



3D PRINTED FLEXIBLE SPINAL MODEL

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OBJECTIVE

Drug injections in the lumbar area of the spine must be better understood to improve the future of medicine. To do so, a study on the cerebrospinal fluid flow via a 3D printed flexible spinal model was completed. This study will assist healthcare workers in understanding and developing safer drug delivery techniques for future procedures and applications.

BACKGROUND

Cerebrospinal Fluid (CSF)

- Generated in ventricles of the brain & flows throughout the spine
- Delivers essential nutrients
- Bypasses the blood brain barrier

Drug Delivery

- Delivery through CSF would lower drug dosage and toxicity
- Many diseases benefit

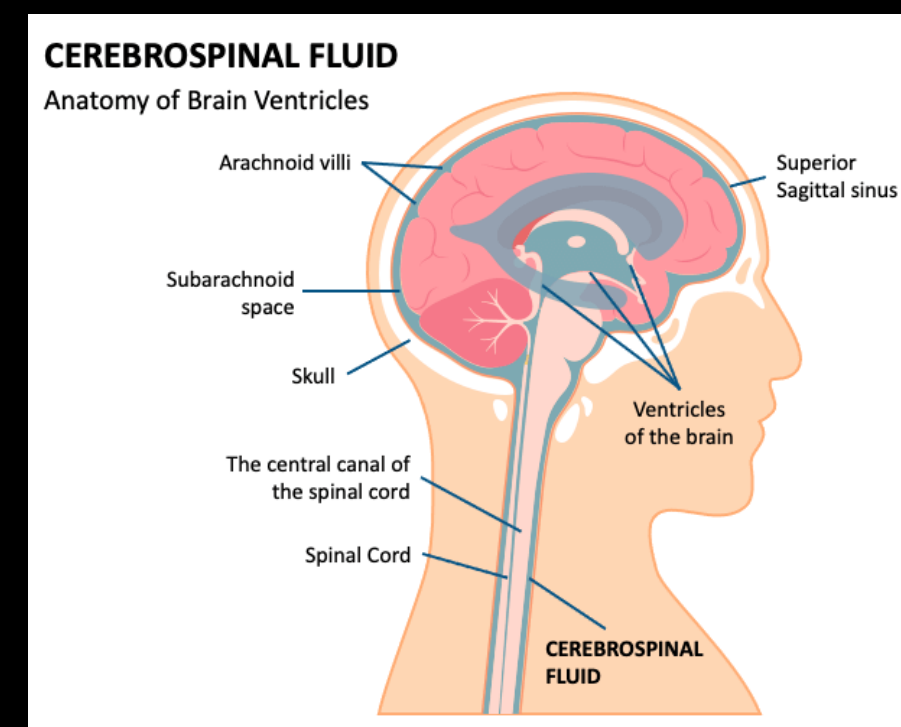


Fig 1: CSF production in brain

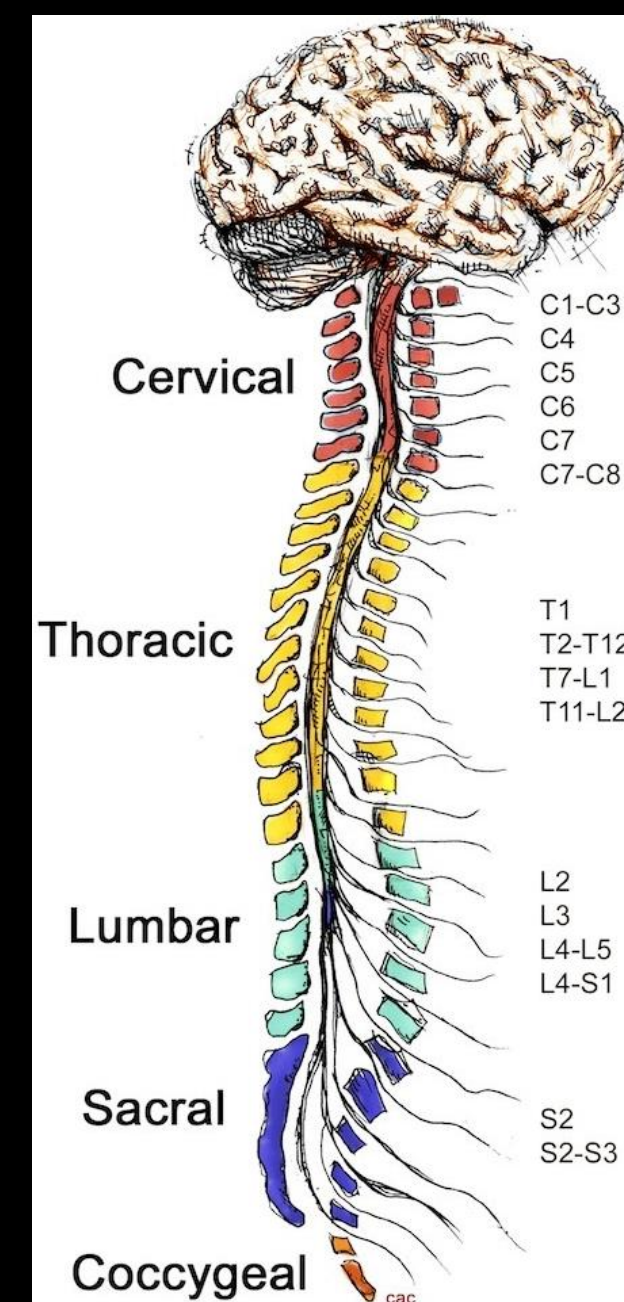


Fig 2: Spine structure

CONCEPT DEVELOPMENT



- 3D files, setup, and equipment inherited from Dr. Bryn Martin's lab
- MRI-derived design for prior rigid models was printed through Stratasys
- Goal to replace & test rigid model with flexible model similar to real human spine
- Flange was designed to connect to upper tubes in setup

REQUIREMENTS & VALIDATION

Adopted previous model configuration & protocol	Utilized previous 3D files & setup
Model flexibility and elasticity of human spine	50A resin with 1.59 MPa max stress
Transparent for imaging	Compared to previous models
Can withstand necessary pressures	Setup and experiments

FINAL DESIGN

Spinal Model

- Split the two 3D files from Dr. Bryn Martin's lab into 1/4 to fit in *FormLabs Form 3* 3D printer
- Added hexagon connectors to the split files to easily glue the pieces together



