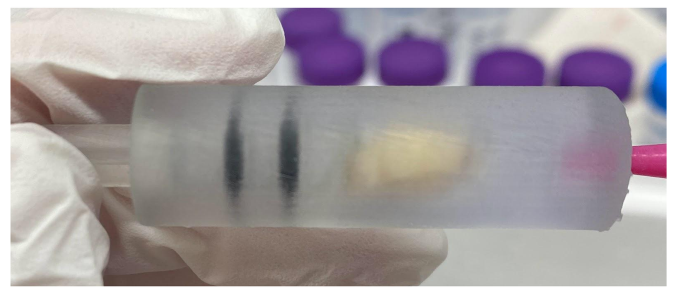


Figure 4.2: Orientation mechanism in double o-ring design, (used in final design)

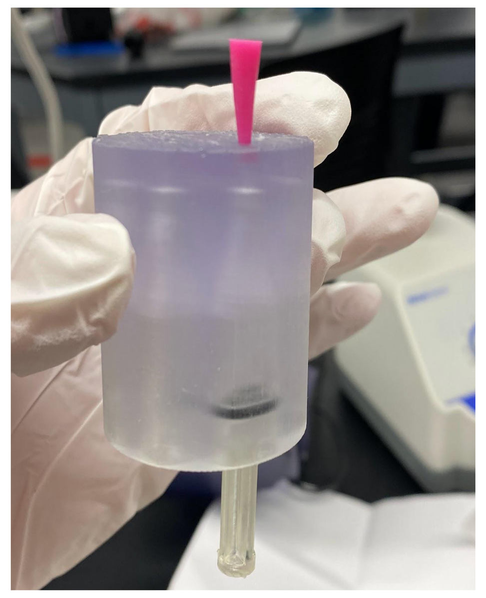
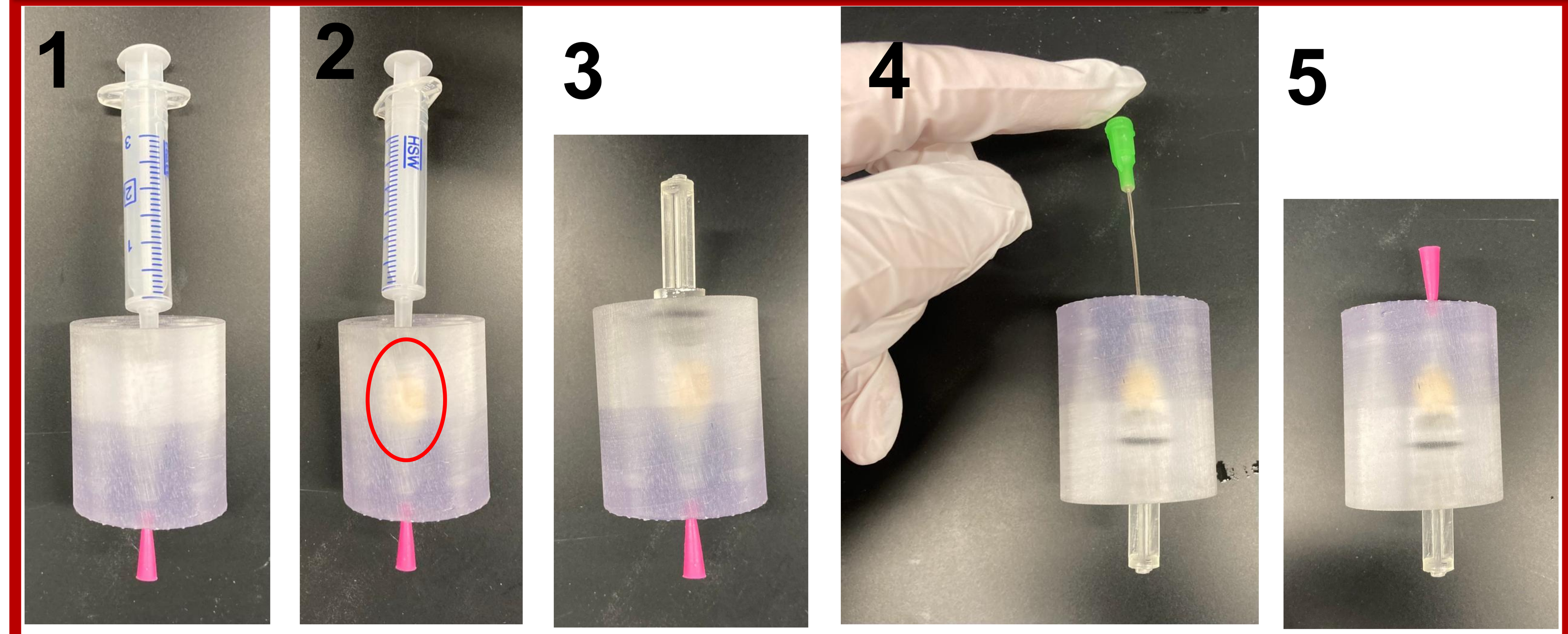


