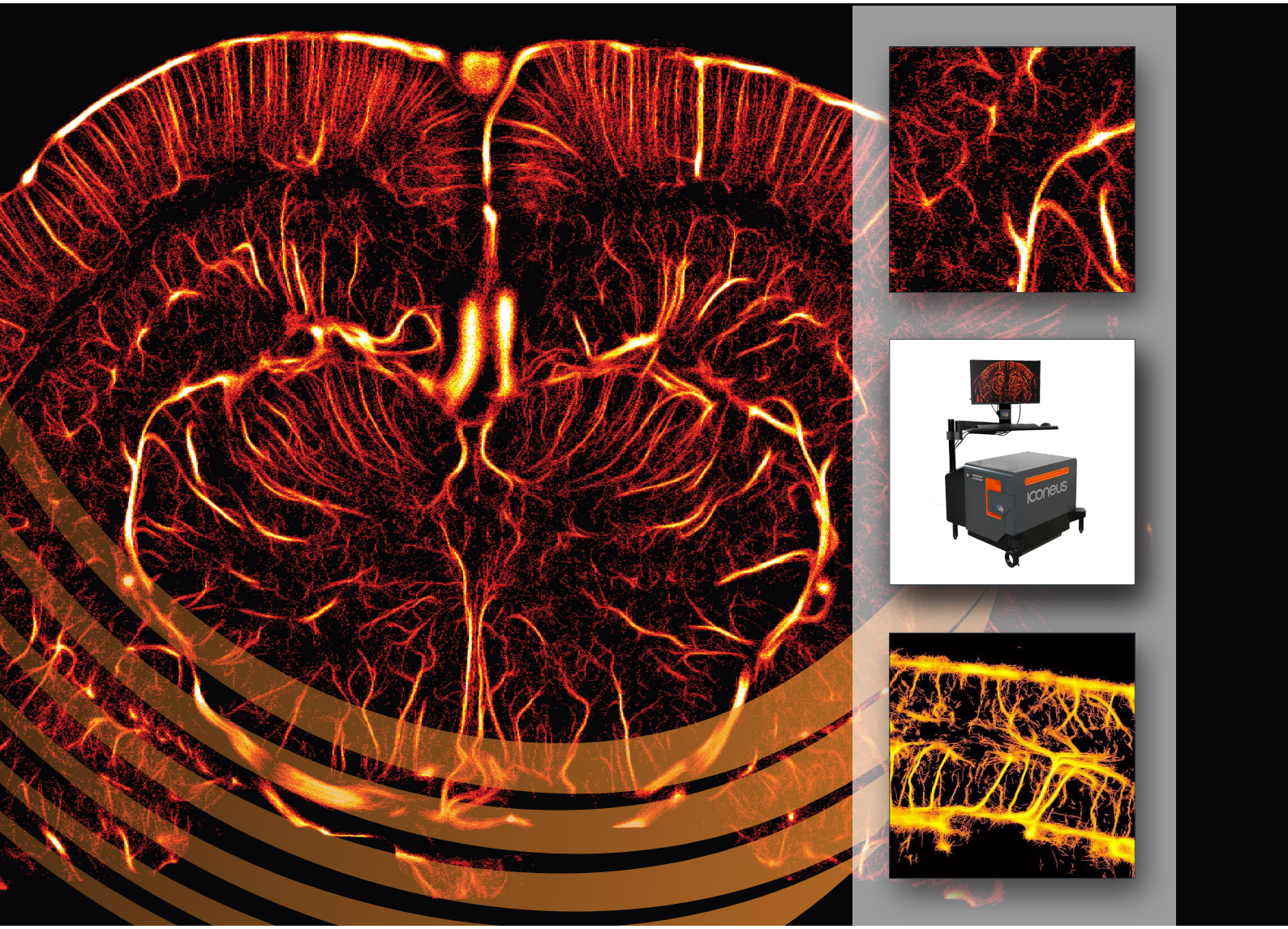
Iconeus

REVEALING THE BRAIN

Ultrasound Localization Microscopy

Option for Iconeus One allowing super-resolution ultrasound imaging



Visualize blood vessels with breaktaking resolution