Fig 3: Printed 3D flexible pieces



Fig 4: UV cure of model

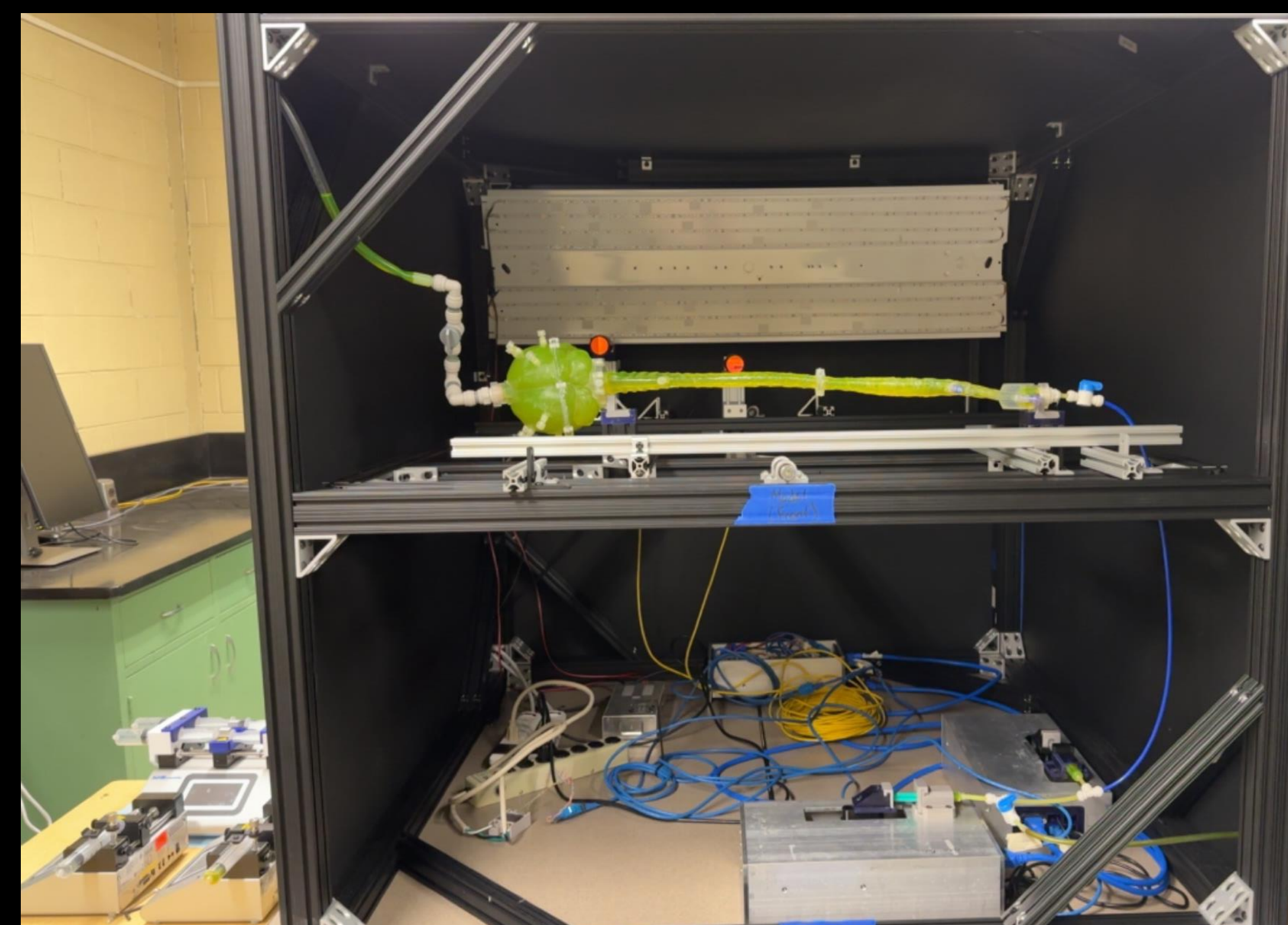


Fig 5: Experiment setup with rigid model connected

ACKNOWLEDGEMENTS

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EXPERIMENT RESULTS

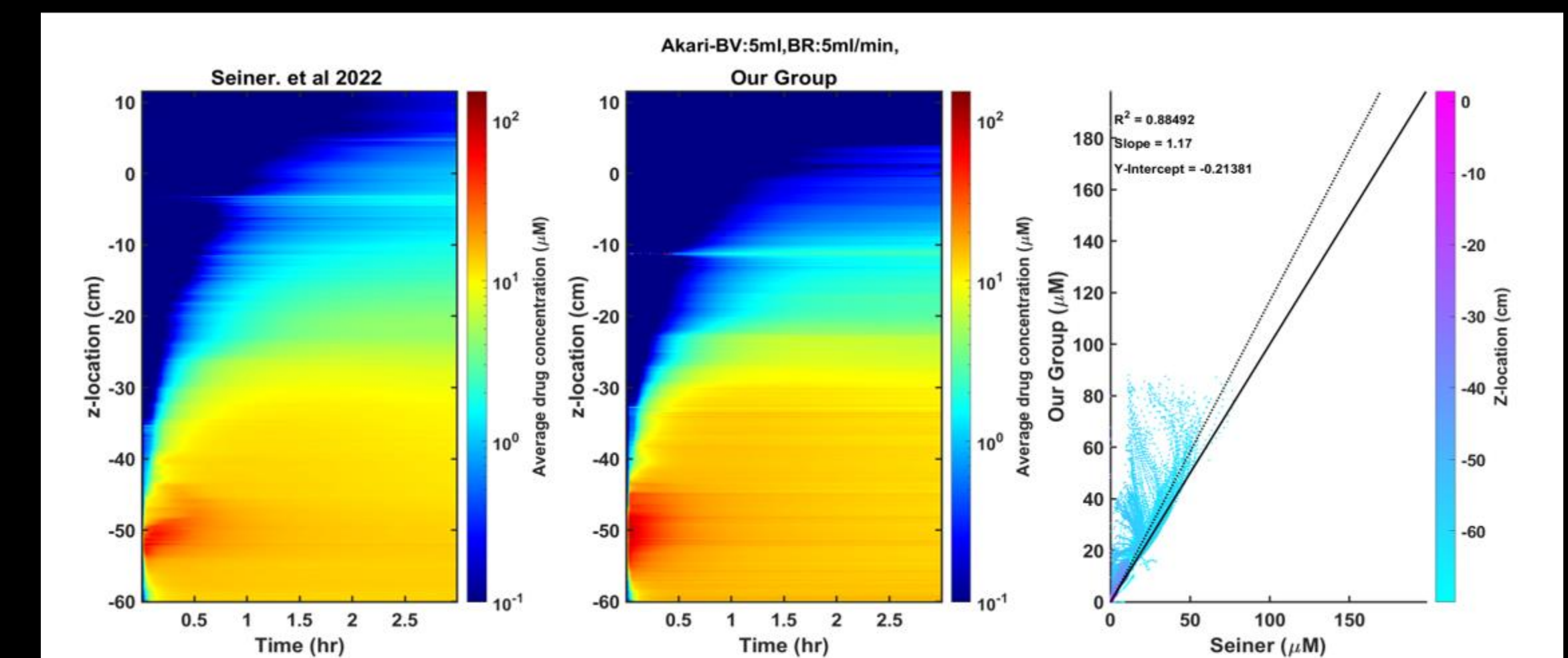


