Imaging

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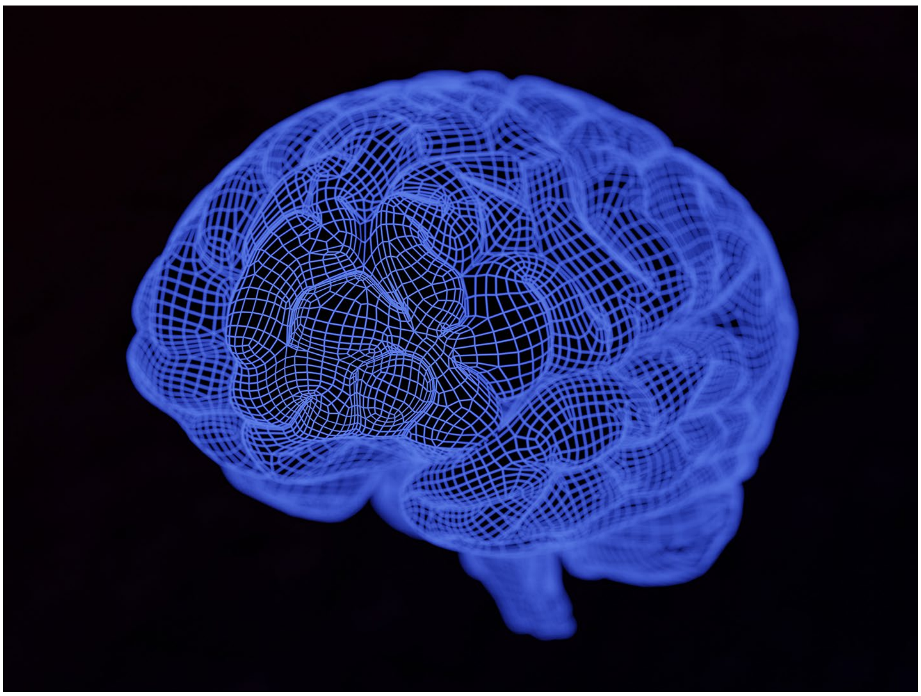
Magnetic particle imaging scanning at the bedside



Rebleeding or restenosis can occur after stroke treatment, which is currently clinically monitored by imaging methods such as computed tomography (CT) and magnetic resonance imaging (MRI). However, although CT provides high-resolution images, it involves radiation exposure and is not ideal for repeated or long-term monitoring. Similarly, MRI has limited patient accessibility and lengthy scan durations. Moreover, both CT and MRI are constrained by their large, fixed systems that are not suitable for placement in intensive care units (ICUs), requiring transportation that poses risks to patients. Magnetic particle imaging (MPI) is a promising tracer-based imaging modality that offers radiation-free, real-time tomographic images with high temporal resolution. Now, writing in *Communications Engineering*, Florian Thieben et al. have developed a human-sized MPI system tailored for brain applications that can be used in environments lacking electromagnetic shielding – that is, directly at the patient's bedside in ICUs.

The team designed the MPI scanner to accommodate human proportions and focused on ensuring instrumental safety. They used 2D excitation from orthogonal drive-field coils and a slow shift of the dynamic selection field to achieve 3D imaging at 4 Hz. The system includes an adaptable graphical user interface and an open-source reconstruction framework to facilitate live inspection of results and safety mechanisms. Several of the encountered challenges required innovative solutions: "We minimized power consumption and heat dissipation by using pulsed sequences and improved image reconstruction schemes to reduce system power while maintaining sensitivity and spatial resolution," explains Thieben. Coil decoupling was achieved by designing smart electronic circuitry to ensure high-quality imaging signals. "Moreover, operation in an unshielded environment – for example, at the bedside in ICUs – requires optimal cable configuration and sophisticated background estimation and subtraction techniques," adds Thieben.

The MPI scanner can detect iron doses as low as 8 μg and achieve a spatial resolution of 12 mm in x-, 7 mm in y- and 31 mm in z-direction at high temporal resolution (4 Hz). The system can also differentiate five levels of stenosis in perfusion experiments and discriminate between two different tracers within the same field of view in multi-contrast images. "The key strength of MPI is real-time perfusion imaging, which provides immediate insight into physiological processes," says Thieben. This feature, coupled with multi-contrast imaging, the affordability of its hardware and the simplicity of a single power plug, could substantially reduce issues related to cost and accessibility, such as eliminating patient transport risks and expediting treatment decisions.

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In the future, tracer approval for MPI is required. In parallel, the researchers now plan to use advanced noise detection and filtering approaches to pave the way for clinical translation of MPI.

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