Figure 4.3: Final design loaded with flourinert. No leaking is observed.

Components:

- Rubber stopper
- Tapered end
- Wedged plunger
- Single o-ring
- Collecting groove
- 8 chambers

Loading Process



- 1
- Plug end
- Fill with some fluorinert
- 2
- Insert brain
- Fill completely with fluorinert
- 3
- Insert plunger enough to seal
- Invert capsule
- 4
- Remove plug
- Oreint brain as needed
- 5
- Push plunger securing brain against ramps
- Plug end
- Repeat 8 times

Testing Results

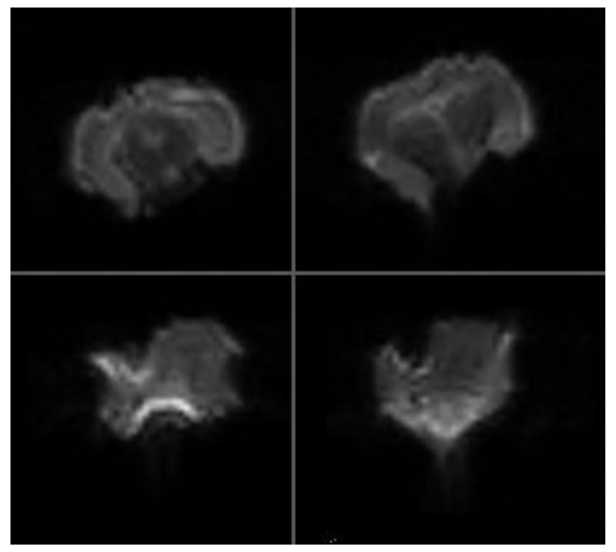


Figure 6.1: T2 for Prototype 1. Shows large artifacts and distortions on cross sections

Testing procedure:

1. Follow procedure to load capsule with brains and fluorinert.
2. Record observations of any leaking, air bubbles, orientation. Reload if needed
3. Perform Scout MRI scan (aerial views)
4. Perform T2 MRI scan (cross sections)
5. Analyze image results