Fig 6: Comparison of rigid model to previously published data

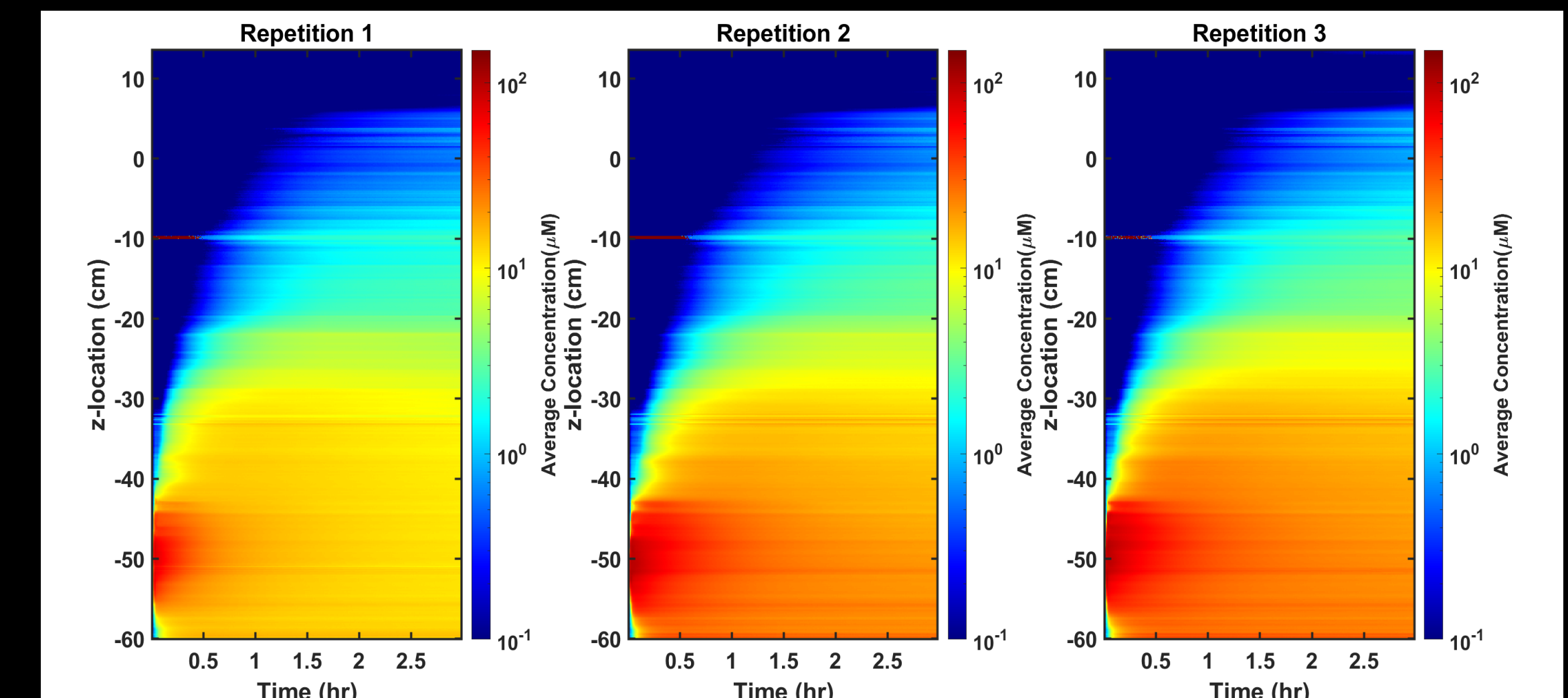


Fig 7: Comparison of 3 experiments conducted on rigid model

FUTURE DIRECTIONS

Conclusion

- Experiment results line up with previous data, validating setup
- 3D printing a transparent spinal model with a flexible material is possible

Future Directions

- Complete additional experiments on flexible model
- Flange reprint
- Print the brain with flexible material to have full model to compare to rigid



2023 Capstone Project

