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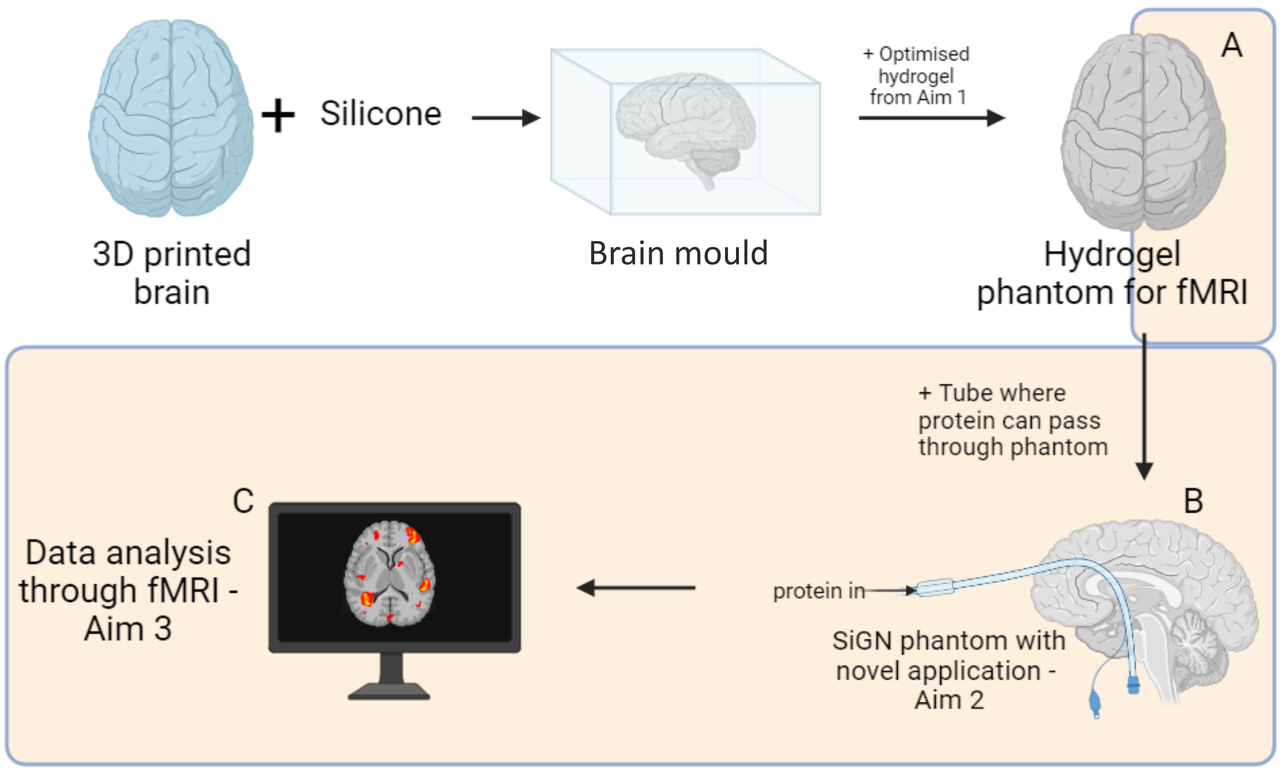
Synthetic Anatomy for Radiological Applications (SARA) - Generating a Functional MRI Phantom