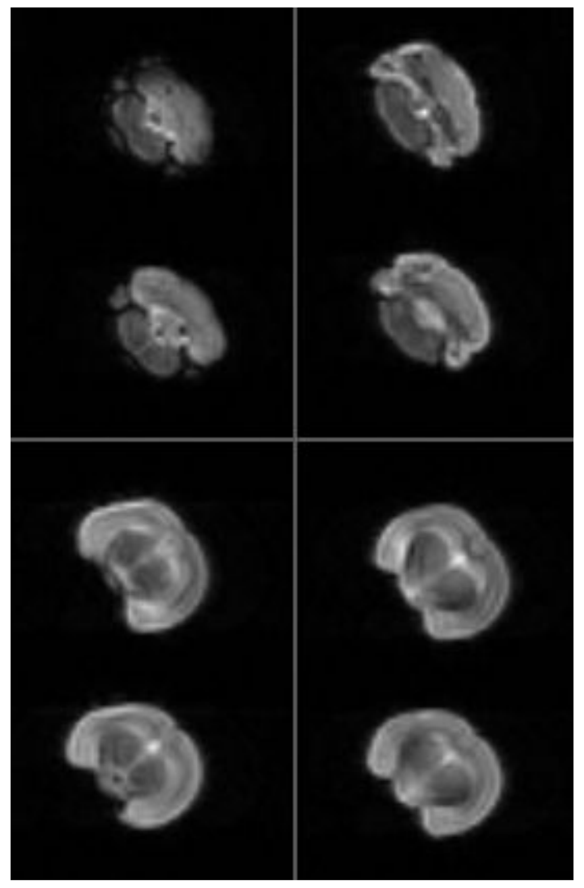


Figure 6.3: T2 for Prototype 2. Much clearer, brighter image, less artifacts

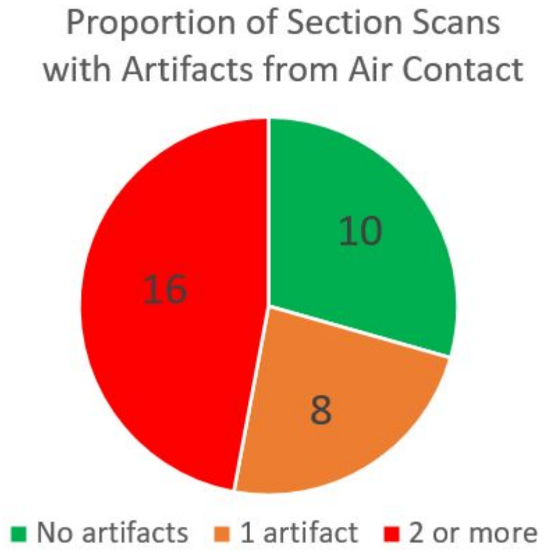


Figure 6.2: Bar graph of how many artifacts on cross sections. 29% of scans had no artifacts.

Results:

- Significant image obstruction from air bubbles
- Good aerial orientation
- Improved image for prototype 2

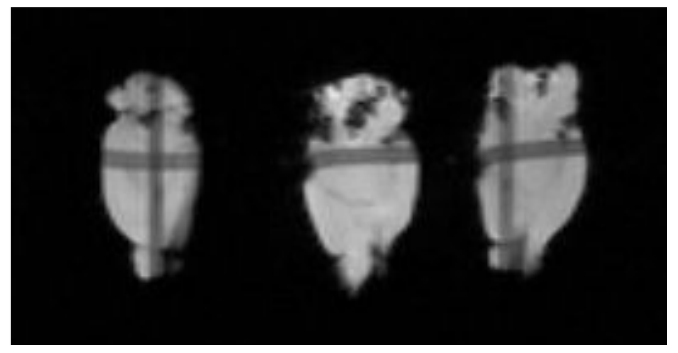


Figure 6.4: Scout scan for Prototype 2. Shows consistent orientation for aerial view.

Future Work

- Guarantee no air bubbles
- Continue to work on orientation
- Change design to further stabilize brain orientation.
- Create a method to catch excess fluid during loading.
- Create a more streamlined water-marker.
- Make a stopper that is more secure in the capsule.

Acknowledgements

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References

- [1] K. Kania, "Small Animal MR Facility - Services & Equipment," Mallinckrodt Institute of Radiology - Washington University School of Medicine in St. Louis. https://www.mir.wustl.edu/research/core-resources/small-animal-magnetic-resonance-facility/services-equipment/ (accessed Oct. 07, 2022).
- [2] J.P. Yu, "Profile," Department of Radiology. https://radiology.wisc.edu/profile/ (accessed Oct. 07, 2022).
- [3] T. Woods, "MRI Safety and Compatibility of Implants and Medical Devices," *ASTM International*, pp. 82–90, doi: 10.1520/STP11156S.