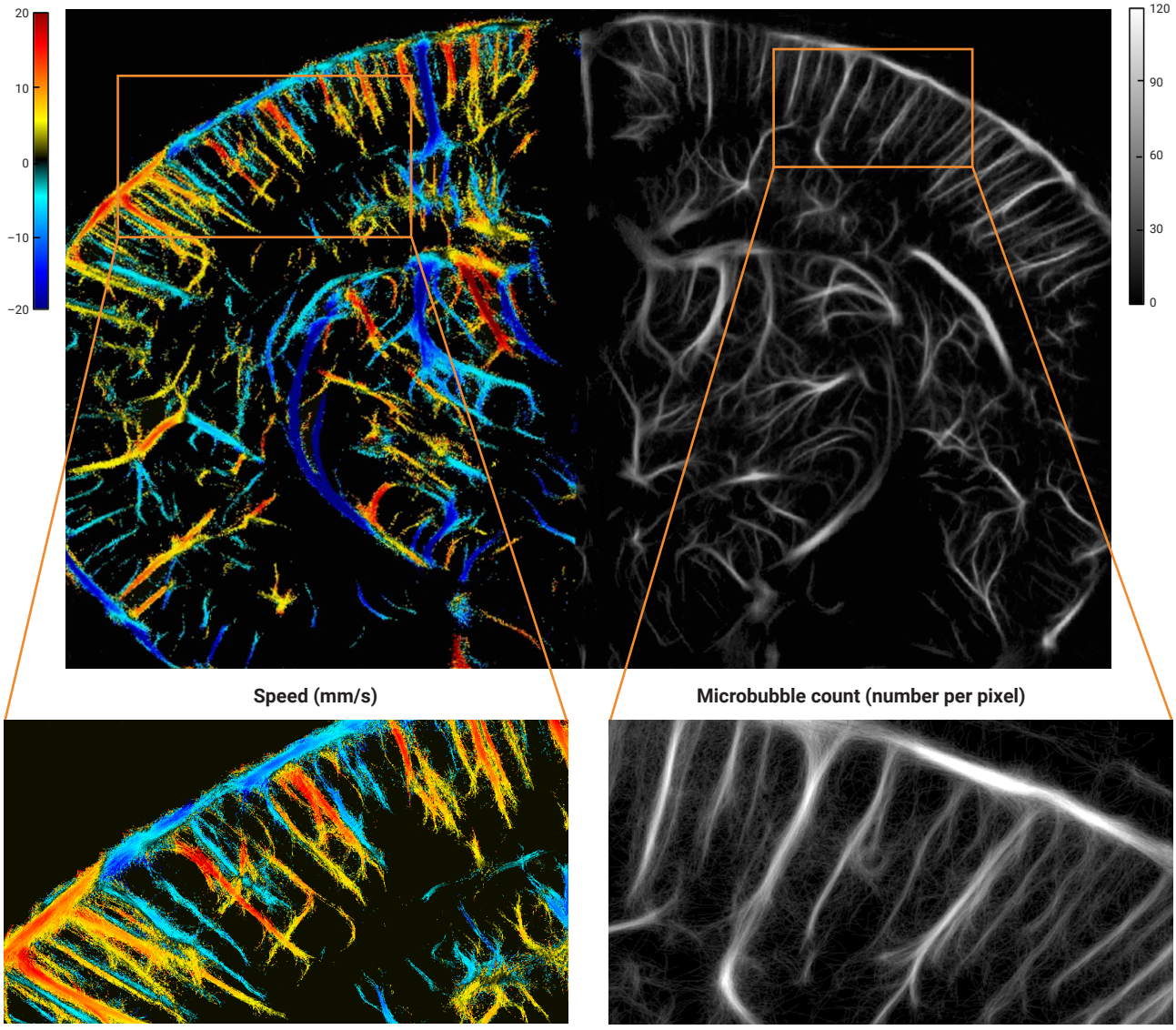
Ultrasound Localization Microscopy (ULM) is a powerful option for Iconeus One that uses functional ultrasound (fUS) to image blood vessels in the brain with amazing detail.