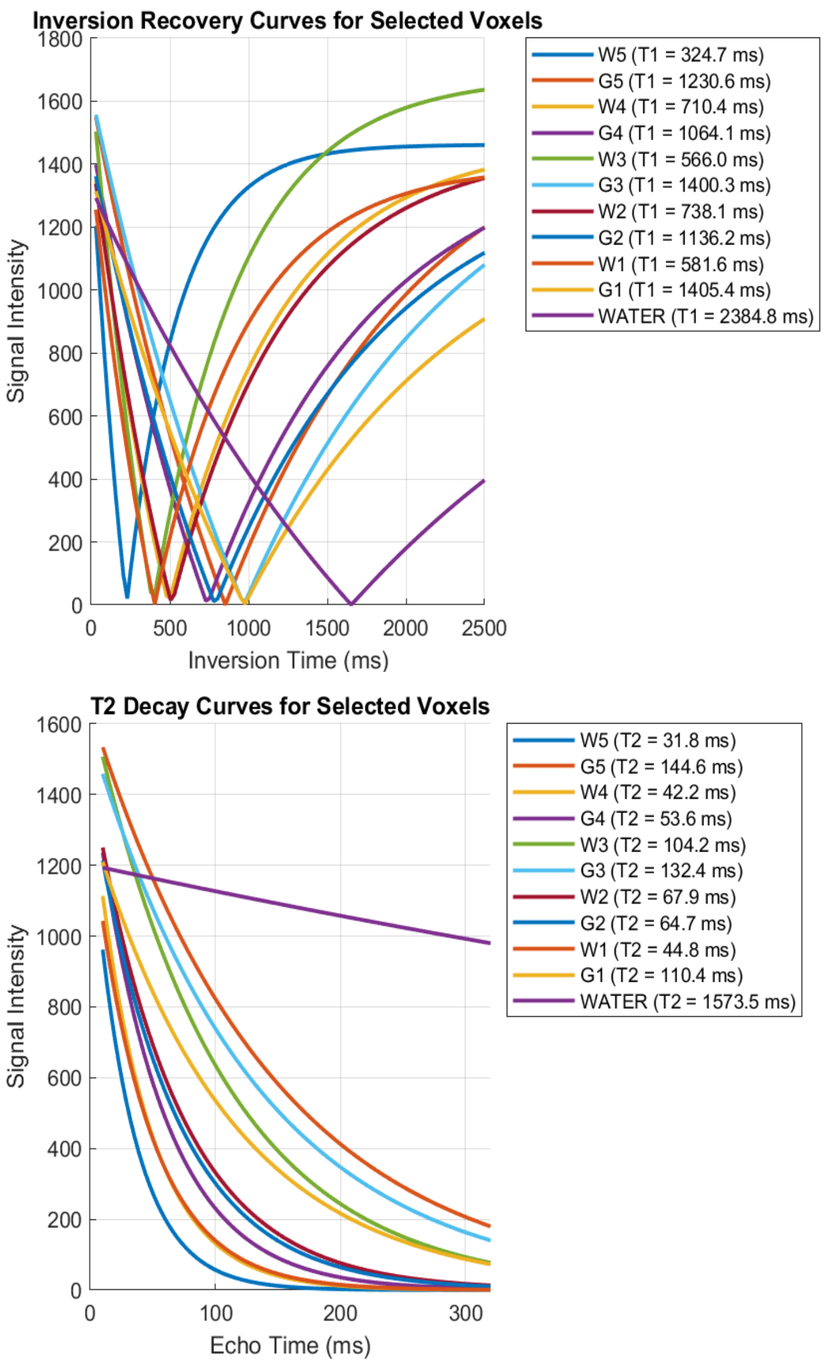
Project brief

Functional MRI (fMRI) is a powerful, non-invasive tool for exploring brain activity and understanding conditions such as schizophrenia, Alzheimer's disease, and epilepsy. By using fast imaging sequences like echo-planar imaging (EPI), fMRI detects changes in blood oxygenation linked to neural activity. Despite its wide applications—from cognitive research to clinical diagnostics—fMRI faces technical challenges that limit its routine clinical use. Reliable data processing and robust quality assurance (QA) protocols are essential for ensuring consistent and valid results. Physical phantoms play a key role in QA by helping calibrate MRI scanners and optimise pulse sequences, supporting the development and validation of fMRI techniques. We aim to produce an anthropomorphic brain phantom that can be used as ground truth data in fMRI studies and develop a tool that may ultimately facilitate early and more dependable diagnosis

Methodology

We are developing a life-sized brain phantom to simulate human brain tissue for fMRI QA. Agar-based mixtures were optimised to replicate the T1 and T2 values of grey and white matter. A mould based on human brain anatomy is now being designed and 3D printed to reflect the spatial distribution of these tissues. The phantom will be scanned using fMRI, and paramagnetic agents will be injected to mimic BOLD signal changes seen during brain activation.





Results & Conclusions

From the results obtained, we optimised the composition of grey and white matter bio-gel to be used for the anthropomorphic brain phantom. We are currently in the process of printing the 3D brain phantom which will be used as the mould. We will inject biomolecules through the phantom to generate fMRI signals. Neuroimaging tools will be employed to identify the best performing molecules. Ultimately, we will produce a signal-generating brain phantom to be used for QA.

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