Research & Innovation

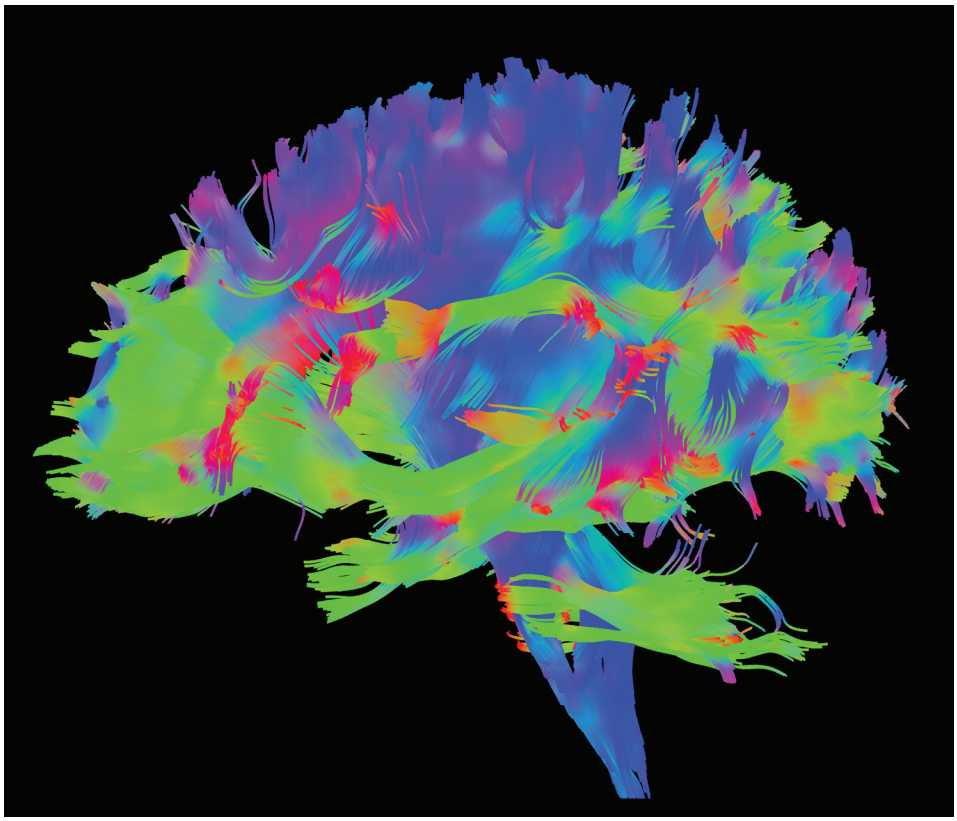
By Feroze Mohamed, PhD, and Chengyuan Wu, MD

The Jefferson Magnetic Resonance Imaging Center (JIMRIC) grew out of a close partnership between the Department of Radiology and the Vickie and Jack Farber Institute for Neuroscience. While our goal is to integrate all aspects of MR imaging so clinicians and researchers across the Jefferson enterprise can have an accessible diagnostic resource, right now there is a pressing clinical need in the area of neurosurgery.

Images are essential to the work we do. Because of how tightly connected brain structures are, we really need to know exactly where we're going before we operate on a patient.

Our primary focus is in functional MRI of white matter networks, which are the connective wiring between brain regions and throughout the central nervous system (CNS). White matter tractography is the process we use to generate functional maps of the CNS, and is computationally intensive, requiring us to precisely calculate billions of variables distributed not only over space but also through time in the case of functional MRI.

The raw data produced by the scanner has to undergo "post-processing" to sort through the collected signals and correlate them into mathematical models, which can be used to create clear, clinically useful images. Previously, we relied on cloud-computing services offered by third-party vendors, but this proved expensive and inefficient. The turnaround time for image-processing could take days and was too slow for us to use in the operating room.



Our solution was to custom-build a desktop supercomputer ourselves, and in a few months we had a functioning machine capable of producing highly detailed images in a matter of hours.

This has enabled us to minimize procedures like stereoelectroencephalography (stereo EEG), where electrodes are implanted into an epilepsy patient's brain to measure electrical activity and determine the locus of seizures. Rather than take off the back of the skull, increasing the risk of infection, surgeons can now implant the sensors through millimeter-sized holes.

We can then turn around and use these data for new epilepsy treatments like asleep deep brain stimulation. Armed with stereo EEG results and an individualized MR map of a patient's brain structure and function, neurosurgeons can plot a course to the area of interest without harming unrelated networks and vital anatomy.

These are only a few of the things we are capable of with the new technology, and we are always working to refine the techniques and models that make these images so clinically rich and help us to really understand the vast networks between our ears and throughout our bodies.

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Feroze Mohamed, PhD, is a professor of radiology and JIMRIC's founding director. He is an internationally recognized authority on magnetic resonance imaging. Mohamed has published widely on applications of functional brain mapping, particularly as it pertains to pediatric spinal cord injury. His research receives funding from the National Institutes of Health and other granting institutions, and he holds several patents, including one on the application of MRI to lie detection.
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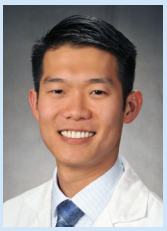

Chengyuan Wu, MD, MSBmE, is an assistant professor of neurosurgery in the Vickie and Jack Farber Institute for Neuroscience and JIMRIC's clinical director. He is a product of Jefferson's neurosurgery residency program and functional neurosurgery fellowship. In addition to his medical training, Wu also received a master's degree in biomedical engineering from Tufts University.
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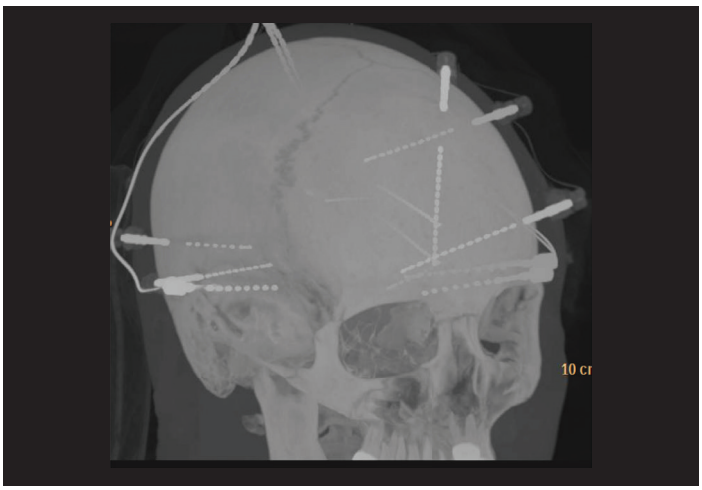
Wu and Mohamed at the supercomputer



X-ray images of stereo EEG probes

Neurosurgeons use imaging to plan their interventions.

The end result: Wu operates on an epilepsy patient.