Using a method first described by our founders,[1] ULM enables you to generate high-resolution images of the brain microvasculature in mice, rats and other animals, by using microbubbles as a contrast agent.

Main cover image: High-resolution vascular map of the rat brain obtained with ULM.

Using ULM, you can:

- Attain an in-plane resolution of about 5 µm
- Quantify blood velocities in the mm/s range
- Track individual microbubbles as they travel through the blood vessels.

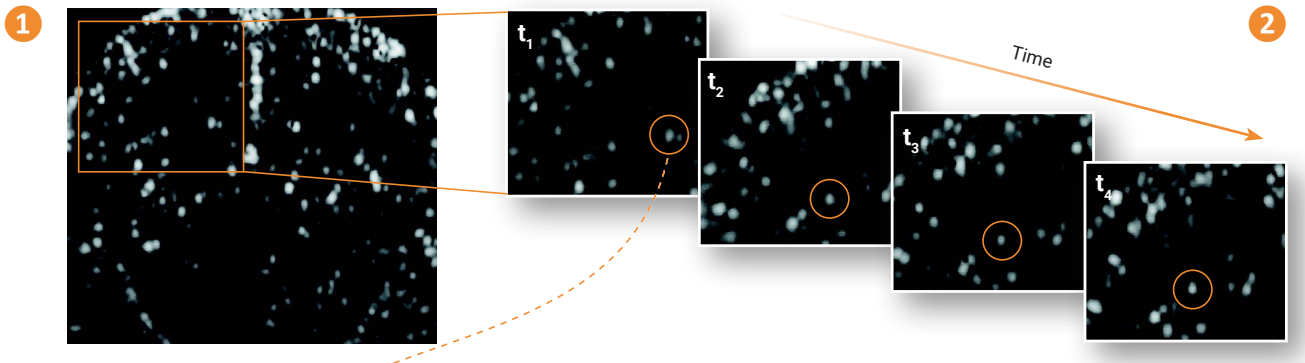


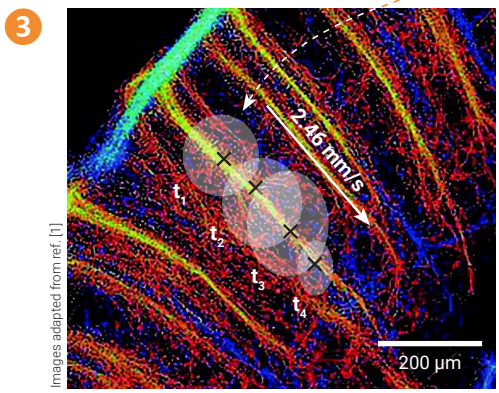
ULM maps showing blood velocity (left) and microbubble count (right) of the mouse brain vasculature at a resolution of 6.5 µm. Cortex flow directionality allows discrimination between arterioles and venules.

Impressive insights, amazing potential

How ULM works

ULM uses fUS to detect the strong reflections from injected gas microbubbles within blood vessels. As well as enhancing resolution, it promises to overcome the limitations imposed by thicker skulls (such as in humans). As shown in the example below, you can also track individual microbubbles.





Images adapted from ref. [1]

Process of creating an ULM image:

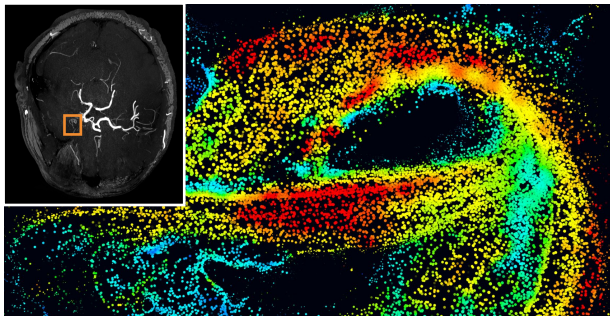
1. *Individual microbubble sources are detected in a 'B-mode' image formed by averaging hundreds of beamformed images.*
2. *Representative frames for each time point (t_1–t_4) are separated, and filtered to remove the slowly-changing signal from the tissue, and highlight individual microbubbles (circles).*
3. *Echoes of bubble events are deconvolved to obtain the exact position of the centroid (white crosses). Superposing thousands of responses per second leads to a highly-resolved time-averaged localization map, at depths far below the ultrasound resolution limit.*

From 2D to 3D...

ULM has amazing capabilities – and we're constantly improving them. In 2022 we released work showing its extension to three dimensions,[2] and have also been granted an exclusive patent (EP2652517) to use ULM for brain applications.

....and from preclinical to clinical

The temporal resolution of ULM is ~60 s, but we're currently working to reduce this to <1 s as part of our 'functional ULM' project.[3] This would allow us to map brain activity and connectivity in real-time, and holds promise for diagnosing and monitoring treatment in humans, too.



Transcranial tracking of microbubbles in the brain of a patient diagnosed with an aneurysm, showing vortex-like blood flows.[4] Scan the QR code to see the video.

Interested in ULM?

To find out how ULM could help your research, please email us at contact@iconeus.com – we look forward to hearing from you!

[1] *Nature*, 2015, DOI: 10.1038/nature16066.
[2] *eBiomedicine*, 2022, DOI: 10.1016/j.ebiom.2022.103995.
[3] *Nature Methods*, 2022, DOI: 10.1038/s41592-022-01549-5.
[4] *Nature Biomedical Engineering*, 2021, DOI: 10.1038/s41551-021-00697-x.

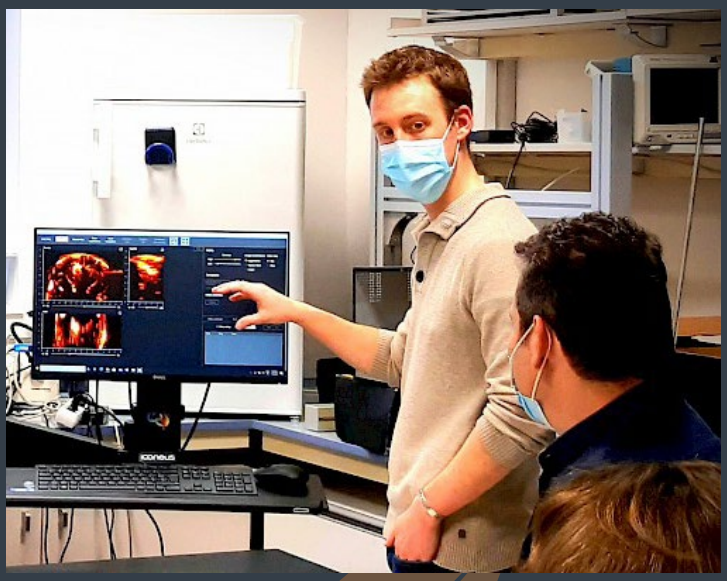
About Iconeus

Welcome to the future of brain imaging

We're Iconeus – a Paris-based company helping researchers to gain new insights into neuroscience using our groundbreaking functional ultrasound technology.

Our team of over 30 neuroscientists, software engineers and ultrasound physicists is dedicated to ensuring functional ultrasound achieves its full potential, by helping you integrate it into your research.

We look forward to hearing from you!



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